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NAVY DEPARTMENT

Report on Test

of

FR-1727

Model XTBT Transmitting Equipment

Contractor: RCA Manufacturing Company, Camden, New Jersey.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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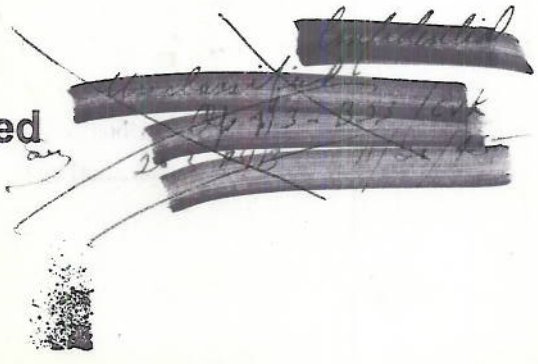

TABLE OF CONTENTS

Subject	Page
Authorization	1
Object of Tests	1
Abstract of Tests	1
Conclusions	2 a
Recommendations	2 b
Material Under Test	3
Method of Test	3
Data Recorded	5
Probable errors in results	5
Conclusions	70
Results of tests	5

APPENDICES

	Table	
Check of Composition Resistors		1
Check of Wire Wound Fixed Resistors		2
Check of Wire Wound Variable & Miscellaneous Resistors		3
List of Fuses and Circuit Breakers		4
Vacuum Tube potentials and currents		5
List of Controls and Meters		6
List of Nameplates		7
Dimensions and Weights		8
Summary of Specification Frequency Stability Tests		9
Accuracy of Calibration		10
Accuracy of re-set to previously calibrated frequencies		11
Locked key operation for 2-hours, 135 MC (MO 7.5 MC)		12
Locked key operation for 2-hours, 180 MC (MO 5 MC)		13
Locked key operation for 2-hours, 180 MC (MO 10 MC)		14
Variation of Ambient Temperature, 135 MC (MO 7.5 MC)		15
Variation of Ambient Temperature, 180 MC (MO 5 MC)		16
Variation of Ambient Temperature, 180 MC (MO 10 MC)		17
Variation of Humidity, 135 MC (MO 7.5 MC)		18
Variation of Humidity, 180 MC (MO 5 MC)		19
Variation of Humidity, 180 MC (MO 10 MC)		20
Variation of Supply Line Voltage, plus & minus 5%		21
Variation of Supply Line Voltage, plus & minus 10%		22
Change of Vacuum Tubes		23
Vibration test, 135 MC (MO 7.5 MC)		24
Vibration test, 180 MC (MO 5 MC)		25
Vibration test, 180 MC (MO 10 MC)		26
Range of M.O. calibration capacitor		27
Operation of M.O. temperature controlled cabinet		28
Inclination Test, 135 MC (MO 7.5 MC)		29
Inclination Test, 180 MC (MO 5MC)		30
Inclination Test, 180 MC (MO 10 MC)		31

Shock Test	Table	32
Lost Motion, Back-Lash and Torque-Lash		33
Detuning of Circuits		34
Effect of Master Oscillator Dial Lock		35
Effect of operation of Tune-Operate Control		36
Frequency Stability, Intermittent Operation		37
Determination of Power Output		38
Operation Frequencies & Multiplication Factors		39
Heating period of Master Oscillator Compartment		40
Operation of Automatic Gain Control		41
Modulation Characteristics - Per cent Distortion		42
Modulation Characteristics - Frequency Response		43
Amplitude Modulation present in Carrier		44
Time required to Shift Frequency		45
Effect of Tune-Operate control on potentials		46
KC per division for M.O. dial		47
Overlap of Master Oscillator circuits		48
Overlap of First Amplifier Circuits		49
Overlap of complete transmitter		50
Ripple present in power supply		51
Loads on 12-Volt Rectifier unit		52
Effect of Amb. Temperature on Rectifier Unit		53
Effect of Humidity on Rectifier Unit		54
Voltage regulation of MG set and Control Circuit Rectifier		55
Terminal designations, Remote Telephone Unit		56
Power required from Supply Line		57
Load on Bulkhead Transformer		58
Load on Motor Generator		59
Antenna open circuited and short circuited		60

Power Output versus Frequency	Plate	1
Ambient Temperature Variations, 135 KC		2
Ambient Temperature Variations, 180 KC (MO 5 KC)		3
Ambient Temperature Variations, 180 KC (MO 10 KC)		4
Variations of Humidity, 135 KC		5
Variations of Humidity, 180 KC (MO 5 KC)		6
Variations of Humidity, 180 KC (MO 10 KC)		7
Efficiency v.s Frequency, Antenna System		8
Control Rectifier Regulation		9
Attenuation curve for Remote Telephone Unit Volume Control		10
Transmitter, front oblique view		11
Transmitter, front view, compartments open		12
Transmitter, views of right side		13
Transmitter, views of left side		14
Transmitter, rear view, shield removed		15
Master Oscillator Unit, front view		16
Master Oscillator Unit, Rear View		17
Master Oscillator Unit, view of right side		18

aster Oscillator Unit, view of left side . . . . . Plate 19
Master Oscillator Unit, top view 20
Master Oscillator Unit, bottom view 21
Motor Generator 22
Motor Starter 23
Control Rectifier and Bulkhead Transformer. 24
Antenna unit on Test Stand. 25
R.F. Power Measuring Equipment (Test equipment only). . . . 26
Remote Telephone Unit, front views, panels closed 27
Remote Telephone Unit, panel open 28
Remote Telephone Unit, panel removed. 29
Local Chest Microphone 30
Extension Hand Set 31
Extension Chest Microphone 32

AUTHORIZATION OF TEST

1. The tests herein reported were originally authorized by reference (a). Other pertinent data are listed as references (b) to (m).

Reference: (a) BuShips Ltr. C-NP14/N8 (1-31-DR6) of 2 Feb. 1940 (Prob. T6-11C).
(b) Contract NOs-66805, 31 May 1939
(c) BuEng. Specs. RE 13A 557D
(d) Contractor's Des. Specs. AS-5474-G
(e) BuEng Specs. RE 13A 554B
(f) BuEng. Specs RE 13A 592B
(g) Prelim. Instr. Book, IB-38093, Ser. #1
(h) BuEng Ltr. to INM Phila C-NOs-66805 (10-2-R6) 1 Nov. 1939.
(i) BuShips Ltr. to NRL BB55/6/S67 (10-11-DR-6) of Nov. 8, 1940
(j) BuEng Ltr. C-NOs-66805(9-8-R6) of 6 Nov. 1939
(k) BuEng Ltr. C-NOs-66805(11-27-DR6) of 22 Dec. 1939.
(l) S&A Ltr. NOs-66805(SPH) 12 July 1939 to RCA
(m) BuEng Ltr. C-NOs-66805(5-3-DR6) of 5 June 1940.

OBJECT OF TESTS

2. The object of the tests was:

(a) To determine the extent to which the equipment complies with the contractural requirements and basic specifications, and modifications thereto.

(b) To obtain sufficient data to permit the submission of recommendations regarding desirable changes to increase the suitability of the equipment and for use in revision of basic specifications required in the purchase of additional equipment.

ABSTRACT OF TESTS

3. The tests herein reported were conducted to determine the degree of compliance of the Model TBT Transmitting Equipment (Preliminary Model) with the mechanical and electrical requirements set forth in the governing contract and specifications.

4. Specifically, tests were conducted to determine the following:

(a) Ability of equipment to withstand shipment and movement from one location to another.

(b) Check of mechanical and physical construction and assembly, general workmanship, materials employed, corrosion resisting measures used and the adequacy of electrical circuits to withstand operation under Naval service conditions.

(c) Power output, power input, overall efficiency and flexibility of tuning and coupling circuits.

(d) Quality of emitted signals, lilt and undesirable modulation.

(e) Check of dimensions and weights of the various component units.

(f) Determination of frequency overlap, limiting frequencies and cycles per division of master oscillator controls.

(g) Check of protective circuits employed in the equipment.

(h) Frequency stability and accuracy under the following conditions:

(1) Accuracy of re-set
(2) Lost motion and back-lash
(3) Operation of Tune-Operate Control
(4) Detuning of circuits
(5) Change of vacuum tubes
(6) Variation of Supply line voltage
(7) Variation of ambient temperature
(8) Variation of humidity
(9) Locked key operation for two hours
(10) Keyed operation
(11) Inclination
(12) Vibration
(13) Shock
(14) Effect of dial locks

(i) Check of control circuit rectifier.

(j) The range of the master oscillator calibration capacitor was determined.

(k) The operation of the 4-wire and 6-wire control circuits was investigated.

(l) The power equipment supplied was tested to determine voltage regulation, voltage ripple and general performance under various conditions of operation.

(m) Modulation characteristics, frequency characteristics and noise level of audio circuits was determined.

(n) An investigation was made as to the suitability and operation of the antenna and transmission line facilities provided.

(o) The construction and operation of the remote telephone units was investigated.

Conclusions

(a) Detailed tests and measurements show that the power output delivered by the Model XTBT equipment under various conditions of operation complies with the requirements of the governing contract and specifications.

(b) The frequency stability and accuracy of the transmitter under the various specified conditions, including re-set, 2-hour locked key operation, temperature variations, humidity variations, line voltage variations, tube changes and vibration, falls within the limits of 0.012% (without vibration) and 0.017% (with vibration) as required by the governing specifications. Additional tests, not definitely specified, were conducted to determine the influence or effect of inclination, shock, back lash in controls detuning of circuits, dial locks, tune-operate control and intermittently keyed operation. The equipment withstood these tests in a manner comparable with the results obtained with other Naval transmitting equipment of good design operating in the lower frequency ranges. In connection with the calibration and re-set accuracy of the transmitter, further consideration is indicated in order that the facilities furnished may best meet the requirements of the Naval Service in a manner to be designated by the Bureau of Ships.

(c) In general, the antenna and transmission line system as submitted functioned successfully and satisfactorily when subjected to a wide variety of test conditions. However, it must be realized that test procedure under laboratory conditions cannot duplicate Naval shipboard operating conditions in all respects and hence the final estimate of the suitability of the Model TBT equipment to fulfill service needs afloat is contingent upon Fleet trials and experience. Additionally, tests and inspection revealed that the antenna and transmission line system requires certain mechanical modifications to improve its suitability and reliability.

(d) While the quality of workmanship and materials employed in the design and construction of the Model XTBT equipment is good, a number of modifications and changes are required to further improve safety, maintenance and servicing features. Certain modifications were accomplished by representatives of the Contractor during the course of the tests conducted at the Naval Research Laboratory, but other modifications which can best be made at the factory must still be accomplished.

Recommendations

It is recommended:

(1) That all defects existing in the protective and safety features of the equipment, as listed in paragraph 28 be corrected, (Par. 28); that a more satisfactory P.A. Blower be provided. (Par. 29).

(2) That adequate grounding facilities be provided on the Transmitter Unit. (Par. 31).

(3) That the master start relay in the transmitter be protected against accidental closure. (Par. 34).

(4) That the necessary precautions be taken to prevent leakage of wax from condensers. (Par. 35).

(5) That the necessary action be taken to eliminate defects in the coil forms of master oscillator, crystal calibrator and first amplifier circuits. (Par. 36).

(6) That all wiring defects be eliminated by proper procedure and that attempts be made to improve terminal board arrangement and accessibility. (Par. 38 and 88)

(7) That indicator lights of satisfactory characteristics be furnished. (Par. 39).

(8) That the contact difficulties experienced in connection with various switches be eliminated. (Par. 40, 106(a) and (112).

(9) That the absence of voltmeters be approved, provided the generator characteristics are improved in a manner to make the monitoring of voltages unnecessary. (Par. 42)

(10) That the cable entrance holes and clamping arrangement in the various units be provided in a manner which will permit entrance and securing of the cables designated by the Bureau of Ships. (Par. 47(1), 47(2), 47(4) and 144).

(11) That the lever type Gamewell switches be made corrosion proof and that a satisfactory assembly be provided (Par. 56).

(12) That the necessary corrective action be taken to improve certain vacuum tube sockets in the equipment. (Par. 62)

(13) That a greater degree of re-set accuracy be provided for Control "C". (Par. 67)

(14) That the required number of calibration cards be provided with production equipments. (Par. 70).

(15) That excessive back-lash be removed from the tuning controls of the transmitter. (Par. 73(b)).

(16) That circuit symbol markings be affixed to the various units of the Model TBT equipment. (Par. 79).

(17) That care be taken to insure that a satiafactory finish is applied to nameplates and plates designating control functions (Par. 80).

(18) That the Bureau indicate specifically the type and color of exterior and interior finishes desired and that dark metallic finish be applied to knurled head screws. (Par. 84, 85 and 86)

(19) That meters be secured by means of tapped holes in the panel to facilitate removal. (Par. 89)

(20) That errors in instruction books be corrected and the instructions be expanded to include all necessary data. (Par. 90 and 109)

(21) That the instructions contain a warning statement relative to the effects to be expected when the antenna or transmission line is short circuited or open circuited (Par. 93)

(22) That the necessary circuit modifications be made to eliminate vacuum tube overloads. (Par. 94)

(23) That consideration be given to supplying more suitable gasket material for the master oscillator compartment. (Par. 95)

(24) That resistors of the latest approved type be furnished with the equipment. (Par. 98 and 208)

(25) That the P.A. Blower motor be connected into the circuit in accordance with specification requirements.(Par. 100)

(26) That the calibration facilities provided be in accordance with the requirements as designated by the Bureau of Ships. (Par. 106).

(27) That further consideration be given to determine whether a modification of the heater arrangement in the M.O. compartment can be accomplished to improve control at zero Deg. C. (Par. 108)

(28) That instruction books emphasize procedure to be followed when changing tubes in Master Oscillator compartment. (Par. 111).

(29) That the necessary provisions be incorporated to prevent Master Oscillator Compartment from striking transmitter frame during vibration (Par. 112)

(30) That required inspection be instituted to insure satisfactory tube construction (Type 829). (Par. 115)

(31) That sufficient overlap be provided between all r anges of master oscillator circuit. (Par. 121)

(32) That the hunting of the motor generator be eliminated. (Par.125)

(33) That the changes in carrier control circuits as outlined in paragraph 131 be given consideration. (Par. 131)

(34) That the inclusion of the P.A.Grid Switch be approved; that trip switches S-114 and S-115 have their functions transferred to Control "D". (Par. 135)

(35) That the Bureau give consideration to approving the transmission line termination provided. (Par. 136)

(36) That the means for bolting the transmitter unit to a foundation be improved. (Par. 137)

(37) That the Bureau determine the mounting means which will be most suitable for shipboard installation and that the Model TBT equipment comply with such requirements. (Par. 139)

(38) That the adequacy of internal shielding be considered suitable unless definite evidence to the contrary is obtained. (Par. 141 and 126)

(39) That consideration be given to improving the "zero" setting of the modulation indicator. (Par. 145 (7).

(40) That defects in transmission line and fittings be eliminated. (Par. 146(a) and 146(b).

(41) That the design of the antenna unit be modified to overcome existing defects. (Par. 150).

(42) That consideration be given to circuit arrangement which will entirely disconnect remote functions when the "Local-Remote" transfer switch is in the "Local" position. (Par. 155)

(43) That a more satisfactory way of mounting the 4-wire maintaining contact start-stop switch be provided in the transmitter unit and that the necessary maintaining contact start stop switches be furnished for remote telephone units. (Par. 166)

(44) That the voltage regulation of the control circuit rectifier unit be considered satisfactory. (Par. 185)

(45) That the Bureau consider the advisability of approving the use of a carrier relay which draws 190 M.A. (Par. 188)

(46) That the Bureau determine whether the indicating lamps supplied, which draw 50 MA, are suitable replacements for CS-5 type lamps which draw 100 MA. (Par. 198(2)).

(47) That the necessary precautions be taken to insure satisfactory operation of the 12-volt relays in the remote telephone units. (Par. 204).

(48) That the "Carrier-On" indicator lamps in the remote telephone units be equipped with centering tubes. (Par. 205).

(49) That the terminal boards in remote telephone units be mounted in a manner to conform with the governing specifications and that these terminal boards be properly identified.(Par. 206)

(50) That the operation of the "Start-Stop" indicator lamp in the remote telephone unit be improved and that series resistors of suitable characteristics be provided. (Par. 208)

(51) That the construction, operation and appearance of various component parts used in connection with the remote telephone units be given consideration with a view of effecting necessary improvements. (Par. 209, 210, 211, 212 and 213).

(52) That the mounting means for securing the panel of the remote telephone unit and the unit as a whole be improved to provide increased strength and reliability. (Par. 215)

(53) That the bulkhead mounted transformer be designed to carry the required load and that consideration be given to equipping the transformer with a terminal panel. (Par. 219(b).

(54) That the necessary action be taken to insure that the slip ring and motor generator circuits are operated at safe, potential, current and power levels. (Par. 220(b) and 108).

(55) That the Bureau indicate whether the motor generator shall be equipped with coupling guards (Par. 224).

(56) That the constructional features of the motor generator assembly be improved to overcome existing defects. (Par. 225, 226, 230 and 233 (a)).

(57) That the Model XTBT transmitting equipment be considered satisfactory for use in the Naval Service after the various items discussed above have been corrected or complied with in a manner acceptable to the Bureau of Ships.

MATERIAL UNDER TEST

5. The material under test consisted of one Model XTBT Radio Transmitting Equipment (preliminary model) which included the following major parts:

1	Radio Transmitter Frequency range: 60 - 200 MC
1	Motor Generator Assembly Electric Specialty Co., 220/440 volts, 3 phase, 60 cycles.
1	Motor Starter Ward Leonard Electric Co., 1.5 HP; 440 V; 3 phase; 60 cycles.
1	Antenna Unit, Remotely Adjustable.
1	12 Volt Rectifier Unit
1	Transformer, Bulkhead Mounting Type MC; 0.25 KVA; 60 cycle Primary 220/440 volts Secondary 110 volts American Transformer Co.
4	Remote Telephone Units
10	20 Ft. lengths 7/8" concentric transmission line, hard drawn copper.
1	20 Ft. length 7/8" concentric transmission line, soft annealed copper.
20	Solder type transmission line couplings
1	Set Nitrogen Gas Filling Equipment

METHOD OF TEST

6. The equipment, when received, was carefully examined to determine whether any damage had been incurred during the process of shipment and handling.

7. The ability of the Model XTBT transmitter to meet the specified power output requirements necessitated the measurement of radio frequency power under the following conditions:

(a) Power output at Transmitter antenna or transmission line terminal, using a matched lamp load.

(b) Power supplied to a matched lamp load at the end of 200 feet of 7/8" concentric transmission line.

(c) Power delivered to the antenna system through 200 feet of 7/8" concentric transmission line.

The power outputs obtained under (a) and (b) above were determined by means of a 50 watt, 64 volt mazda lamp from which the base had been removed to minimize capacity losses, and a photronic cell and microammeter. Over the range of 60 to 160 MC the lamp load was matched to the transmission line by means of a small variable air capacitor. At frequencies above 160 MC a half wave concentric matching section was employed. Evaluation of the power delivered to the antenna system was made by means of the standing wave ratio method. Holes, 1/4" in diameter, were bored in the section of transmission line adjacent to the transmitter at three inch intervals. These holes extended over a section of line somewhat in excess of a half wave length at 60 MC. A vacuum tube voltmeter fitted with a probe which could be inserted in the drilled holes and so designed that it had a minimum influence upon the transmission line was used to determine the relative amplitude of the voltages existing along the probe section of transmission line. The term "standing wave ratio" as here used is defined as the ratio of the minimum voltage to the maximum voltage existing in adjacent quarter waves along the probe section of line. Theoretical considerations show that the standing wave ratio may be used as an index to the losses in a transmission line caused by the standing waves. Losses in a transmission line are due to the attenuation of the line and the additional losses caused by standing waves which are the result of an imperfect match. The power input into the transmission line was determined and the power output into a matched load was also determined. The measurements made under these conditions were then employed to determine the overall efficiency of the system when operating into the antenna system provided with the equipment.

8. Frequency changes and drifts were checked by means of a Model LK frequency indicator at the second harmonic of the master oscillator circuit.

9. The complete transmitting equipment including one remote telephone unit and accessories, was placed within the Laboratory test chamber and subjected to variations in ambient temperature between the limits of zero and plus fifty degrees Centigrade and variations in relative humidity at 40 degrees Centigrade, between the limits of approximately 30% and 95%. The emitted frequency and power output were kept under constant observation during these tests and additional data relative to transmitter currents and potentials, M.O. cabinet temperatures and line voltage conditions were also recorded.

10. Frequency range, overlap and end tolerances were determined by means of an LM frequency meter.

11. Measurements of ripple voltage present in the output of the generators were made by means of high impedance output voltmeters while the ripple present in the microphone supply was measured by means of an RCA type 69-B distortion and noise meter.

12. The ability of the equipment to withstand vibration and the roll and pitch of a vessel was determined by mounting the entire equipment on the laboratory test stand which is capable of producing the necessary conditions of test.

13. Shock tests were conducted by subjecting the equipment to blows from a 20-pound weight suspended in the manner outlined by the governing specifications.

14. The degree of amplitude modulation present in the carrier was determined through the medium of a suitable rectifier and a type RCA 69-B distortion meter.

15. The audio frequency characteristics of the equipment were determined by means of a cathode ray oscillograph and the RCA type 69-B distortion and noise meter.

16. The antenna supplied was subjected to operational tests under various weather conditions and additionally was subjected to low temperatures in the test chamber. The antenna system was subjected to shock designed to simulate the conditions which will be encountered afloat.

17. Transmission tests were conducted in conjunction with a number of suitable receivers at distances ranging from a few feet to fifteen miles.

DATA RECORDED

18. Complete data were recorded during all tests conducted, and this information is appended hereto as tables 1 to 60 and Plates 1 to 32, inclusive.

PROBABLE ERRORS IN RESULTS

19. Precautions were taken to minimize errors in the results obtained during the tests; where necessary or desirable, duplicate tests were conducted to insure accuracy.

20. Meters of the precision type, of verified accuracy, were employed under conditions to insure greatest accuracy.

21. Power output tests were conducted in a manner calculated to minimize the effects of time and temperature.

RESULTS OF TESTS

22. In the following paragraphs of this report, reference is made to the governing specifications RE 13A 557D and reference specifications RE 13A 554A, RE 13A 555A and RE 13A 592B. Additional reference is made to the governing contract, NOs-66805 and the "Notes" contained therein.

23. The Model XTBT equipment was received at the Naval Research Laboratory on November 27, 1940. Transportation was accomplished by Contractor's truck and the equipment was only partially crated or boxed due to this form of transportation. Inspection revealed no damage upon receipt and the equipment was placed into operation.

Specifications RE 13A 557D

24. Introductory (paragraphs 1-1 to 1-8 inclusive). The general construction and design of the Model XTBT equipment conforms with the Introductory section of the specifications. Such defects in operation or design as would prevent the equipment from functioning in a satisfactory or reliable manner under Naval service conditions are pointed out under appropriate paragraphs in the following sections of this report. The equipment covers the required range of 60 to 200 megacycles continuously and is arranged for amplitude modulation by either voice or 1000 cycle telegraphically keyed tone. The manufacturer supplied the necessary interconnecting cables and lines of special nature and the fabricated antenna systems. The gross weight of the combined transmitting and receiving equipment falls well within the specified limit of 2100 pounds.

25. General (Par. 2-1). This paragraph of the governing specifications refers to reference specifications RE 13A 554A and indicates certain exceptions thereto. Reference, therefore, is made to RE 13A 554A.

Specification RE 13A 554A

26. Par. 1-1 to 1-3, inclusive. The general terms of these paragraphs were taken into consideration during the design and construction of the Model XTBT equipment.

27. Par. 2-1. The equipment was operated under full power conditions in ambient temperatures ranging from zero to plus 50 degrees Centigrade. The equipment was also subjected to humidites ranging from 30% to 95% at ambient temperatures of 40 degrees C. During these tests the equipment functioned satisfactorily, except for a few minor details which will be discussed later in this report.

28. Par. 2-2. The design of the electrical circuits and controls are, in general, liberal and such parts which are likely to be subjected to overloads have been afforded protection by means of fuses and overload relays. However, certain items exist which require further consideration, as outlined below. The construction of the controls in the preliminary model of the transmitter contain certain undesirable features which require correction. The controls falling into this group are as follows:

Oscillator Range Switch "A"
Oscillator Reset Adjustment
P.A. Grid Current Switch "L"
P.A. Tank Trip Switches
Oscillator Plate Tuning "C".

A discussion of the defects in connection with the above controls will be found in paragraphs 40(b), 67, 94 and 135 of this report.

(a) The fuses provided in the Model XTBT equipment are listed in Table 4. Some of the low voltage fuses provided were of the renewable type while others were of the non-renewable type. In production equipment care should be exercised to insure that all low voltage fuses provided are of the renewable type. The fuses located in the output circuits of the generator are Littelfuses of the non-refillable type, rated at 1000 volts. These fuses have been acceptable for use in Naval Transmitting equipment in the past. A condition of operation is presented in connection with the high voltage fuse in the 275 volt output circuit of the generator which is decidedly unsatisfactory. If this fuse should become disrupted during operation of the transmitter the power amplifier tube is subjected to a rush of plate current of sufficient magnitude to constitute a serious overload. This overload is protected against by the P. A. plate overload relay if the current is sufficient to trip the relay although conditions have been noted wherein the relay failed to open immediately although the setting of the relay was correct. In order to provide additional protection under these conditions it is recommended that the circuit revisions suggested in paragraph 131 below be given consideration.

(b) The bulkhead mounted transformer (T-110) is not provided with fuse protection, other than that which may be provided on the ship's switchboard. In order to afford definite protection for this transformer it is recommended that two fuses be supplied, one in each leg of the primary input circuit.

(c) A condition exists which may prove to be troublesome in connection with the pilot circuit fuse and the heater type circuit breakers in the motor starter. If this fuse or either of the circuit breakers open while the equipment is in operation the motor is shut down. However, if the transmitter is not shut down by means of the start-stop switch, renewal of the pilot circuit fuse or closure of the heater type circuit breakers will start the entire transmitting equipment. If side shields were removed from the transmitter this condition might constitute a hazard. However, no simple means of overcoming this defect is apparent unless changes are made in the motor starter. However, it is deemed advisable to call attention to this condition in order that the Bureau may take it under advisement if deemed necessary.

(d) The motor starter is equipped with a magnetic door latch. In view of the fact that this type of protection has been abandoned on transmitting equipment of recent design it is recommended that the XTBT starters be equipped with heavy disconnect switches in the main line capable of opening the circuit under full load and also capable of being operated external to the starter cabinet.

This switch should be of such design that the starter door cannot be opened while the switch is closed and additionally should prevent the switch from being closed while the door is open.

(e) One overload relay is provided in the Transmitter which is located in the cathode circuit of the Power Amplifier. The coil of this relay, K-105, is shunted by a 100 ohm resistor, R-106. When the P.A. plate current is adjusted for maximum normal operating current, 212 MA, the current flowing through the relay coil is 118 M.A. The relay was adjusted so that it would operate when subjected to a 25% overload, or 148 M.A. in the coil circuit. Under this condition the relay operated satisfactorily in the presence of vibration and shock. The overload relay is re-set by means of a small bakelite tab projecting through the relay access door. This tab is engraved with the work "Lift" to indicate the procedure to be followed in re-setting the relay. The movement of this tab is so slight that it does not afford a visual indication that the relay has been tripped. Hence, until an operator is thoroughly familiar with the equipment and has had occasion to learn from experience, time may be lost in placing the equipment back into operation after the relay has been tripped. It is recommended, that if possible, some indicating means be provided to inform the operator that the overload relay has functioned.

(f) Tests were made to determine the efficacy of the heater type circuit breakers, H-211, in the Motor Starter. One line fuse was removed and the start button was depressed applying single phase voltage to the motor. The rotor remained locked and drew approximately 13 amperes. During the first test the relay failed to function after thirty seconds and the test was stopped. Another attempt was made but after one minute of locked rotor condition this attempt was discontinued. In order to protect the motor the circuit breaker was disconnected from the 440 volt circuit and a current of 13 amperes from a test transformer was inserted in the circuit. The circuit breaker functioned in 11 seconds. Subsequent trials caused the breaker to function in 11 to 18 seconds. The circuit was then restored for 440 volt operation and the breaker was again tested on locked rotor. The circuit breaker functioned satisfactory on each trial in periods of 11 to 18 seconds. While this circuit breaker now functions satisfactorily assurances should be obtained that production models are thoroughly tested to insure the desired operation.

(g) M.O. Compartment thermal protection. The master oscillator temperature controlled compartment is not provided with thermal protection. During one period of the tests the wire connecting to the thermoregulator broke causing heat to be applied continuously to the compartment. This excessive heating ruined the indicating thermometer. It is therefore recommended that the

M.O. compartment be equipped with a thermal protective device of the automatic re-set type which will operate at temperatures above 75 degress C.

29. Par. 2-3. Ventilation of the transmitter unit is provided by means of a perforated rear shield. The removable portions of the side shields, which constitute approximately one half of the side area, are equipped with ventilating louvres. Additionally, a perforated area of approximately 2" x 9" is provided in the main access door on the front panel. The top shield is not perforated. The bottom shield of the transmitter is solid. None of the shelves within the transmitter extend completely across, hence natural ventilation within the unit is provided. Additionally, a motor driven blower is provided for forced ventilation of the power amplifier tube. This blower projects a stream of air through an opening in the interior perforated shield surrounding the power amplifier circuits. During the course of the tests this blower tended to become noisy at intervals and required frequent lubrication to overcome this difficulty. The motor is fitted with oil cups for lubrication; however, access to these cups is not convenient. It is recommended that a more suitable blower be provided for production equipment, so designed that lubrication will be required only at infrequent intervals and that steps be taken to provide greater accessibility for lubrication. During the course of the numerous tests conducted under locked key conditions and at ambient temperatures as high as 50 degrees C., no signs of undue heating which could be attributed to lack of ventilation were observed.

30. The following electrolytic capacitors are used in the equipment:

C-182, 1000 Mfds capacity, rated at 25 volts, between the cathode of the P.A. tube and ground. The voltage across this condenser is 12.5 volts.

C-144 and C-145, 1000 mfds capacity, rated at 25 volts in the filter circuit of the 12 volt rectifier unit.

C-201, 75 Mfds capacity, rated at 25 volts, in the microphone circuit of the Remote Telephone unit; 12 volt circuit.

C-177, 75 Mfds. capacity, rated at 25 volts, in microphone circuit of modulator unit, 12 volt circuit.

31. Par. 2-5. All units of the Model XTBT transmitting equipment are electrically shielded on all sides and the mounting means are such that the shields are grounded upon installation. In this connection, however, it is pointed out that the Transmitter unit is mounted on two transverse flexible shock mounts which employ rubber. A single ground strip of Belden braid is used to ground the equipment at one corner of the forward shock mount. It is recommended that flexible grounding straps be provided at all four corners in order to insure a greater degree of reliability.

32. Par. 2-6. The design and control of the circuits of the XTBT transmitter are considered to be as simple and straightforward as possible under the requirements of the governing specifications. Certain modifications of the controls are recommended, as discussed elsewhere in this report.

33. Par. 2-7. The design and construction of the equipment is such that the spirit of this paragraph is complied with, however, certain modifications and improvements are indicated and will be discussed under appropriate paragraphs of this report.

34. Par. 2-8. The two access doors on the transmitter unit are equipped with door interlock switches which cause the motor generator to be shut down when the doors are opened. The contacts of these interlock switches are in series with the coil of the master start relay, K-106. This relay is located on the terminal panel immediately behind the lower access door and is so positioned that if an operator attempts to remove one of the adjacent resistor units his hand may accidentally close the contacts of this relay. This accidental closure starts the motor generator and the high voltage appears on the terminal panel. It is recommended that attempts be made to relocate the master start relay to avoid this difficulty.

35. Par. 2-9. The transformers used in the Model XTBT equipment are of the metal encased, compound filled type. During the tests conducted ambient temperatures ranged from zero degrees to plus 50 degrees C. No signs of compound leakage were noted during the tests even though the transformers are so positioned that the compound could flow from the container. A further discussion of these transformers will be found in paragraph 219(b) of this report. During the course of temperature tests it was found that wax dripped from the 2nd IPA plate meter by-pass condenser, C-139. This wax dropped on relay K-103, keying control relay, and lodged in such a manner as to make the relay inoperative. The proper steps should be taken to prevent a repetition of this occurence.

36. Par. 2-10. In general, the insulation used throughout the radio frequency circuits is ceramic material or mycalex. The ceramic coil form for the master oscillator coil was found to be cracked, although no apparent trouble developed from this defect. Care should be taken, however, to insure that this condition is corrected. The coil form for the crystal calibrating circuit appears to be of "Styrol" construction and fails to present a workmanlike appearance and appears to be too frail for use in the Naval service. Corrective action in this connection is recommended. The first IPA Tank Coil, L-108, is of the wire wound, self-supporting type. This coil is in danger of distortion each time that the first amplifier tube is removed or replaced in its socket. Such deformation causes the calibration of the circuit to change and there is danger that short circuited turns may develop. It is recommended that this coil be strengthened by means of a suitable coil form.

37. Par. 2-11. In accordance with the requirements of this paragraph the preliminary model is not required to comply with the provisions regarding marking of parts. Very few of the items in the XTBT equipment bore type number or other identification marks.

38. Par. 2-12. In general, the wiring of the XTBT equipment is neat and the workmanship is good. However, certain items require corrective action as indicated below. Standard copper wire of appropriate size, covered with 2 layers of varnished cambric and an outer cover of woven cotton, color coded, is employed. Connections, except relay connections, are soldered and clamped to lugs, affording ample electrical and mechanical strength. The following suggestions are submitted with a view of correcting certain deficiencies and avoiding future difficulties.

(a) Cabled leads to the modulator unit should be lengthened and anchored near the back edge of this unit. This will eliminate friction between this cable and part of the front panel when the modulator is opened.

(b) Connections to relay K-103 in the modulator unit require more clearance.

(c) Connections to grid caps on tubes in the modulator should be covered for about one inch at the clip end with suitable material to eliminate possibility of breakage. This is especially true of the 807 modulator tubes.

(d) Cable to lower left hand door should be relocated or improved where it crosses edge of "A" terminal board.

(e) The cable running up the edge of "A" terminal board should be supplied with suitable buffers under anchor straps. Relocation of this cable would add to the general neatness.

(f) The sheaths of the shielded type cables should be grounded by means of pigtails formed on end of the shielding instead of the soldering methods now used.

(g) Leads to relay K-106 should be cabled. Connection to second contact from left of this relay should be relocated to eliminate possibility of grounding to antenna control support. Leads to relay K-104 should also be cabled.

(h) Leads to two top terminals on filament transformer should be properly insulated to eliminate possibility of grounding to case.

(i) Cable on top right side of H.O. unit should be relocated to eliminate friction with flexible H.O. ground strap.

(j) Third amplifier filament leads at tube socket should be properly anchored.

(k) Adequate clearance should be provided between ground ferrule of R-116 and cable adjacent thereto.

(l) Cable to output indicator diode should be anchored.

(m) Cable to top section of terminal board on rear of M.O. unit should be anchored to a point on terminal board support strap.

(n) Cable to M.O. unit should be covered with suitable tubing and properly protected from abrasion.

(o) Lead to bottom terminal of R-104 on rear of M.O. unit should be lengthened.

(p) Leads to M.O. blower motor should be properly anchored. String now used as tie-down to be eliminated.

(q) Grommets should be supplied wherever cables or leads pass through shields, frames, etc. Suitable tubing should be supplied at all points where cables or leads pass under, across or over edges of frames, shields, etc.

(r) Terminal board "G" should be relocated to improve accessibility.

(s) Cable in modulator unit should be more securely anchored.

(t) Cable to meters should be anchored at appropriate points.

(u) Wherever feasible tubing should be slipped over relay and key switch connections for about one inch and include therein the relay soldering terminals.

(v) Cables running up front standards should be properly anchored.

(w) The leads connecting to the contacts of the M.O. compartment thermoregulator broke during vibration. An improved wiring job should be used in this location.

(x) The interconnecting cables which the Bureau has indicated are to be used for wiring up the various units of the Model TBT equipment are of such overall size that the lugs furnished on the terminal panels are incapable of securely gripping the insulation. Thus, the entire strain is placed on the soldered joint. It is recommended that the lugs furnished for external connections be of such design that the insulation may be gripped securely. Lugs similar to those which have been provided in connection with certain Model TBK transmitters are satisfactory for this purpose. Samples of these lugs are available at the Naval Research Laboratory.

(y) Connections to the main terminal board are made by means of stud type connections. The number of cables which are concentrated in this restricted space cause some difficulty in making the required connections. It is recommended that careful consideration be given to a possible rearrangement of parts with a view of improving conditions in this location.

39. Par. 2-15. Pilot or indicator lamps are furnished on the front panel of the transmitter unit as indicated in Table 6. These four indicators employ 6 watt, 115 volt lamps. The lamp is pear shaped having an overall length of 1-7/8" by 7/8" maximum diameter, fitted with screw type candelabra base. The socket portion of the indicators extends two inches deep behind the panel of the transmitter and the bezel and lens projects approximately 1/2" from the front panel. The lenses are of glass and color coding is obtained by inserting a colored glass disk behind the lens. The bezel is a push fit and during vibration two of the bezels were dislodged. It will be necessary to provide some suitable mechanism to prevent dislodgment of the bezel and lenses under the influence of vibration. The bezels are finished in nickle or chromium plate, polished. It is to be noted that recent requirements in this connection specify a dull black finish. Additional pilot lamps are furnished in the remote telephone units and in the external loud speaker units. These lamps are described in connection with those units.

40. Par. 2-16. The number of pressure or friction contacts have been kept to a minimum commensurate with the requirements of the equipment. However, certain contacts exist in the equipment which require improvement.

(a) The 3rd Amplifier Tank, L-110; the P.A. Grid Tank, L-111 and the P.A. Plate Tank, L-112, are tuned by means of double sliding contacts, driven by a lead screw. The action of these mechanisms is sufficiently erratic to cause difficulty in obtaining proper tuning adjustments. It is recommended that efforts be made to improve the action of these controls.

(b) Oscillator Range Switch "A". This is an eight point switch by means of which the proper range of frequency is selected for operation of the master oscillator frequency establishing circuit. The detent mechanism of this switch is not positive and varying degrees of contact are obtained which in turn cause considerable frequency shifts and in some instances the contact has been poor enough to prevent oscillations entirely. It will be necessary to institute necessary corrective action to overcome these difficulties.

(c) 1st Amplifier Tuning Switch, "D". This switch is of similar construction to that employed in the Oscillator Range Switch. While no serious difficulties were encountered in connection with this switch, it is deemed advisable to incorporate the same improvements in this switch which are devised for the Oscillator Range Switch.

41. Par. 2-17. The electrical indicating instruments included in the transmitter are listed in Table 6. The meters are of 2.5 inch size, flush mounting type and are provided with anti-glare glass. Meters of appropriate ranges of a minimum number of types have been provided. All

meters, except two, carry Navy Type numbers and hence it is assumed that the meters meet the specification requirements of special treatment to prevent injury from moisture. No meters failed during the course of the tests which included exposure to high humidity.

42. Par. 2-18. No voltmeters are provided in the Model XTBT equipment. The omission of such instruments is satisfactory provided the motor generators furnished have more stable characteristics than the generator furnished with the preliminary model. A complete discussion of this feature will be found under that section of this report devoted to motor generators.

43. Par. 2-19. The design of the transmitter unit is such that the replacement of vacuum tubes, ferrule type resistors, indicating lamps and the adjustment of relays may be accomplished from the front panel or through the access doors provided in the front panel.

44. Par. 2-20. All transformers provided with the equipment withstood continuous operation during the test period at various ambient temperatures ranging up to 50 degrees C., without showing signs of overheating. The transformers furnished are of the encased, compound filled type.

45. Par. 2-21. As stated in paragraph 40 above, pressure type contacts have been held to the minimum requirements.

46. Par. 2-22. Satisfactory soldered joints have been supplied in the Model TBT equipment. No paint or lacquer has been used to cover soldered joints. The omission of lacquer is in accordance with directions contained in paragraph 2-1 of Specifications RE 13A 557D.

47. Par. 2-23. This paragraph has been deleted and is superceded by paragraph 2-1 (2-23) on page 4 of Specifications RE 13A 557D.

(1) The entrance leads to the transmitter enter the unit from the rear and cable clamps have been provided for securing the cables. Entrance is provided for ten separate cables of various sizes. It is pointed out, however, that since the cable requirements have been modified by the Bureau, the entrance holes and cable clamping arrangement as provided on the preliminary model is not suitable for the new type of cables. For example, the type IHFA-19 cable is too large in diameter to fit in any of the entrance holes provided. The proper size and number of entrance holes and cable clamps will have to be provided.

(2) The remote telephone units as provided are drilled and tapped for cable entrance, but these tapped holes are not of suitable size to accommodate the revised cable layout.

This item is discussed in detail under the heading of "Remote Telephone Units" later in this report.

(3) Provision for incoming leads to the motor starter is provided in the form of a 1/4" thick, 3" x 6" steel plate riveted to the top of the cabinet in accordance with paragraph E-17 of Specifications 17C10(a).

(4) The motor and generator are equipped with terminal boxes. The generator terminal box is of sufficient thickness to permit tapping the entrance holes by means of which the external cables are introduced. The wall of the motor terminal box is drilled, but not threaded, since the wall thickness precludes this operation. The motor box is not provided with a terminal block. The terminal leads enter the motor housing through the aperture existing between the housing and the motor core. The leads are carried around and are lashed to the winding for approximately one half revolution before entering the winding. As recommended in paragraph 226 below, it is believed that a fixed terminal block would provide an improved method of making connections to the motor leads.

(5) The entrance leads to the control circuit rectifier and bulkhead mounted transformer units are accomodated by knockouts suitably located.

48. Par. 2-24. Numerous units of standard design are used in the equipment, but due to the special nature of the equipment specially designed parts have been provided to meet the requirements of the governing specifications.

49. Par. 2-25. The following tubes are used in the Model XTBT transmitter unit:

2	-	6D6
2	-	76
6	-	807
1	-	84
2	-	6A6
2	-	829
1	-	955

50. Par. 2-26. The number of tubes and the number of types of tubes employed is believed the minimum consistent with the requirements of the specifications.

51. Par. 2-27. The design of the equipment is such that satisfactory operation is obtained when tubes are used whose characteristics vary within the limits set forth in the specifications.

52. Par. 2-28. Wood is not used in the construction of the Model XTBT transmitting equipment.

53. Par. 2-29. All electrical indicating instruments, with the exception of the modulation indicator, are provided with by-pass condensers of 0.006 mfds, Model T, Navy Type 48251. Attention is invited to the fact that leakage of wax occurred from by-pass condenser C-139, as pointed out in paragraph 35 above.

54. Par. 2-30. Suitable fuses have been provided to protect the various circuits in the transmitter unit, except as pointed out in paragraph 28(a) above, certain of the fuses operating below 440 volts are of the non-refillable type

55. Par. 3-1. The equipment is well constructed of good materials and good workmanship has been displayed in the majority of cases. Such items of workmanship or material as require further consideration are discussed in detail under appropriate paragraphs of this report.

56. Par. 3-2. Care has been taken in the selection and plating of the materials used to prevent corrosion. No corrosive action was observed during the course of the tests except in connection with the screws which are used for assembly in the Gamewell lever type switches. Blued steel screws used in this connection exhibit signs of rust. It is recommended that screws of non-ferrous material be substituted and in addition that the screws be locked in place by means of a nut and lock washer. This same type of switch is used in the remote telephone units.

57. Par. 3-3. The use of iron and steel has been kept to a minimum in the Model XTBT equipment. In such applications where iron or steel is used provision in the form of plating or painting has been used to prevent corrosion, except the instance noted in paragraph 56 above.

58. Par. 3-4. Liberal use of aluminum or aluminum alloy has been made in the construction of this equipment in the interests of weight reduction.

59. Par. 3-5. The design of the transmitter is such that no damage occurred in handling, movement from one location to another or during shipment. The units, when properly packed can be orientated 180 degrees from the vertical without damage. The equipment was given several tests while in operation on a moving platform inclining 45 degrees from the vertical, both fore and aft and from side to side, without damage.

60. Par. 3-6. The equipment was subjected to shock and vibration tests without damage. However, as will be pointed out later, the master oscillator compartment requires firmer mountings. Lock washers have been used where required except in the instance pointed out in paragraph 56 above. A complete discussion of wiring practices has been given in paragraph 38 above.

61. Par. 3-7. The entire transmitter unit is supported by two shock mountings and the master oscillator compartment is further shock mounted within the transmitter frame. Vacuum tubes are therefore not provided with separate shock mountings.

62. Par. 3-8. All vacuum tube sockets are of the single unit type. Certain of the sockets employed in the Model XTBT are not considered wholly suitable and the following changes are recommended.

(a) The socket used in connection with the 955 tube is an old style Hammerlund socket. A new style socket made by this same manufacturer is now available and is considered superior. It is recommended that the new style socket be used in this equipment.

(b) The two 807 tubes used in the Modulator unit fit rather loosely in their sockets and while no definite trouble was experienced during the test of the equipment it is recommended that provision be made for more securely gripping these tubes. It is believed that the shocks likely to be encountered on certain types of Naval vessels will cause the tubes to leave the present sockets. Some means of securely gripping the tube base would be acceptable.

(c) The sockets provided for the type 829 tubes are of a special hinged construction. The hinged plates to which the sockets are secured do not assume a vertical position when they are clamped in place for operation. The necessary changes should be made to permit these plates to be positioned vertically. Additionally, the anode clips which are secured to the tuning frames of the 3rd amplifier and P.A. plate, are so rigid that considerable force is required to seat home the tube anode terminals. Slight deviations in the position of the tube anode terminals causes additional strains of varying degrees and it is feared that under Naval service conditions tube breakage may result from this condition. The necessary corrective action should be taken.

63. Par. 3-9. All controls necessary for the operation of the transmitter are located on the front panel and the number has been held to the minimum deemed consistent with the operation required by the governing specifications.

64. Par. 3-10. All metal control shafts are suitably grounded for the protection of operating personnel and all control knobs are suitably insulated to prevent shock or burns due to stray radio frequency fields.

65. Par. 3-11. In all cases dial scales rotate in a clockwise direction to increase the numerical readings and the final controlled effect.

66. Par. 3-12. Except for such controls as are actuated by a direct drive, the tuning controls are driven by means of positive gearing.

67. Par. 3-13. As pointed out in paragraph 40 above controls "G", "H", "I", "A" and "D" are inherently erratic to a degree which interferes to some extent with the proper setting of these controls. Additionally, control "C" Oscillator Plate Tuning, which is driven through a train of 1 to 1 gears, cannot be re-set with the degree of accuracy which is required to realize the maximum frequency accuracy of the master oscillator circuit. Tentative instructions issued by the manufacturer indicate that maximum accuracy will be obtained by resetting this control by observation of the 1st amplifier grid current. The general subject of re-set is discussed in detail later in this report. (See paragraph 106) Subject to the decision of the Bureau of Ships, a control of greater re-set accuracy is indicated for control "C".

68. Par. 3-14. Friction type locking devices have been provided on each continuously variable tuning control to prevent accidental movement of the controls. These devices are of such a type that they do not adversely affect the calibration of the circuits. For example, as illustrated in Table 35, the operation of the locking device on the M.O. circuit affects the frequency by a matter of only 0.00005%. The locking devices present no sharp edges which might injure an operator's hands and are so located that they do not interfere with the normal manipulation of the controls.

69. Par. 3-15. Verniers have been provided on all tuning controls where required from the operational standpoint, except in the case of Control "C", Oscillator Plate Tuning, as pointed out in paragraph 67 above.

70. Par. 3-16. A calibration card, 3" x 5 1/2", mounted in a metal frame behind transparent shield is provided on the front panel of the equipment. This chart is located on the front of the lower access door. Provision is made for logging 10 frequencies, 1/4" space being available for each frequency. Additionally, a roller type calibration chart is provided on the front panel for providing calibration data covering the master oscillator circuit. This chart, as submitted, carried a complete calibration of range 1 only. A detailed discussion of calibration facilities is contained in paragraph 106 below. The four extra charts called for under this paragraph were not provided, but space is available for the stowage of such charts.

71. Par. 3-17. Adjacent to each control on the front panel of the transmitter, small nameplates carrying descriptive words or phrases have been attached to denote the particular purpose of each control. Additionally, the controls used for tuning the transmitter have been designated by letters from "A" to "L". A complete list of controls and their markings is contained in Table No. 6 appended hereto.

72. Par. 3-18. All rotatable devices, including control knobs, are secured to their shafts by means of taper pins or by means of two set screws located 120 degrees apart.

73. Par. 3-19. The construction of the vernier controls is such that they are easy running and free from binding.

(a) Back lash in the master oscillator control is less than one vernier division. As illustrated in Table 33 the average backlash is 0.00122%, or 122 cycles in 10,000 kc. Reference to Table 47 shows that the cycles per dial division varies over the frequency range from 140 cycles to approximately 650 cycles. Hence, this control complies with the requirements of the governing specifications.

(b) The backlash existing in remaining vernier controls is listed below:

Control "E" - 1 division backlash out of 90
"F" - 1 division backlash (vernier)
"G" - 15 divisions backlash (vernier)
"H" - 10 divisions backlash (vernier)
"I" - 10 divisions backlash (vernier)
"J" - 9 divisions backlash (vernier)

It will be noted that the specification requirement that "The total of all "play" including backlash and torque lash shall not exceed one vernier division" is violated in the case of controls "G", "H", "I" and "J". All of the above listed controls are equipped with two universal joints to permit angular drive. This undoubtedly contributes to the degree of backlash observed in some of the controls. As pointed out under paragraph 40 above erratic contacts are present in some of these controls. The necessary corrective action should be taken to reduce backlash to a minimum in the controls where play is excessive.

74. Par. 3-20. Where verniers are employed to divide dial divisions, the marking is such as to provide continuity throughout the dial range. As illustrated in Table 6, Controls "C" and "E" are marked on the basis of 90 division instead of the 100 divisions required by the specifications. Control "K" is a direct reading dial marked in megacycles. The 90 division dials have been used in previous Navy equipment and have been considered satisfactory from this standpoint. However, as pointed out in paragraph 67 above, there is a possible need for a vernier control to replace the present "C" control.

75. Par. 3-21 All scales, dials, verniers and band selector switches are so designed that the values of the settings increase numerically with increase of the final controlled effect.

76. Par. 3-22. Panels are so drilled and adjacent equipment so disposed that substitution of replacement meters having maximum dimensions permitted, can be accommodated.

77. Par. 3-23. Design tolerances sufficient to accommodate replacement units such as tubes, instruments, resistors, etc., have been provided.

78. Par. 3-24. Integral parts of the transmitter unit have been so mounted that replacement can be effected without major disassembly compatible with the restrictive limitations of the governing specifications. Certain improvements are desirable, if possible, to accomplish the rearrangement of terminal boards as discussed in paragraph 38 above.

79. Par. 3-25. No circuit symbol markings have been attached adjacent to the various component parts in the transmitter, such as tubes, resistors, capacitors, etc. Such markings should be furnished in all production models.

80. Par. 3-26. Nameplates have been affixed to major units as listed in Table No. 7. Since this is a preliminary model all nameplates do not contain complete information. Additionally, certain of the nameplates used on the transmitter unit are losing their finish, thus making them illegible.

81. Par. 3-27. All indicating instruments and controls are located on the front panel of the equipment, suitably marked for identification and as symmetrically disposed as possible in view of various other limiting factors.

82. Par. 3-28. The subject of ventilation is discussed in paragraph 29 above.

83. Par. 3-29. To determine whether all screws and bolts used in the Model XTBT equipment complied with the requirements of this paragraph would necessitate complete disassembly of the equipment. This was not done. It is assumed that such inspection has been and will be made at the point of manufacture.

84. Par. 3-30. The exterior surfaces of the various units comprising the Model XTBT equipment are finished as follows:

Transmitter Unit	-	Black wrinkle finish
Motor Generator unit	-	Black Japan finish
Motor Starter	-	Black Japan finish
Bulkhead Transformer	-	Black Japan finish
Rectifier Filter Unit	-	Black Wrinkle finish
Remote Telephone Unit	-	Black Wrinkle finish
Antenna Unit	-	Gray Paint finish
Loud Speaker Unit	-	Gray Paint finish

From the foregoing it will be seen that the finishes supplied with the preliminary units do not conform with the latest requirements of the Bureau of Ships. Since the Laboratory is not cognizant of the exact mounting locations of these various units, it is suggested that the Bureau inform the contractor as to the exact finishes required in each instance.

85. Par. 3-31. The interior surfaces of the various units of the Model XTBT equipment are finished as follows:

Transmitter Unit	-	Natural aluminum color
Motor Starter	-	Black Japan finish
Bulkhead Transformer	-	Black Japan finish
Rectifier-Filter Unit	-	Aluminum paint over copper plated steel
Remote Telephone Unit	-	Natural aluminum color.
Loud Speaker Unit	-	Natural aluminum color

As in the case of exterior finishes, it is recommended that the Bureau designate the interior finishes considered most suitable for the purpose.

86. Par. 3-32. In general, all screw heads and knurled metal knobs are finished in black. The knurled head screws by means of which the side shields are secured and the knurled head screws used to secure the modulator unit are painted black, but this paint flakes readily. It is recommended, therefore, that in production models a black metallic finish be substituted.

87. Par. 3-33. The Model XTBT transmitting equipment was subjected to vibration and shock tests as required by this paragraph of the specifications without incurring damage. A complete discussion of the effect of vibration and shock upon the frequency characteristics of the equipment will be found in paragraphs 112 and 115 below.

88. Par. 3-34. As pointed out under paragraph 38 above electrical leads are passed through metallic panels and shields without the use of grommets to protect them. This condition should be rectified.

89. Par. 3-35. All meters in the Model XTBT transmitting unit are secured by means of through screws fitted with a nut and lock washer. It is recommended that all meters be secured by means of tapped holes and that sufficient length of flexible cable be provided to remove meters from the front of the transmitter and thus effect disconnection of terminal studs.

90. Section V - Instruction Books. The Model XTBT Transmitting Equipment was accompanied by a preliminary instruction book of sufficient scope to permit placing the equipment into operation. During the course of the tests and study of the instruction book, the following items were noted:

(a) The connection on the "F" terminal board from terminal 4 to 2 should be shown as a link, to be removed for 4-wire control circuit operation.

(b) Jack J-102 is not wired in accordance with the schematic wiring diagram. The proper connections should be indicated.

(c) Since it is contemplated to change the function of S-106 by having this switch assume the additional functions of S-114 and S-115, diagrams should be corrected accordingly.

(d) The internal connections of the two tunable antennas were different; in the interests of simplicity all antenna connections should be alike.

(e) The schematic diagram shows the P.A. Blower motor connected to the slip ring circuit of the M.G. set, while actually this motor is connected to the start stop circuit of the transmitter.

In general, the final instruction books should contain more complete data on proper maintenance procedure and methods of detecting and eliminating troubles.

91. In the following paragraphs, reference is again made to governing Specifications RE 13A 557D.

Specifications RE 13A 557D

92. Par. 2-2. Three two hour key locked tests of the equipment operating at full power were conducted as illustrated in Tables 12, 13, and 14. Additional key locked tests were conducted wherein the ambient temperature and humidity were varied through the specified limits. No failures of any kind were encountered during the course of these tests. The equipment was keyed at various rates of speed up to 100 words per minute without signs of brush discharge, corona or sparking and no damage was incurred during the course of these tests.

93. Par. 2-3. The antenna circuit was open circuited and short circuited while the equipment was operating at full power output at 150 MC. The results of this test are illustrated in Table No. 60. It will be noted that in the open circuited condition the P.A. plate current rose to 250 MA without causing the overload relay to trip out. If this condition were maintained for any considerable period of time, tube damage would result. This condition cannot be taken care of by the setting of the overload relay, since a plate current of 200 M.A. could cause the P.A. plates to heat seriously if the tube were not operating in an efficient manner. No practicable method of overcoming this deficiency is apparent.

94. Par. 2-4. The vacuum tubes used in the equipment are operated within their published limits, as illustrated in Table No. 5 attached hereto. However, care must be exercised to follow instructions accompanying the equipment to insure that the P.A. tube is not overloaded at frequencies above 150 MC. Paragraph 6.14 of the instructions specifies 212 MA at frequencies 60 to 150 MC and a maximum plate current of 180 MA at 200 MC, with a uniformly tapered current between 150 and 200 MC (0.64 ma per megacycle). As originally received, difficulty was experienced

with the 2nd amplifier circuit. This circuit showed a decided tendency toward plate current creepage, particularly in the region of 180 MC. A representative of the contractor investigated this condition on January 3, 1941 and January 7, 1941. As a result of this investigation the cathode resistor, R-116, was changed from a value of 225 ohms to a value of 400 ohms. This caused a reduction in plate current (per tube) from approximately 82 MA to 67 MA, without a reduction of power output from the transmitter, and eliminated the difficulties in connection with plate current creepage. This modification should be adhered to in production equipments. At this same time another modification was effected in connection with switch S-111, Control "L". As originally received the potentiometer connected across the 275 volt supply, as controlled by switch S-111, consisted of the following resistor units:

R-178	2200 ohms
R-179	2200
R-180	3300
R-181	9000
R-182	9000

Switch S-111 was provided with four positions for selecting various voltages on this potentiometer, which in turn indirectly controlled the drive and grid current of the Power Amplifier Stage. As the tests progressed it was found that the control provided was inadequate for the purpose and a representative of the contractor made the following modification. S-111 was changed to a 5 point switch and the potentiometer was modified as follows:

2200 ohms
2200
3300
2700
6600
6600

When this change had been effected, proper control of the P.A. grids was obtained. This modification should be incorporated in production models and the necessary changes in wiring diagrams and markings should be accomplished. Another factor in connection with tube dissipation which requires consideration is the functioning of the motor generator. When the generator is started from a cold condition, the voltages are sufficiently in excess of normal values to overload the power amplifier stage. During tests this difficulty was minimized by preheating the generator, however, under service conditions this procedure could not be adhered to. Hence the proper steps must be taken to provide a generator which will function satisfactorily in this respect. (A further discussion of the motor generator will be found in paragraph 220 of this report.

95. Par. 2-5. Rubber is used in shock proof mountings in the following locations:

(a) The transmitter unit is mounted on two transverse

members of a commercial design, which employ rubber.

(b) The master oscillator compartment is mounted by means of four "Lord" type mountings. The mounting provided possesses insufficient stability when the equipment is subjected to roll and vibration and it is recommended that improved mountings be provided.

(c) The transmission line outlet arrangement in the transmitter is mounted on three rubber washers.

All of these items are replaceable by identical units, and replacement may be effected with a minimum amount of disassembly. The master oscillator compartment is provided with a rubber gasket to provide an airtight assembly. While this gasket functioned satisfactorily during the course of the tests it is suggested that further consideration be given to this item with a view of providing an improved method. It is possible that the use of a felt gasket may offer advantages.

96. Par. 2-6. As indicated in Table No. 8, the transmitter unit is the largest sized unit of the Model XTBT equipment. The overall dimensions of this unit are 18-1/4" x 30-1/8". This latter dimension includes the transmission line fitting on the transmitter. It will be noted that passage through a hatch 25" x 36" can be effected.

97. Par. 2-7. and 2-8. These paragraphs cover instructions governing instruction books and working drawings.

98. Resistors. The various types of resistors used in the Model XTBT equipment are listed in Tables 1, 2 and 3. It will be noted that many of the resistors do not carry type numbers and in some instances the resistors do not conform with the manufacturer's part list. Certain resistors are used which violate Navy specifications. In general, the resistors supplied withstood the operational tests to which they were subjected, but one resistor failed and various resistors as indicated in Table 2 are of the low temprature type and will be unsuitable for use in the TBT equipment. It is recommended that the matter of suitable resistor units be decided by conference between the resident inspector and the manufacturer, subject to the instructions and approval of the Bureau of Ships.

99. Par. 3-1. The Model XTBT equipment as supplied requires 440 volts, 3 phase, 60 cycles for operation of the motor generator and the bulkhead transformer. 115 volts, single phase, 60 cycles is also required for operation of the master oscillator filament.

100. Par. 3-1(1). A.C. power required within the transmitter unit exclusive of that required for motor starting control and master oscillator temperature control equipment is obtained from the slip rings on the motor generator. However, the power amplifier air blower in the preliminary

model derives its power from the bulkhead transformer, through a contact on the master start relay, K-103. This is a violation of this paragraph of the governing specifications. The blower motor consumes approximately 28 volt/amperes, as shown in Table 58. If the P.A. air blower is transferred to the slip ring circuit of the motor generator, this additional load will cause this circuit to be overloaded. It is recommended that the manufacturer take the proper steps to provide the necessary power without overloading any circuits. It will be noted by reference to Table 59 that the slip ring circuit is already working at full capacity. The slip rings supply power for all tube filaments, except that of the master oscillator tube. Additionally, the 12 volt microphone and control circuit supply rectifier is energized by the slip ring circuit. A bulkhead transformer, rated 220/440 volt primary, 110 volt, 250 voltampere secondary, is provided to supply power for the master oscillator temperature control equipment, for the motor control circuits and also for the P.A. air blower as noted above. Both the driving motor for the motor generator set and the bulkhead transformer may be operated on either 440 or 220 volt supplies, by changing the proper connections. A double pole single throw snap switch, located on the front panel of the transmitter unit, is provided in the primary circuit of the master oscillator filament transformer. One pole of this switch energizes the M.O. filament transformer while the other pole is in series with one side of the line from the bulkhead transformer to the motor control circuit and prevents starting of the motor generator set unless the M.O. filament is lighted. This switch bears a nameplate bearing the legends "Standby" and "Off". An oscillator filament indicator light is provided, connected across the primary of the M.O. filament transformer.

101. Par. 3-1(2). All power transformers in the transmitter unit are designed for operation from the potential available from the generator slip rings. The slip rings are rated at 115 volts and the transformers are designed to operate from this potential. This paragraph of the governing specifications states that the voltage shall be 110 volts, but the arrangement provided is not considered a violation since 115 volts is accepted as a standard potential.

102. Par. 3-1(3). No batteries are used in the Model XTBT equipment.

103. Par. 3-2. The XTBT transmitter is capable of adjustment to any frequency in the band of 60 to 200 megacycles by controls which are considered to be the minimum number compatible with the other requirements of the governing specifications. It is capable of delivering to the transmission line not less than 50 watts of pure continuous wave radio frequency carrier power at any frequency between 60 and 150 MC, this power tapering off to approximately 34 watts at 200 MC. A single type 829 tube is employed in the final R.F. amplifier; this tube contains two complete beam tetrodes in one glass envelope. No plug-in coils are used in the Model XTBT transmitter.

104. Par. 3-2(cont'd). The CW output from the Model XTBT transmitter was determined at the transmission line output terminal by means of a properly matched 50 watt lamp load. The results of these tests are covered in detail in Table No. 38. It will be noted that in all cases the power output obtained is in excess of specification requirements. These data are presented graphically in Plate No. 1.

105. Par. 3-3 (General). This paragraph of the specifications states "The carrier frequency shall be capable of adjustment to, and maintenance of, an assigned frequency within plus and minus 0.012 per cent under any combination of the following circumstances exclusive of vibration (7) and within 0.017% including vibration (7)". In order to obtain the necessary data in this connection, three master oscillator frequencies were chosen, namely, 5 MC, 7.5 MC and 10 MC. These particular frequencies were selected since they constitute the lowest, middle and highest frequencies employed in the nominal range of the master oscillator circuit. The output frequencies derived from these master oscillator frequencies were as follows:

5 MC - 180 MC (Multiplication 36 times)
7.5 MC - 135 MC (Multiplication 18 times)
10 MC - 180 MC (Multiplication 18 times)

Frequency drifts and changes were measured by means of Model LK Equipment No. 1. The actual frequency of measurement was twice that of the master oscillator, and the LK equipment was coupled lightly to the doubler plate circuit. A summary of the tests conducted in accordance with sub-paragraphs (1) to (7) inclusive, of paragraph 3-3 are presented in Table No.9. The arithmetical sums of the tests conducted at the three test frequencies are as follows:

Output Frequency:	135 MC	180 MC	180 MC
M.O. Frequency:	7.5 MC	5 MC	10 MC
Arithmetical sum with vibration:	0.01295%	0.01460%	0.01597%
Arithmetical sum without vibration:	0.01162%	0.0137%	0.00967%

Average of three frequencies, with vibration: 0.01451%
Average of three frequencies, without vibration: 0.01167%

In considering the above figures, attention is invited to the fact that the master oscillator frequencies of 5, 7.5 and 10 MC are crystal calibrator check points and hence the values for adjustment to an assigned frequency are the most accurate and optimistic values which are likely to be obtained. As will be discussed in greater detail in paragraph 106 below, accuracy of adjustment to assigned frequencies will be less favorable at M.O. frequencies which do not coincide with crystal calibrator check points. From the foregoing summary it will be observed that the Model XTBT equipment complies with the requirements of paragraph 3-3. The total deviation was determined on the basis of the arithmetical sum of the individual tests. In actual operation certain of the deviations will undoubtedly compensate each other.

106. Par. 3-3(1). Table 10 presents data collected during tests to determine the accuracy of the calibration facilities provided.

(a) Reference to Table 10 reveals that the accuracy of calibration ranges between the limits of approximately 0.00027% and 0.015%. It is pointed out, however, that these larger and more serious deviations from the desired frequency, are caused mainly by an improperly constructed master oscillator range switch. When more than usual care was taken in operating this switch the degree of unwanted deviation could be considerably reduced. However, as pointed out in paragraph 40(b) above, the operation of this switch was so erratic as to prevent oscillations at times. A redesigned switch of better characteristics must be provided before operation can be considered satisfactory. An additional test was conducted as illustrated in Table 11. This test consisted of resetting the transmitter to a predetermined calibration in less than one-man-minute. The average of five trials shows a deviation from the original setting of 0.00096%.

(b) The crystal calibrator check points referred to previously are provided through the medium of a quartz crystal controlled oscillator. The crystal and the circuit elements of this oscillator are mounted within the temperature controlled M.O. compartment, while the 6A6 tube employed in this circuit is mounted externally. The nominal frequency of the crystal provided is 7.5 MC, while a measurement made by employing the standard frequency transmission from WWV indicated the actual frequency to be 7,500.056 kc, plus or minus 19 cycles. Since the master oscillator compartment is maintained at a constant temperature of approximately 70 degrees C. this crystal oscillator provides an accurate frequency standard. However, it will be noted that the crystal oscillator provides only three check points, namely at 5 MC, 7.5 MC and 10 MC. These check points fall within master oscillator bands 1, 5 and 8. The instructions furnished stated that the check point for band 1 was intended to carry over into bands 2 and 3. Likewise the check point for band 5 applies to bands 4 and 6 as well as band 5 and the check point in band 8 is also applicable to band 7. From the experience gained during the tests of the Model XTBT equipment, it is recommended that the Contractor attempt to provide a crystal calibrator which will provide a distinct and separate check point in each master oscillator band.

(c) A calibration capacitor is provided to correct for a general shift of the M.O. frequency such as is caused by aging of the circuit elements or change of vacuum

tubes in this circuit. It is by means of this capacitor that the master oscillator circuit is adjusted to the check points provided by the crystal calibrator. This is accomplished by setting the main master oscillator dial to the reading indicated on the calibration chart for the check frequency and adjusting the calibrating capacitor to produce zero beat with the desired check frequency. The signal level produced by the crystal calibrator circuit was measured at the three check points with the following results:

Frequency of M.O.	M.O. Band	Audio Output at 1000 cycles
5	1	Less than 0.02 MW
7.5	5	0.03 MW
10	8	Much less than 0.02 MW

It was found that when the transmitter was located in a region of considerable noise level, the 0.03 milliwatt signal was suitable for calibration purposes. However, it was exceedingly difficult to make proper adjustments when the signal fell below this level to any considerable degree. It is recommended, therefore that steps be taken to insure that a calibrating signal of not less than 0.03 milliwatts be provided on all calibrating frequencies. The frequency range of the M.O. calibrating condenser is shown in Table No. 27. It will be noted that the position of the condenser for each calibration point is approximately in the middle of the capacity range of the condenser. The calibrating capacitor is adjusted by removing a snap cap from a hole in the M.O. panel and inserting a screw driver into the slotted shaft of the capacitor. Since this adjustment must be made each time a shift is required from one to the other of the three groups of bands, the present screw driver control is considered unsatisfactory. It is recommended that the calibrating capacitor be fitted with a suitable knob and dial to provide the necessary control.

(d) As submitted, the master oscillator calibration consists of a paper chart of the roller type, on which is drawn a calibration curve for master oscillator band No. 1. This same chart also carries a calibration for every 50 KC of the frequency ranges covered by the other seven master oscillator bands. The chart is mounted on the front of the modulator unit panel and is protected by a glass window. A large knurled knob on the side is provided for moving the chart. The approximate time to rotate the chart for band 1, is one minute and 20 seconds. If the chart were designed to cover all eight ranges it would require about 10 minutes to cover the entire distance.

This appears to be unsuitable for Naval use. It is recommended that the Bureau of Ships decide the type of calibration which will be most suitable for shipboard use and inform the contractor accordingly. It is suggested that consideration be given to a calibrating means similar to the small booklet types which are provided in connection with Model LM calibrating equipments.

107. Par. 3-3(2). Locked Key Operation for Two Hours. Tests were conducted to determine the action of the equipment during locked key operation. Three such tests were conducted as illustrated in Tables 12, 13 and 14. During these tests the carrier was modulated 95% with a 1000 cycle tone. It will be noted that consistent results were obtained and the maximum frequency shift noted was 0.00347% when adjusted to an output frequency of 135 megacycles. During these tests no signs of overheating were observed. The master oscillator circuit is contained in a temperature controlled compartment. Previous to the tests illustrated in the foregoing tables precautions were taken to assure that the M.O. compartment had reached temperature equilibrium. In order to determine the time required for the M.O. compartment to reach stable operating temperature a test was conducted as shown in Table No. 40. It will be observed that the M.O. compartment reaches temperature stability in approximately two hours. Table 40 contains additional data showing the variation in frequency which occurs while the M.O. compartment is attaining operating temperature.

108. Par. 3-3(3). Variation of Ambient Temperature. Three tests were conducted to determine the influence of varying ambient temperatures over the range of plus 50 degrees C to zero degrees C. The results of these tests are illustrated in Tables 15, 16 and 17, and in Plates 2, 3, and 4. The total frequency changes during these tests were found to be 0.002% at 135 MC (MO at 7.5 MC); 0.00365% at 180 MC (MO at 5 MC) and 0.00205 at 180 MC (MO at 10 MC). These frequency limits compare favorably with the results obtained with previously procured Navy transmitters operating in the high frequency range (2000 to 18000 kc). Examination of Tables 15, 16 and 17 reveals that during the last hour of each test when the ambient temperature was at zero, the master oscillator compartment was incapable of maintaining its temperature and the compartment temperature fell off about one degree. However, this slight loss of temperature did not have any ill effects upon the frequency stability of the equipment. Further information relative to the operation of the master oscillator heat cabinet is shown in Table 28. This table reveals that the heater element remains energized 100% of the time at zero degrees, while at an ambient temperature of 50 degrees C. the heater element remains energized approximately 15% of the total time. It should be pointed out that the NRL temperature room subjects the equipment under test to a considerable air blast which has the effect of accelerating the loss of heat from the equipment. This condition is not likely to exist to such a degree on board ship and hence the inability of the M.O. compartment to maintain exact temperature at zero degrees is not considered a serious defect. However, as revealed by Table 28 it would be possible to provide

a heater of slightly greater capacity and it is recommended that the contractor consider the advisability of such a modification. A further phenomena was noted in connection with the high voltage motor generator. Reference to plates 15, 16 and 17 reveals that the output of this generator rose to approximately 475 volts, with a consequent increase in plate current drawn by the P.A. tube. While this overload condition did not appear to adversely affect the equipment, it is considered an undesirable feature and steps should be taken to modify the motor generator to alleviate this condition.

109. Par. 3-3(4). Variation in Humidity. Tests to determine the influence of humidity variations were conducted as illustrated in Tables 18, 19 and 20. These data are illustrated graphically in Plates 5, 6 and 7. The tests reveal that the maximum frequency change resulting in a change of humidity from 30% to approximately 95% at 40 degrees C. was in the neighborhood of 0.002%. Part of this frequency change is undoubtedly due to the inherent drift in the transmitter as is revealed during the two hour key locked tests at a constant temperature and constant humidity. High humidity has only a minor effect upon the power output of the equipment. The magnitude of this effect is considered negligible. The master oscillator compartment of the Model XTBT transmitter is equipped with two containers filled with silica gel. This material has the property of absorbing moisture and is used in this application as a means of producing a low and constant relative humidity within the master oscillator compartment. Information relative to the drying of the silica gel following a period of use is included in the instruction book. These instructions do not state whether or not it is necessary to remove the gel from the containers in order to properly dry it; the instructions should be worded to more completely cover the necessary procedure. Of the two containers supplied, one was a commercial product suitably clamped in place; the other unit was obviously designed for this particular application. It is suitably mounted to permit removal, but it was noted that one mounting screw had been broken off before the equipment was delivered to the Naval Research Laboratory.

110. Par. 3-3(5). Variation of Supply Line Voltage. The XTBT equipment is capable of maintaining its original frequency within the limits shown in Table 21 during variations of the ship's supply line voltage of 5% above and below normal. Additionally, data were taken with variation of supply line voltage of 10% above and below normal. These data are presented in Table 22. Since the speed of the induction motor on the Motor Generator set varied but slightly with change of supply voltage, the plate and screen voltages remained essentially constant. The shifts in frequency noted during these tests are due almost entirely to the change in the voltage applied to the filament of the master oscillator tube. This fact was further verified by connecting the primary of the master oscillator filament transformer to the slip rings of the motor generator instead of to the supply line which was being varied. Under these conditions the frequency deviations, even with a 10% change in line voltage, which is in excess of the variations required by the governing

specifications, did not exceed 0.00015%. Attention is invited to the fact that the equipment submitted for test is designed for A.C. drive. In equipments operating from a D.C. source the magnitude of these variations will undoubtedly be greater.

111. Par. 3-3(6). Change of Vacuum Tubes. Table No. 23 indicates the frequency deviations encountered when changing vacuum tubes in the various circuits of the Model XTNT transmitter. The frequency variation with change of tubes was taken without readjusting the calibrating capacitor, since to do so eliminates the frequency deviation resulting from the use of tubes of different characteristics. The need for the calibration capacitor, particularly when changing master oscillator tubes, is clearly shown by these data. While the frequency deviation due to change of tubes can be eliminated by use of the calibrating capacitor, the frequency drift occasioned by the cooling of the master oscillator compartment due to its removal from the heat box, is very appreciable. It should be noted that the master oscillator tube is mounted within the temperature controlled cabinet, which is maintained at approximately 70 degrees C. Assuming the tube change to be made in approximately one minute; it is necessary to allow from 20 to 60 minutes for the compartment to return to precise thermal equilibrium before resetting the calibration capacitor. However, transmission approximately "on frequency" may be accomplished immediately upon replacing the unit by adjusting the capacitor at that time. Then as the compartment temperature gradually approaches its stable condition readjustments of the calibration capacitor will be required to compensate for changes in temperature. The need for this procedure should be described fully in the instruction book. Attention is invited to the tolerance figures for tube changes presented in Table 9. These values were obtained by taking the percentage of reset accuracy on the calibration check points and adding the variations which were occasioned by changing vacuum tubes in the circuits following the master oscillator. By use of the calibrating condenser all frequency changes resulting from change of M.O. tube were compensated for. It is pointed out that the calibrating capacitor could have been adjusted to compensate for the entire frequency change resulting from changing a complete set of tubes. Thus, in effect, changing vacuum tubes would produce no frequency deviation, other that the inaccuracies due to resetting by means of the calibration facilities provided.

112. Par. 3-3(7). Vibration Test. The maximum set in frequency and the maximum variation in frequency during periods of vibration are illustrated in Tables 24, 25 and 26. These tables reveal that at vibration frequencies of approximately 950 cycles per minute the master oscillator compartment strikes the frame of the transmitter and causes undesirable "jumps" in the emitted frequency. The poor contact afforded by the M.O. range switch Control "A" was also instrumental in producing these "jumps". Hence it is recommended that the proper steps be taken to dampen the oscillations of the M.O. compartment and that an improved switch be substituted for the present M.O. range switch. The individual frequencies noted in Tables 24, 25 and 26 are the average frequencies read on the visual frequency indicator of the LK equipment, and do not show the

amount of "warble" or lilt in the audio beat note. As previously noted this warble reaches a maximum at vibration frequencies in the region of 950 cycles per minute, plus and minus 50 cycles. Listening tests were conducted while the XT T transmitter was being subjected to vibration. With the Model XRAQ receiver reception was normal, no effect being noted even during the periods when the M.O. compartment was striking the frame of the transmitter. However, during reception on another receiver having a much narrower band width, the signal dropped out entirely for an instant when the MO compartment struck the frame.

113. Additional tests not definitely required by the governing specifications. Certain additional tests were conducted which are not definitely called for by the governing specifications. Tests of this nature, however, have been conducted in connection with the procurement of Naval transmitting equipment operating in the intermediate and high frequency bands, and it was deemed advisable to collect data of this nature in order that it might be available for modification or expansion of Bureau of Ships specifications, should this be considered advisable.

114. Inclination Tests. The Model XTBT equipment was secured to the inclination test stand through the medium of the regular base or hold down fittings provided and subjected to inclination up to 45 degrees on either side of the vertical. The inclination rate was approximately 5 cycles per minute. The results of these tests are shown in Tables 29, 30 and 31. It will be noted that the results vary for different settings of the master oscillator, the greatest variation occurring when the master oscillator was adjusted to 5 MC and the output frequency was 100 MC. The various units, which included the transmitter, motor generator unit, motor starter, bulkhead transformer, 12 volt rectifier and one remote telephone unit, withstood these tests successfully without damage or operational difficulties.

115. Shock Test. The transmitter was secured to the deck by means of the regular base fittings and subjected to shocks in the manner prescribed on sheet 34A of RE 13A 554. No mechanical failure of parts occurred due to this test, except that the plate weld inside the 829 power amplifier tube opened up. It is believed, however, that this was a faulty weld and the failure was not directly attributable to the shock test. The frequency shifts encountered during this test are listed in Table 32.

116. Lost motion and back lash in M.O. control "B". The degree of back lash present in the Master Oscillator Tuning control was determined as illustrated in Table 33. The average variation encountered during five trials was 0.00122%

117. Detuning of Circuits subsequent to M.O. Circuit. The effect upon the frequency of the master oscillator caused by detuning the circuits subsequent to the M.O. was determined as illustrated in Table 34. The greatest detuning effect was produced by control "C", the doubler plate circuit.

118. Effect of Master Oscillator Dial Lock. The effect of operating the master oscillator dial locking mechanism upon the frequency of the master oscillator was found to be practically negligible, as shown in Table No. 35.

119. Effect of Tune-Operate Control. The effect upon frequency when changing from "Tune" position to "operate" position of the Tune-Operate control was determined as illustrated in Table No. 36 attached hereto. The frequency variation was found to be 37 cycles in 10 MC, or 0.00037%.

120. Effect of Intermittently Keyed Operation. Tests were conducted to determine the effect of intermittently keyed operation upon the carrier frequency. As will be noted from Table No. 37, the difference between the transmitter frequency at the beginning and the end of a five minute stand-by interval was 0.00105%. The difference in the carrier frequency occasioned by removal of the 1000 cycle modulation was approximately 0.0003%.

121. Par. 3-4. The carrier frequency of the Model TBT transmitter is continuously variable between the limits of 60 and 200 megacycles. The master oscillator circuit employes an electron-coupled circuit, the frequency determining portion of which operates in the range 5 to 10 megacycles and the plate circuit of which operates in the range 10 to 20 megacycles. This fundamental range, 5 to 10 MC, is multiplied 12 times to produce output frequencies between 60 and 120 MC; 18 times for frequencies between 120 and 180 MC and 36 times for output frequency between 180 MC and 200 MC. The operation of the various circuits in the transmitter required to produce the desired output frequencies is covered in detail in Table 39 attached hereto. A single calibrating crystal is provided which functions in the manner described in paragraph 106(b) above. This crystal is suitable for use in other Model TBT transmitters. However, as recommended in paragraph 106(b) above, it is considered desirable to modify the crystal calibrating circuit in a manner which would provide definite calibration points in each band of the master oscillator. Certain measurements and calculations were made to determine the overlap and end tolerances existing in the various circuits of the transmitter and to determine the kilocycles per division of the main master oscillator tuning dial. The data presented in Table 47 shows the kc per division of the MO dial. This information was obtained from the calibration data submitted with the equipment, which in turn was verified at intervals throughout the range. The end tolerances and overlap existing between the various ranges of the master oscillator circuit are shown in Table 48. It will be noted that the overlap prevailing between ranges 4 and 5 and ranges 7 and 8 is less than 1%. It is recommended that efforts be made to increase this tolerance in production models. Table No. 49 shows the overlap existing between the various ranges of the 1st amplifier circuit. Satisfactory overlap has been provided. Table No. 50 shows the extreme ranges to which it is possible to adjust the transmitter and indicates the limiting circuits. The end tolerances provided are considered satisfactory.

122. Par. 3-5. The transmitter is provided with an automatic level control which maintains the average modulation between the limits of 75 and 95 per cent for variations of average speech input power between the limits of 0.6 and 6.0 milliwatts. Table 41 shows that this control is effective at levels considerably beyond the maximum required. However, during the course of tests it was noted that whistling into the microphone caused over 100% modulation. A test was made to ascertain the level of the audio output from the remote telephone unit. It was observed that when a speaker's voice ranged from a normal tone and volume to a very loud value, the output from the remote telephone unit varied from 0.1 to 20 milliwatts and that whistling into the microphone produced an output of 30 milliwatts. It is evident that the automatic gain control cannot control excessively high peaks of modulation. It was further noted that loud voice tones failed to produce modulations in excess of 100%, but a loud whistle would cause the modulation meter to go off scale. Although the equipment was subjected to overmodulation many times during the course of the tests, no detrimental effects upon circuit components were noted from this cause.

123. Par. 3-6. Means have been provided for modulating the rated carrier 100% by either voice or 1000 cycle tone. The actual frequency of the tone oscillator provided was measured as 975 cycles, which is well within the plus and minus 10% specified. The level of the 1000 cycle modulating oscillator and the automatic gain control are separately adjustable. The output from the 1000 cycle oscillator was adjusted, as received, to produce 85 to 95 per cent modulation. The automatic gain control for voice modulation was set at the limits shown in Table No. 41. The automatic gain control is blocked by the carrier control relay when 1000 cycle keying is employed, to avoid transients which otherwise would occur each time the key is depressed. The percent distortion at 85% modulation was determined at various modulating frequencies as illustrated in Table 42. The percentage distortion is well below the 10% limit permitted. These measurements were made with three remote telephone units connected, the maximum number available at the time.

124. Par. 3-7. With three remote telephone units connected in parallel across transmitter 600 ohm input circuit, an 80% modulation level was established by applying a 1 MW, 1000 cycle signal to the low impedance winding of the microphone transformer in one of the connected remote telephone units. The automatic level control was temporarily blocked during the test. The frequency of the input voltage was then varied over the range of 100 to 4000 cycles with the results indicated in Table 43. The modulation levels obtained were well within the specified limits.

125. Par. 3-8. The amplitude modulation or noise level present in the carrier was determined for two output frequencies, 60 and 200 KC. As shown in Table 44, the noise level varied between 0.45% and 0.80% at 60 KC and between the limits of 0.20% and 0.36% at 200 KC. This variation in noise level is caused by hunting of the motor generator. This effect

produced no noticeable interference in the received signal, but it is recommended that steps be taken to eliminate the hunting.

126. Par. 3-9. In general, the design and construction of the equipment is such that key clicks and other objectionable disturbances have been kept to a minimum. However, the inherent design of the circuits is such that the output frequency is produced by a series of multiplications which indicates that a certain proportion of harmonic energy will undoubtedly be present. However, the amplitude of this energy and its ability to cause undesirable interference on board ship is difficult to estimate. It is intended to conduct an investigation of this phenomena at the Naval Research Laboratory provided the equipment is available, and the results obtained will be made the subject of separate correspondence. A decided lilt is present in the carrier frequency of the XTBT during the instant that the carrier is applied. This lilt is caused by the fact that the application of the carrier is accomplished by applying plate and screen voltages through a high voltage relay. The voltage applied to the master oscillator plate and grid circuits varies following closure of the relay due to the charging of filter condensers and the build up of current in the filter choke. This lilt would be decidedly objectionable if the STBT equipment were intended for use as a keyed CW transmitter. However, since telegraph transmission is by means of keyed 1000 cycle modulation this difficulty is not encountered. The 1000 cycle tone oscillator, when in use, remains in operation continuously as long as the key is not held open for periods longer than 1.2 seconds, and keying is actually accomplished by interrupting the audio supply to the modulator unit. Each time the carrier is applied the carrier frequency sweeps thro gh a band, estimated to be approximately 70 kilocycles wide before stabilizing at the desired output frequency. This phenomena produces no noticeable effect in a receiver with a sufficiently wide band acceptance.

127. Par. 3-10. The speech input circuit is designed for satisfactory operation with signals which vary between 0.6 and 6.0 milliwatts and which are supplied at a 600 ohm level or at the level of the microphone supplied with the equipment. Terminals are provided for the 600 ohm circuit, which connects through a resistor and coupling capacitor network direct to the grids of the first audio amplifier. The microphone transformer in the transmitter unit is connected through the test key to the microphone jack on the front panel. No terminals are provided on the main terminal board for the low impedance microphone winding on this transformer. The secondary of the microphone transformer is equipped with terminals providing a 200 ohm input. In accordance with the instructions contained in paragraph 4 of reference (m) operation using the 200 ohm tap is accomplished by change of soldered connections.

128. Par. 3-11. The transmitter and antenna are capable of adjustment to any previously calibrated frequency within the band specified within five minutes by one man. Table No. 45 shows the actual time consumed in making adjustments of this nature.

129. Par. 3-12. The transmitter is provided with means whereby the operation of a start button places it in a standby condition. No time delay is provided to prevent application of plate voltage during the time that the tube heaters are reaching operating temperature. The control is such that plate voltage is applied immediately upon starting of the motor generator unit. When the tube heaters reach operating temperature the plate voltage is removed by action of the carrier control tube. A further discussion of this situation will be found in paragraph 131 below.

130. Par. 3-13. The "Test Key" located on the front panel of the transmitter, when closed, causes the transmitter to emit the carrier, substantially immediately, by applying plate voltage through a high voltage relay. Having closed the test key, it is necessary only to plug in the microphone and talk in order to modulate the carrier. Upon release of the test key the transmitter assumes the standby condition. Substitution of the marking "Test Key" in place of "Talk Key" is considered satisfactory.

131. Par. 3-14. The transmitter is provided with means whereby the operation of the telegraph key causes the transmitter to emit the 1000 cycle modulated carrier. Upon release of the telegraph key the modulation ceases, but the transmitter does not assume the standby condition until the expiration of a time interval of approximately 1.2 seconds. This operation is accomplished by controlling the grid bias of a vacuum tube (carrier control tube) with one contact of the keying relay. The carrier control relay in the plate circuit of the carrier control tube in turns controls the high voltage carrier relay. The carrier control relay also operates to block the automatic gain control and applies plate voltage to the tone oscillator. Two contacts on the keying relay connect the output of the tone oscillator to the 600 ohm input circuit of the audio amplifier. The contacts of the carrier control relay close when the relay is de-energized, thia is, when the carrier control tube is <u>not</u> drawing plate current. Plate voltage is therefore applied to all the tubes immediately upon starting the motor generator and before the tube heaters have had time to reach normal temperature. Plate voltage will also be applied and the carrier placed on the air, with no means of removing it other than shutting down the motor generator, if the carrier control tube fails during operation. Further, plate voltage without proper bias or excitation will be applied to the P.A. tube in case of failure of the fuse in the positive side of the 275 volt supply, since it is from this supply that the carrier control tube is energized. In order to avoid these undesirable features of operation it is recommended that the contacts of the carrier control relay be made normally open and that the grid circuit of the carrier control tube be altered to produce normal operation with normally open contacts on the carrier control relay. Since the Test Key operates the high voltage carrier relay direct, by-passing the contacts of the carrier control relay, failure of the carrier control tube with consequent removal of the carrier, can be overcome during the emergency period, by use of the test key.

132. Par. 3-14 (Continued). The keying arrangement provided produces suitable keying over the range of 5 to 100 words per minute. When transmitting "dots" at the rate of 100 words per minute the output of the transmitter was observed oscillographically and it was found that 7 complete cycles of the modulating frequency out of a possible 12.5 cycles, were present for each dot. Listening tests conducted at a distance of about 300 yards indicate clean cut keying and no adjacent channel interference. Break-in operation is not provided.

133. Par. 3-15. Under stand-by conditions all radiation from the transmitter is eliminated since the carrier relay removed all high voltage from the tubes, including the master oscillator.

134.- Par. 3-16. The transmitting equipment was subjected to vibration with the results indicated in paragraph 112 above. Additionally, the noise level or modulation of the carrier was measured during vibration and found to range between the limits of 1.2 and 1.7%, which is well within the specification limit of 5%.

135. Par. 3-17. With ont exception, it is possible to shift frequencies without manually readjusting the potentials applied to the transmitter. Actually, no controls are provided on the transmitter panel for varying filament, bias or plate voltages. However, a switch labeled "P.A. Grid Current" is located on the front panel (lower access door) which adjusts the screen grid voltages on the intermediate amplifier stages as the frequency is varied across the range of the transmitter. These screen grid adjustments in turn vary the P.A. grid current so that it is possible to obtain the necessary values. While this control appears to violate paragraph 3-17, it is considered essential for the proper functioning of the transmitter and it is recommended that the addition of this control be approved. A further control of the screen grid voltages on the intermediate amplifiers is obtained through the operation of "Trip Switches" S-114 and S-115. These switches are operated automatically through the medium of control "I", P.A. Tuning. While these switches perform the functions which they are intended to control, difficulties are experienced in the frequency range at 120 KC and 180 KC. Proper adjustment of control "I" is interfered with due to the fact that each of these switches has two positions for the frequency at which the changeover is made. However, only one position is correct for a given multiplication ratio. An inexperienced operator is likely to neglect this fact, with the result that unsatisfactory operation is obtained. This matter was discussed with representatives of the Contractor and it was mutually decided that improved operation would result if the trip switches S-114 and S-115 were eliminated and their functions transferred to the First Amplifier Range Switch, Control "D". This modification can be accomplished by the addition of another switch wafer to the existing switch. Since this modification entails a considerable change in the wiring of the transmitter unit, the Contractor's representatives recommended that this change be made at the factory after the return of the preliminary model to the manufacturer. It is recommended that this change be authorized and that the efficacy of the changes be demonstrated to the resident Inspector or to such representatives as the Bureau of Ships may designate. A Tune-Operate switch is

mounted on the front panel, which inserts a resistor in the negative 435 volt supply when in the "Tune" position. The function of this switch is to aid in tuning operations without overloading the various circuits. The effect of this switch upon the tube potentials and currents is illustrated in Table 46.

136. Par. 3-18. The total volume required by the transmitter unit, excluding the transmission line termination, is 12 cubic feet. The dimensions of the various units are listed in Table 8. The dimensions of the transmitter unit are 24" wide, 18-1/4" deep (including front panel protuberances) and 47-1/2" over the flexible mounting pedestal. The outer conductor of the transmission line termination protrudes beyond the right side of the transmitter for a distance of 3-5/8", 7/8" of which will be enclosed by the transmission line coupling. The inner conductor of the termination extends another 2-1/4" beyond the outer conductor and will also be enclosed by the transmission line and coupling. The specifications require that "provision must be made within the limiting dimensions for transmission line connections and all external cable connections". Thus, the transmission line connection violates this portion of the specifications. However, in view of the fact that this termination is actually an extension of the transmission line itself it is recommended that the Bureau consider the advisability of waiving this apparent violation of dimensions. The transmitter unit weighs 360 pounds, which is within the limit specified.

137. Par. 3-19(1). The transmitter is so constructed that it may be bolted to the deck or to a table by means of four mounting holes, 3/8" in diameter. These mounting holes are so located under the overhang of the transmitter unit that if bolts appreciably longer than 1-1/2" are required for this purpose, it will be impossible to pass the bolts through the mounting holes. This difficulty could be avoided by lengthening the bottom supporting plates approximately 1" on each side, thus bringing the mounting holes out into the clear. However, this would increase the overall width of the transmitter by two inches. It is recommended that the Bureau give consideration to this matter with a view of deciding the best compromise arrangement.

138. Par. 3-19(2). The replacement of vacuum tubes and the adjustment of circuits and relays can be accomplished through access doors in the front panel and by withdrawal of the master oscillator unit from its compartment. These functions are accomplished without disconnecting any leads. Attention is invited to the fact that replacement of relay parts, such as contacts or coils would be extremely difficult and in this connection reference is made to paragraph 38(y) above, wherein it is recommended that further consideration be given to a rearrangement of parts on the main terminal panel.

139. Par. 3-19(3). The transmission line connection is made on the right hand side of the transmitter unit. The connecting leads are brought into the transmitter unit through the rear shield in the manner described

in paragraph 47(1) above. Paragraph 2-23 of sub-specifications RE 13A 554 requires that the cable leads be brought through the rear panel, "unless otherwise specified". Paragraph 2-1 of specifications RE 13A 557D deletes paragraph 2-23 of RE 13A 554, but does not indicate the method to be used in bringing in the external leads. Paragraph 2-19(3) of RE 13A 557D requires that the transmitter be capable of being installed and serviced with its back against a bulkhead. As pointed out in paragraph 138 above routine servicing such as tube and ferrule type resistor replacements may be made from the front panel. However, since the incoming leads are brought through the rear shield, it will be impossible to place the back of the transmitter against a bulkhead. A MHFA-19 cable cannot be bent safely on a radius smaller than 5 inches, thus the minimum distance between the bulkhead and transmitter must be at least 5 inches. Additionally, connections must be made to certain sub-terminal panels at the rear of the transmitter and these can be reached only by access through the rear. Other component parts, including carbon type resistors, must be serviced through the rear panel. In view of the fact that certain of the specification requirements appear to offer some conflict, it is suggested that this matter be given further consideration by the Bureau of Ships.

140. Par. 3-19(4). No panel mounted instruments or switches are mounted within six inches of the base of the transmitter unit.

141. Par. 3-20. The transmitter is completely shielded externally by aluminum panels and shields and nearby metallic objects have no effect upon its operation. Sufficient shielding has been incorporated internally to prevent interaction between the audio and radio frequency circuits and between the various amplifier stages. Attention, however, is invited to paragraph 126 above, wherein is discussed the possibility of harmonic interference. At the conclusion of the contemplated tests referred to in the above paragraph more definite information should be available to indicate whether the shielding provided is entirely adequate.

142. Par. 3-21. During the course of the tests conducted with the Model XTBT equipment, which were performed at various ambient temperatures ranging between zero and 50 degrees C., no signs of overheating were observed in connection with any transformers in the equipment.

143. Par. 3-22. A total of six relays are used in the Transmitter unit, which is considered the minimum number compatible with the operation required under the terms of the governing specifications.

144. Par. 3-23. This paragraph of the specifications has been modified to a great extent by written and oral instructions issued by the Bureau. A sufficient number of terminals have been provided in the XTBT equipment to make the necessary connections. However, as pointed out in paragraph 38 (y) above, considerable congestion prevails in the neighborhood of the main terminal board due to space limitations. Additionally, the increased physical size and increase in the number of cables which the Bureau indicates is necessary will further increase this congestion. While the actual type and number of cables were not available at the Naval

Research Laboratory to make a positive test, such tests as it was possible to perform, indicate that the necessary connections can be made, but not without excessive crowding and great difficulty. As submitted, provision has been made in the XTBT transmitter unit to afford entry for ten separate cables of different sizes, but as pointed out above under paragraph 47(1), the size of the holes and cable clamping devices will not accommodate the cables subsequently specified. In view of the rather complex situation which exists in connection with this subject, it is recommended that the best compromise arrangement be decided upon by conference between all interested activities.

145. Par. 3-24. In addition to the tuning controls and indicating instruments mounted on the front panel, the following devices have been provided:

(1) A push button type "Emergency" switch is provided on the front panel. The switch is marked "EMERGENCY" and the "OFF" and "ON" positions are clearly marked. The "OFF" button is encircled with a red bullseye. While these markings are not in strict accord with the specified method of marking, the intent of the specification has been complied with and the switch is considered satisfactory.

(2) As submitted, the equipment was provided with a suitable two-button momentary contact start-stop switch. However, in accordance with specifications RE 13A 592B, this switch may be replaced with a two-button maintaining contact switch.

(3) A "Remote-Local" switch is provided and provides satisfactory operation, except that when this switch is in the "local" position and the motor generator is running, a remote operator can modulate the transmitter by voice by simply closing one of the remote talk switches. The circuit to the external hand key, however, is opened preventing the possibility of tone modulation.

(4) A three position key switch, marked "Test Key" is provided. The down position of this switch affords momentary contact, the center position is "off", while the up position locks the switch.

(5) A jack has been provided on the front panel for plugging in a chest microphone.

(6) A pilot light has been provided to indicate the energized condition of the master starting relay.

(7) A modulation indicating instrument, calibrated in percent modulation, is provided. This meter is a rectox type AC voltmeter connected directly across the output winding

of the modulation transformer. No capacitor is provided to block the dc voltage drop across the modulation transformer (caused by the winding resistance and the P.A. plate current) from the meter. Hence, a minimum reading of 5% appears upon application of the carrier when no modulation is present. The accuracy of the modulation meter was checked at various levels by means of an oscillograph and was found to be satisfactory for the purpose.

(8) An output radio frequency indicating instrument is provided which consists of a one milliampere full scale DC instrument connected in the rectified output of a 955 tube. The plate and grid of the 955 are connected together to form the anode of a diode rectifier. The rectifier is capacity coupled to the bottom end of the R.F.Output coupling circuit, therefore, the device shows the relative voltages which the transmitter delivers to the transmission line. Readings are relative, not quantitative. This indicator has proved to be a satisfactory instrument in adjusting the transmitter.

146. Par. 3-25. Transmission Line, Fittings and Accessories.

(a) The Model XTBT equipment was accompanied by 200 feet of nominal 7/8" diameter hard drawn concentric type transmission line and 20 feet of soft annealed transmission line. The line was fitted with ceramic bead insulators spaced at intervals of 3", and was manufactured by the Communications Products Co. The transmission line was supplied in 20 foot lengths, and had a nominal wall thickness of 0.035". The ends of a portion of the 20 foot lengths were fitted with metallic end caps to prevent the entrance of foreign materials. However, some of the lines were not provided with these caps and many of the caps fitted so loosely that they became displaced during shipment. In production equipments the necessary steps should be taken to insure that the transmission lines are properly sealed to prevent contamination. Upon receipt it was found that the 20 foot length of soft annealed line was dented and deformed to such an extent that the inner conductor could not be removed. It will be seen therefore, that more care must be exercised in packing and shipping to preserve line of this type. However, experience with transmission lines indicates that soft annealed lines are unsuitable from several viewpoints and hence it is recommended that no soft annealed line be provided with the TBT equipment. Experience has also indicated that a wall thickness of 0.035" is not as generally satisfactory for Naval use as a wall thickness of 0.045". It is recommended, therefore that the Bureau consider the advisability of specifying the heavier wall transmission line.

(b) Twenty sets of solder-type transmission line couplings were furnished with the equipment. Connection of the inner conductors was provided for by means of solder pins. These pins are of the smooth, shoulderless type which are difficult to center properly in installation. It is recommended that pins of the shouldered type be provided for this purpose.

(c) The antenna end of the transmission line is provided with a gas tight termination equipped with a plug and a bleeder valve. The transmitter end of the line is fitted with a gas tight termination equipped with a gas admission valve and a pressure gauge, range 0 to 50 pounds. A nitrogen flask, manufactured by the Ohio Chemical and Manufacturing Co., Cleveland, Ohio, containing 6 ounces of nitrogen at a pressure of approximately 1800 pounds per square inch, was furnished. The tank is equipped with the required fittings to permit refilling from a standard gas cylinder and for controlling the flow of gas to the transmission line. Connection to the transmission line gas fitting is made through the medium of three feet of pressure tubing. The gas tank is equipped with a pressure gauge, range 0 to 2000 pounds, manufactured by the U.S.Gauge Co., New York. Appropriate provision is made to disconnect the flask from the line without losing appreciable gas pressure from either the line or the flask.

147. Par. 3-26. Power Delivered to Antenna System. The power delivered to the antenna system was determined by the standing wave ratio method described in paragraph 7 of this report. A view of the radio frequency measuring equipment used in making power output determinations is shown in Plate 26. Plate No. 8 shows the results of these measurements in graphic form. It will be noted that the power delivered at the various frequencies within the band is 60%, or greater, of the output power of the transmitter. The measurements were made with the antenna connected to the transmitter through 200 feet of transmission line.

148. (Par. 3-26 continued). The design of the antenna is such that it radiates a maximum of vertically polarized wave energy in a horizontal plane. The antenna is capable of being adjusted to operate in the frequency range of 60 to 200 MC. A capacitor type, reversible induction motor is used to vary the length of the antenna and the antenna matching section which is contained in the antenna housing. Remote control of the antenna is obtained through the medium of sunchro motor and generator. The variable control "K" on the panel of the transmitter is calibrated directly in frequency. An indicator light is provided on the panel of the transmitter to inform the operator when the antenna mechanism is in motion. The indicator is extinguished when the antenna comes to rest in the proper position. Limit switches are provided to prevent over-travel in either direction. The accuracy of the antenna length adjustment was checked and it was found that

the accuracy when adjusting from a high to a lower frequency, or vice versa, falls within the same limits. A deviation of 1/16" may be expected in re-setting to a given frequency, although on occasion deviations of 1/4" were observed. This accuracy is considered adequate. No hunting is experienced when the antenna is lengthened. When the length of the antenna is decreased the mechanism carries over a short distance, but immediately returns to the desired setting.

149. Par. 3-26 (continued). Operation of TBT Antenna at Low Temperatures. The TBT antenna was placed in the temperature room, in a horizontal position, since lack of ceiling height prevented vertical installation. All covers were in place but the bakelite protective tube was removed from the variable radiator element so that the movement of the radiator could be observed. The temperature of the room was reduced to minus 26 degrees C (-14.8 F). The temperature was held at this level for approximately two hours. The control box was located outside of the room. The control was then operated to cause the antenna to move from the 200 MC setting to the 60 MC setting. Results were as follows:

(a) It required 3 minutes and 30 seconds to move from 200 to 60 MC position, on the first trial.

(b) In the second trial, made immediately thereafter, it required 3 minutes and 25 seconds to complete the travel from the 60 MC position to the 200 MC position.

(c) In the third trial the complete range of movement was covered in 2 minutes and 10 seconds.

(d) On the fourth trial the complete travel was accomplished in 1 minute and 35 seconds.

The normal time of travel from the 200 to the 60 MC position at 25 Deg. C. is 30 seconds. After the temperature of the room was raised to about plus 10 Deg. C. the normal rate of travel was again obtained. The decreased rate of travel at low temperatures is undoubtedly due to the increased resistance of the lubricant.

150. Par. 3-26 (continued) Mechanical Construction of Antenna.

(a) The Model XTBT antenna unit consists of a vertical radiator section adjustable from a remote point to a length approximately equal to one-quarter wavelength at the operating frequency of the transmitter. Twelve equally spaced ground rods extend radially in a horizontal plane from the base of the vertical radiator for a distance of 36 inches from the axis of the antenna. This array is supported on the top end of a housing which contains concentric line impedance matching sections and the mechanism for changing simultaneously the length of the antenna and the matching sections. A view of the antenna (as mounted

on vibration test stand) is shown in Plate 25, while additional views are included in the report on the Model RAQ Receiver. The dimensions and weight of the antenna are listed in Table 8.

(b) The box section of the housing contains the driving motor and associated synchro-generator. The terminal board for making electrical connections is also located in this housing, the control leads entering through the bottom of the box. The narrow portion above the box contains the concentric antenna impedance matching sections, while the tubular portion below the box forms the outer conductor of a 70 ohm section of line which matches the impedance of the 7/8" transmission line. Inspection plates are provided, one of which covers the whole length of the section above the box while the other gives access to the box proper. Both plates are provided with rubber (or synthetic rubber) gaskets which were cemented to provide a watertight seal. A length of bakelite tubing, 1" outside diameter, is provided for the purpose of protecting the radiator from the weather. The top end of this tubing is plugged, while the bottom end is slotted and provided with a metallic clamp for securing purposes.

(c) Insulation between the quarter wave antenna and the ground rods and housing is provided by a ceramic insulator 3-1/8" in diameter and 3/8" thick. During the period from December 1940 to March 1941 (approximately 3-1/2 months), the antenna was installed above the roof of the Transmitter Building and exposed to winter weather conditions. A sleet storm occurred during this period and deposited a layer of ice approximately 1/8" thick on one side of the bakelite antenna guard as well as over portions of the mechanism housing and the ceramic insulator. Power measurements made at this time, by means of the standing wave ratio method, indicated that the standing wave ratio was not altered appreciably in the range from 60 to 140 MC and only slightly in the range from 140 to 200 MC. It is worthy of note, however, that ice formed in this locality (over land) is relatively free from impurities as compared to the accretions which may be deposited in locations subjected to salt spray. Additionally, the flat surface of the insulator may become coated with deposits of foreign materials. The minimum spacing between points of opposite polarity is 3/16" on this insulator. It is suggested that consideration be given to the addition of an inverted cup shaped shield or phenolic material to protect the ceramic insulator.

(d) In addition to the tests described in paragraphs 147, 148 and 149 above, the antenna unit was subjected to vibration and shock tests in order to observe operation under these

conditions. The vibration tests covered a period of 1-1/2 hours at various vibration frequencies from zero to 2000 cycles per minute, including three quarter hour continuous vibration at 900 cycles per minute. The ground rods resonated at 670 cpm, their ends assuming a vibration amplitude of 1-1/4". At 1060 cpm the pipe below the box (hanging clear with no transmission line connected) was subjected to an amplitude of 1/4". At 1350 cpm the entire unit resonated, the node being at the top of the bakelite housing over the antenna with the maximum amplitude appearing at the ceramic insulator. At 1400 cpm the inner conductor of the matching section vibrated heavily, but not sufficiently to touch the outer conductor. At 1900 cpm the antenna, which was adjusted to 60 MC, was heard rattling inside the housing. No damage to the antenna was evident as a result of these tests and it was noted that the antenna had not changed its physical position even though the 110 volt supply was disconnected during the vibration tests. The removal of the power supply simulates actual operating conditions since when the Tune-Operate switch of the transmitter is in the "operate" position, one side of the 110 volt supply to the antenna unit is open.

(e) Due to the difficulties of actually having the antenna in a radiating condition while it was mounted on the vibration table, measurements of the effect on the output caused by the vibration of the inner conductor of the matching section were not made. It is possible, if such vibration is encountered afloat, that the output will be subjected to amplitude modulation. It is recommended that further consideration be given to the design of these parts in an effort to reduce the amplitude of vibration.

(f) With the antenna secured to the test stand in the manner illustrated in Plate 25, shocks were imparted to the test table by means of a pneumatically operated shocking device. This device causes the table top to move through a distance of approximately 5/8" in a time of about 0.1 second, under the influence of a 7,000 pound thrust. Five such shocks were administered without the antenna suffering any damage. It is pointed out, however, that the antenna unit was securely attached to the I-Beam mounting used during the test by means of a heavy "U" shaped bracket encircling the box-like housing, in addition to the lugs provided on the upper matching section. This method of mounting could not be utilized on board ship since it would prevent entry into the housing containing the drive mechanism.

(g) The instruction book accompanying the XTBT equipment states states that mounting brackets must be designed for the par-

ticular installation and that a clamp must be provided to encircle the large tube immediately below the motor housing. Inasmuch as the antenna unit will probably be installed on a member perpendicular to a yardarm, with the motor housing at the yardarm and the large tube extending in free space below the arm, the indicated mounting means will not be suitable. It is recommended that a suitable mounting boss be cast integral with the motor housing so designed as to permit securing to the vertical support erected perpendicular to the yardarm.

(h) In considering the yardarm type of mounting, it was apparent that the transmission line would probably follow the yardarm to the motor housing and then parallel the large tube from the housing down to the present gas tight fitting. With this in view a special fitting was constructed by modifying an Isolantite Co. type 1360-Y junction box. The transmission line, through the use of this fitting, can be brought out on a level corresponding to the motor housing and then run down parallel with the large tube beneath this housing. For added strength, the transmission line can be clamped to this large tube. Thus the transmission line and the gas tight seal provided with the antenna both enter the 1360-Y junction box. Power output tests conducted before and after this fitting was installed showed no appreciable difference and hence this method of making transmission line connections is satisfactory from the electrical or radio frequency point of view.

(i) Leakage of water into the motor housing was noted upon inspection of the unit following its exposure to the weather. The water apparently seeped into the housing through a space caused by buckling of the inspection plate. A spacing of four inches exists between the hold down screws on both the top and bottom edges of the plate. It is recommended that this spacing be reduced to two inches by the addition of another screw on each edge. It was also noted that one hold down screw in this plate opens into the motor housing, while all other screws are tapped into the walls of the housing. At this particular point the wall of the housing is offset. The screw was provided with a fibre washer to insure water tightness, but since these washers are subject to aging, injury or loss, this method is not considered satisfactory. It is recommended that the housing be made of sufficient thickness at this point to prevent the tapped hole from opening into the housing and thus remove the necessity for the fibre washer.

(j) The method used for introducing the gas tight seal into the bottom of the antenna unit does not provide a watertight fit and is weak mechanically. Two 10/32 screws must

support this assembly plus any strain imparted by the transmission line. One of the lock nuts used in this assembly rusted badly during exposure to the weather. It is recommended that consideration be given to improving the design of this part of the antenna assembly.

(k) Component parts in the motor housing, such as the drive motor and synchrogenerator, are secured by means of screws and nuts, and heads of the screws being on the outside surface. Composition washers, apparently of felt, backed by a flat metallic washer, are placed under the screw heads to prevent entry of water. However, it was found that the composition washers gradually became compressed and finally disintegrated thus permitting the likelihood of the screw becoming loose. Furthermore, some of these screwheads will be inaccessible if the back of the motor housing is covered by the supporting member of the yard arm. It is recommended that cap screws, tapped into interior bosses be used for mounting these parts, care being taken to insure access to the cap screws to permit replacement of parts.

(l) The ground rods appear to be made of copper plated stainless steel tubing with a brass plug fitted in one end and a brass fitting threaded and equipped with a hexagonal section on the other end. It appears that eight ground rods were originally used with the antenna and locking screws were provided on these rods. However, twelve rods are now supplied. The additional rods are accommodated by clamping two half rings to the original mounting by means of two ground rods each. The remaining eight rods are screwed into the half rings at equal spaces around the circle formed by the rings. No locking screws are provided for these eight rods. It is recommended that the original casting be enlarged to the size of the rings to accommodate all 12 rods and that suitable locking means be provided for all ground rods.

(m) The instruction book provided states that in order to adjust the quarter wave radiating section of the antenna unit to synchronism with the remote control on the transmitter panel, the bakelite housing should be removed from the radiator. The radiator is then adjusted to 13-13/16" by manually rotating the driving motor (power off), leaving the remote control adjusted to the 160-200 MC mark. This operation could be considerably simplified and the removal of the bakelite housing could be obviated if position marks were placed inside the motor housing and on the driving shoe for the telescoping section to indicate the 160-200 megacycle point.

151. Section IV of Specifications RE 13A 557D. This section of the specifications covers the receiver portion of the equipment. The investigation and test of the Model RAQ receiver is being made the subject of a separate report. The test of the Loud Speaker-Amplifier Units will also be covered by a separate report.

152. Par. 5-1. This paragraph of the governing specifications refers to reference specifications RE 13A 592B and indicates certain exceptions thereto. Reference therefore is made to Specifications RE 13A 592B.

Specifications RE 13A 592B

153. Par. 1-1 and 1-2. The general requirements of these paragraphs have been taken into consideration in the design and construction of the control circuits and control units supplied with the Model XTBT equipment. Actually, four remote telephone units were supplied, but provision is made for operation of five such units.

154. Par. 2-2. The arrangement of the control circuits is essentially that shown on Sheet 9-A of these specifications.

155. Par. 2-2(1). A control transfer switch has been provided on the front panel of the transmitter unit, which when in the "local" position causes the remote circuits to be inoperative, providing the motor generator start relay is not energized from the local position. In this case the push to talk switches in the remote units can operate the carrier relay in the transmitter. It is recommended that this condition be eliminated if possible. This could be accomplished by providing another pair of contacts on the transfer switch to open the desired circuits when this switch is in "Local" position. As pointed out in paragraph 56 above, this switch should be provided with corrosion resisting screws and should be equipped with lock washers.

156. Par. 2-2(2). An emergency push button switch has been provided, so connected that when the equipment is shut down by means of this switch, it cannot be restarted until this switch is thrown to the "on" position. This switch operates to remove all control voltages including the master oscillator heater voltage. The only remaining voltage is the 115 volts on the primary of T-109, the master oscillator filament transformer. This voltage may be removed by use of the "stand-by" switch.

157. Par. 2-2(3). Terminals have been provided on the main terminal board of the transmitter for connection of 6 and 4 wire remote control circuits. The necessary terminals for changing from a momentary contact to a sustained contact start-stop switch have been provided on sub-terminal board "F". Terminals are numbered and wired in accordance with Diagram 9-A of the specifications.

158. Par. 2-2(4). The start-stop switches for four and six wire control are mechanically and electrically interchangeable without undue difficulty. However, the mechanical arrangement as provided whereby the 4-wire control switch is fastened in place is not sufficiently rugged for

Naval usage. 4/40 machine screws threaded into the transmitter panel are used, and stripped threads have developed in the tapped holes. A more suitable arrangement is required. In this connection, representatives of the contractor have indicated that more satisfactory switches and mounting arrangement will be provided.

159. Par. 2-2(5). The keying circuit of the XTBT transmitter derives its voltage from a voltage dividing network consisting of a 1200 ohm resistor (R-146) and a 500 ohm resistor (R-147) across the 275 volt supply. The working voltage across the key relay coil is 40 volts.

160. Par. 2-2(6). A potential of 115 volts AC is used for starting and indicator circuits. This voltage is obtained from the bulkhead mounted transformer (T-110).

161. Par. 2-2(7). Keying potential is obtained from a voltage divider across the 275 volt output of the motor generator. Hence, keying voltage is not obtained until the motor generator has reached operating speed.

Six-Wire Control

162. Par. 2-2(9). With six wire control, the equipment may be started or stopped locally by means of a two button momentary contact switch (contacts normally open) located on the front panel of the transmitter. This feature is operative when control transfer switch is in either "Remote" or "Local" position.

163. Par. 2-2(10). The equipment may be started, stopped, keyed or voice modulated from any connected remote unit after the control transfer switch, located on the front panel of the transmitter, is placed in "Remote" position.

164. Par. 2-2(11). The local indicator lamp, marked "Master Start", is located on the front panel of the transmitter. This lamp is connected in parallel with the master-start relay.

165. Par. 2-2(12). The remote indicator lamp is connected in parallel with the local indicator lamp, through the necessary relay contacts.

Four-Wire Control

166. Par. 2-2(13). The equipment may be started and stopped locally by means of a maintaining contact switch. This feature is operative when the control transfer switch is in the "Local" position. The equipment is so designed that it may be stopped locally when the control transfer switch is in the "Remote" position or started locally if the remote starting switch is in the "On" position and the control transfer switch is in the "Remote" position. Actually, no maintaining contact switches were provided with

the remote telephone units and the necessary steps should be taken to insure that such switches will be provided.

167. Par. 2-2(14) The equipment may be started, stopped and keyed from a remote unit after the local start switch is placed in the "on" position and the control transfer switch is placed in the "Remote" position.

168. Par. 2-2(15). The local indicator lamp is connected in parallel with the master-start relay.

169. Par. 2-2(16). The circuit arrangement is such that the remote indicator lamp is placed functionally in parallel with the local indicator lamp after the control transfer switch is placed in "Remote" position.

170. Par. 2-3. The current values required in the start stop remote control circuits are approximately 0.5 ampere, under maximum conditions. This current includes the supply to five remote indicator lamps (I-201) and the master start relay (K-106).

171. Par. 2-4. Solenoids and relays included in the equipment operated satisfactorily over long periods of operation during which time extremes of temperature and humidity were encountered. This performance indicates the ability of these components to operate under conditions of continuous duty as required by the specifications.

172. Par. 2-5. The keying relay is integral with the transmitter and is mounted on the front panel behind a removable protective cover fitted with a vision opening. The necessary terminals, marked in accordance with the specifications, are provided on the main terminal board of the transmitter.

173. Par. 2-6. The model XTBT transmitter is not designed for CW transmission and when operating an an HCW transmitter, the carrier is not keyed.

174. Par. 2-7. The keying relay operates to control the 1000 cycle modulation in the manner described in detail in paragraph 131 above.

175. Par. 2-8. The keying relay is designed for satisfactory operation up to 100 words per minute. The operating voltage of the relay is 40 volts and the coil requires 85 M.A. at this voltage. The control key is required to break 85 M.A.

176. Par. 2-9. A bulkhead mounted transformer is supplied for providing the necessary 115 volts for control circuit operation. The primary of the transformer may be connected for either 440 or 220 volt operation. A single 110 volt primary is provided, in conformance with paragraph 6-2 of the basic specifications, RE 13A 557D.

177. Par. 2-10. The control circuits functioned satisfactorily when the supply line voltage was varied over the limits required by the basic specifications, plus and minus 5%. Additionally, satisfactory operation

was obtained when the supply line voltage was varied over the limits of plus and minus 10% of the normal voltage.

178. Par. 2-11. The potential across the open hand key is 76 volts.

Telephone Control Circuits

179. Since no DC supply equipment was furnished with the Model XTBT equipment, all tests were made using AC supply.

180. Par. 3-1. The telegraph and telephone remote units are supplied by the contractor.

181. Par. 3-2. The general requirements of this paragraph have been complied with in the design and construction of the Model XTBT transmitting equipment.

182. Par. 3-3. The Model XTBT equipment incorporates the following:

(1) A low voltage (12 v DC) supply.
(2) A carrier control relay.
(3) A suitable audio input circuit.
(4) Terminals to permit connection to external circuits.

183. Par. 3-4. The low voltage source for microphone and control circuit supply of the transmitting equipment and remote telephone units is of the copper oxide rectifier type. This rectifier and its associated transformer, filter and so forth, is mounted in a bulkhead type mounting case, separate from the transmitter unit.

184. Par. 3-4(1). The low voltage source supplies a nominal 12 volts, suitably filtered. As indicated in Table 51, the percentage of ripple (R M S) is 0.015%, when the unit is delivering 425 MA. One remote telephone unit, when controlling the transmitting equipment, requires a current of 235 Milliamperes plus 190 MA required for energizing the carrier relay K-104 in the Transmitter. In addition to the above, the remaining four remote telephone units (one in local position) require 420 MA. See Table No. 52. From the foregoing it will be seen that the total normal load on the 12 volt unit is 845 MA. The equipment is capable of supplying this load without damage or overheating. Additionally 1200 or 1500 MA overloads may be applied to the 12 volt source at infrequent intervals without damage. A two hour test was conducted wherein the 12 volt rectifier was subjected to a load of 955 MA continuously at an ambient temperature of 24 degrees C. At the end of the 2 hour period the temperature of the copper oxide rectifier had risen to 56.7 degrees C. The other component parts in the unit showed slight temperature rises, but in no case was serious overheating noted. The control circuit rectifier was subjected to varying conditions of ambient temperature and humidity as illustrated in Tables 53 and 54. It will be noted that the variations in temperature and humidity produced no ill effects upon the functioning of the equipment.

185. Par. 3-4(2). The voltage regulation of the control circuit rectifier is illustrated in Table 55 and Plate 9. The transformer in the control circuit rectifier is supplied with tapped primary and secondary as indicated below:

Primary	Tap 1	110 v	Secondary	Tap 1	25.1 v
	Tap 2	115		Tap 2	26.2
	Tap 3	120		Tap 3	27.5

During the course of these tests Primary Tap 2 and Secondary Tap 3 were employed. It will be noted from Plate 9 that the no load voltage of the rectifier unit is approximately 16 volts while with an overload of 1.2 amperes, the voltage is 12.1 volts. The control relay in the Remote Telephone Unit operates satisfactorily on voltages as low as 9.7 volts. While the foregoing data reveals that the no-load voltage exceeds the specified 14 volts, the tests showed that the equipment performed satisfactorily and hence the arrangement provided is considered satisfactory.

186. Par. 3-4(3). Power for operation of the Control Circuit Rectifier is obtained from slip rings on the motor generator.

187. Par. 3-4(4). No ground connections are made to the low voltage supply.

188. Par. 3-5. The carrier relay K-104 in the Transmitter unit requires 190 MA for operation. This is in excess of the specification requirement of 75 MA. In view of the fact that this relay performed satisfactorily throughout the tests and that the additional current required for its operation did not adversely affect the Control Circuit Rectifier, it is recommended that the Bureau consider the advisability of waiving the 75 MA requirement. The circuit is so arranged that with the equipment in the stand-by condition, operation of the press to talk switches associated with the remote telephone units or the transmitter causes immediate emission of the carrier with no further operation being required to modulate the carrier other than speaking into a microphone. Opening of the press to talk switch causes the emission to cease immediately.

189. Par. 3-5(1). One side of the carrier relay K-104 is permanently connected to the negative side of the low voltage supply and the positive connection is completed through contacts on the relay located in a remote telephone unit and through press to talk switches associated with the transmitting equipment.

190. Par. 3-5(2). Since the carrier of the XTBT unit is not keyed, this paragraph does not apply.

191. Par. 3-5(3). Carrier relay K-104 controls the transmitter emission directly by removing or applying the plate and screen potentials to the vacuum tubes. The key relay K-102 controls the required delay circuits and the carrier relay K-104 as described in paragraph 131 above.

192. Par. 3-6. The audio circuits of the speech amplifier equipment are suitable for the type of microphone supplied with the transmitter and for operation with the 600 ohm output circuits of the remote telephone units. Taps are provided on the input transformer for use with 200 ohm levels if desired.

193. Par. 3-7. Terminals are provided in the transmitter for connection to the ship's distribution board from which point up to 4 remote telephone units may be connected. These terminals are numbered in accordance with the diagram on sheet 25A of RE 13A 592B.

(1) A terminal (No. 12) is provided for connection to a telephone unit located adjacent to the transmitter.

(2) Terminals for connection of the receiver noise suppressor control leads (Nos. 15 and 16) are provided in the Transmitter unit.

194. Par. 3-8. In addition to the noise suppressor terminals mentioned above, terminals numbered 13 and 14 are provided in the transmitter for accommodating the audio circuits from the receiver.

Combined Telephone and Telegraph Remote Control Unit.

195. Par. 4-1. Four remote telephone units were supplied with the Model XTBT equipment.

196. Par. 4-2. The units are provided with circuits for controlling the Model XTBT transmitter. Either 4-wire or 6-wire systems may be employed. The start-stop and keying circuits are independent of the telephone circuits and there are no common external connections between the two groups of circuits.

197. Par. 4-3. The telephone start-stop and keying control of the XTBT transmitter is controlled from the Remote Telephone Unit equipped with the following:

Item "A". A permanently connected combination hand set.

Item "B". A local chest microphone

Item "C". A telephone extension consisting of a combination hand set.

Item "D". A telephone extension consisting of a chest microphone equipped with a jack for plugging in a telephone headset. (For use in lieu of Item "C").

198. Par. 4-4. There are mounted on the front panel of the telephone unit the following controls and indicating devices, designated by suitable and appropriate markings, conveniently located with respect to

the circuits involved and symmetrically arranged so far as possible:

(1) A two button momentary contact start stop switch (Contacts normally open). This switch may be replaced by a SPST maintaining contact switch. The switch is well constructed to withstand potentials up to 350 volts and currents up to 2.5 amperes.

(2) A 6 watt, 115 volt lamp mounted back of the panel and viewed through a blue lens indicating the energized condition of the transmitter starting relay. The exact type of the lamp is not indicated, however, it is equipped with a candelabra screw base. This lamp requires only 50 MA for operation instead of the 100 MA specified for a type CS-5 lamp.

(3) A two position "off-on" toggle switch for controlling application of the 12 volt DC control voltage, labelled "12 Volt Control Circuit".

(4) A 12 volt lamp (GE Mazda 12-A) mounted back of the panel and viewed through a red lens indicating carrier on. Labelled "Carrier On".

(5) A five pin jack located near the lower edge of the panel for use with Item "C" or "D". Labelled "Extension".

(6) Two standard Navy type 49021 jacks located near the lower edge of the panel, one for use with item "B" and the other for use with a standard Navy Head Phone. Labelled "Local Chest Mic." and "Local Head Set".

(7) A three position key switch so arranged that when in the center position labelled "Extension", the circuit of the microphone jack referred to in Par. 4-4(6) will be open and the transmitter control may be controlled and modulated through the jack referred to in par. 4-4(5). The down position, labelled "Local Chest Mic", provides momentary contact to energize the control relay referred to in par. 4-10, energizes Item "B" if plugged in and causes the microphone and control circuit of the jack referred to in par. 4-4(5) to be inoperative. The "up" position, labelled "Local Chest Mic", provides the same connections as "down" but provides locked-in operation.

(8) A holder for hand set, Item "B", is provided. A hook switch is provided to function as required by par. 4-19.

(9) A two position "off-on" Toggle switch opens the earphone circuit of the jacks referred to in paragraph

4-4(5) and (6). Labelled "Earphone Circuit".

(10) A two position "off-on" toggle switch opens the telegraph key circuit. Labelled "Key Circuit".

(11) A momentary push button switch (contacts normally open) controls the associated receiver noise suppressor. Labelled "Noise Suppressor".

(12) A level control to adjust the audio level in the earphone circuit to a suitable level is provided. A fluted knob controls the 200 ohm rheostat and is labelled "Earphone Level", with an arrow indicating the direction for increased effect. The control is capable of reducing the audio level 36 DB below the maximum, as shown in Plate 10.

Start Stop and Keying Control.

199. Par. 4-5. The operator is able by use of the start-stop and keying circuit controls to:

(1) Start or stop the transmitting equipment.

(2) Determine by means of the indicator lamp whether the startin relay of the transmitter is energized.

(3) Telegraphically key the transmitter by means of a hand key connected to the unit.

Telephone Control

200. Par. 4-6. The operator is able by use of the telephone control devices supplied to:

(1) Control application of the 12 volt DC control voltage to the unit.

(2) Transmit and receive voice communication using the handset (Item "A"), a telephone extension (Item C or D) or a chest microphone (Item B) and a standard Navy type headset and the panel talk key switch.

(3) Receive voice signals by means of a loud speaker connected to the unit.

(4) Adjust the audio level of connected earphones to a suitable value.

(5) Determine by means of a 12-volt panel lamp indicator when the carrier is on.

(6) Open the telegraph key circuit by means of the appropriate switch.

(7) Plug in by means of a jack the extension handset (Item C) or the extension chest set (Item D).

(8) Open the earphone circuit of all panel jacks by means of a suitable switch.

(9) Transfer microphone carrier control from the jacks referred to in par. 4-4(5) and (6) to the local handset (Item A) by removing the handset from its holder.

(10) Cut off momentarily the noise suppressor of the receiver through the medium of the momentary push button switch provided.

Components and Terminal Board Requirements.

201. Par. 4-7. The unit includes everything necessary to take power from the 12 volt DC source of the bulkhead mounted rectifier unit and deliver a satisfactory level of audio energy for normal speech to the transmitter speech input circuits. Controls the carrier by means of the unit relay which in turn controls a relay in the transmitter energized from the same DC source. Energizes the "carrier on" indicator and similar indicators in other connected units and transfers the audio input to a connected loud speaker to a 620 ohm 1/2 watt resistor load (R-202) when the unit control relay is energized. Operation from the 12 volt DC supply is satisfactory over a range of 10 to 14 volts. The total current required by a remote telephone unit is shown in Table 52 and as indicated in paragraph 188 above the transmitter carrier relay requires 190 MA instead of the specified 75 MA. The 60 MA current to the microphone is supplied through a 180 ohm 2-watt resistor (R-208). The positive 12 volt dc supply is connected mutual to the unit control relay contacts and the single lead connection of the press-to-talk switches.

202. Par. 4-8. Means are provided in the unit to minimize as far as practicable, variations of the load across the incoming receiver output leads, regardless of the number of earphones provided for.

(1) A 620 ohm 1/2 watt resistor load (R-204) is automatically substituted for the 600 ohm headset when the plug is removed from the headphone jack and when the earphone circuit switch is "on".

(2) A 620 ohm 1/2 watt resistor load (R-207) is automatically substituted for the 600 ohm earphone of Item A when the local handset is placed on the hook.

(3) A 300 ohm 1/2 watt resistor load (R-206) is automatically substituted for the earphone or headphones of Items C or D (which may be plugged in) when the earphone circuit switch is thrown to the off position.

203. Par. 4-9. The unit is provided with a microphone transformer suitable for use with the microphone supplied and the 600 and 200 ohm transmitter input circuits. The fidelity and distortion values of the equipment are not appreciably affected and satisfactory operation is obtained when as many as 4 units are connected to the transmitting equipment. See Tables 42 and 43.

204. Par. 4-10. The unit includes a 12-volt relay which is energized by the various press-to-talk switches. The relay is provided with three sets of contacts which perform the following functions:

(1) One set controls the transmitter carrier relay.
(2) One set energized the "Carrier On" indicator.
(3) One set transfers the audio input to the loud speaker to an equivalent resistor load.

During the course of the humidity tests conducted the relay coil developed an intermittent contact. It is not known whether this relay suffered due to humidity or whether a defect in manufacture was responsible for this failure. Precautions should be taken to insure that production relays will not develop defects of this nature.

205. Par. 4-11. The "Carrier On" indicator is a 12-A GE Mazda lamp conforming to the specifications as to dimensions, mounted back of the panel and viewed through a red lens. It would be advantageous to supply a centering tube to slip over this lamp to limit its side to side motion.

206. Par. 4-12. Adequate terminals are provided for connecting necessary leads from the transmitter and receiving equipment with additional terminals for connection of Item ";", hand key and loud speaker. The required terminals for connections to transmitter and receiver are numbered 1 to 16 and their functions are as indicated in Table No. 56. The additional terminals are numbered 17 to 21, with the exception of terminals for the local hand set which are mounted on a separate terminal board and are marked 7 to 11. The terminal boards are not suitably identified by markings and should be labelled "Z" and "Y" to conform with the diagrams submitted by the manufacturer. The terminal boards are conveniently accessible. Connections from the main or "Z" terminal board to the unit chassis are made by means of cabled flexible leads of sufficient length to permit withdrawal of the panel on its hinge. The leads to the terminals are removable by removing four nuts on the main terminal board and then withdrawing the terminal board. The terminal board is then turned over and terminals may then be removed by use of a screw driver. The terminal board mounting screws extend through the back of the unit case and the heads are not accessible when the unit is mounted on a bulkhead. Any spacing between the back of the unit and the bulkhead will allow the terminal board mounting screws to drop back. Changes in terminal board design will be necessary to conform to the requirements of this paragraph for easy removal of internal connections.

Starting Circuit Requirements

207. Par. 4-13. The unit is so designed that the two button momentary contact start-stop switch may be replaced with a SPST maintaining contact switch. Since no maintaining contact switch or adapter plate was furnished with the preliminary model, it was not possible to determine the mechanical interchangeability of the switches. The SPST, when required, is wired in accordance with the specifications through the use of an additional terminal board, labelled "Y" in the schematic diagram. It is pointed out that when this SPST switch is used on more than one unit that they are in parallel and should more than one switch be in the "on" position, the opening of any single switch will not stop the transmitter.

208. Par. 4-14. The transmitter starting relay indicator is a 6 watt, 115 volt lamp mounted back of the panel and viewed through a blue lens. In locations with subdued lighting the lens is sufficiently visible but in brightly lighted locations it is impossible to determine whether or not the indicator is lighted. There is a decided leakage of light around the panel edges, which may be objectionable when the remote telephone unit is mounted in exposed locations and when "darken ship" rules are in force. Satisfactory operation is not obtained when a nominal line voltage of 230 volts DC is varied over the limits of minus 23% to plus 52%. Under these conditions the lamp and series resistor are subjected to overloads, as follows:

Condition of Operation	Supply Line Potential	Potential of Lamp	Resistor Dissipation
Normal	230 V	75 V	5.8 Watts
Minus 23%	177	42	3.9
Plus 52%	250	137	11.4

The series resistor (R-201), 4000 ohms, used when connected for nominal 230 volt DC operation, heats to such an extent at plus 52% operation that the winding insulation is damaged. Under normal voltage operation this resistor heated to 80 Deg., C. and very noticeable softening of the insulation was observed. At minus 23% operation the lamp is dimmed to the point where it is practically invisible. It is evident that a more suitable resistor is required in this location. Operation on 115 volts is accomplished by the use of a shorting bar across the series resistor. The insulation of the start-stop circuit is adequate for potentials up to 350 volts.

Combination Handsets, Chestset and Chest Microphones.

209. Par. 4-15. The local handset (Item A) is equipped with a four foot, 5-conductor rubber covered cord. The individual conductors making up this cord are rubber covered and color coded. The color coding provided, however, possesses insufficient contrast to permit ready identification of the individual circuits. Humidity and temperature also affected the covering of the main cord, which faded from black to a

light gray. This cord is of the unshielded type as are all the other telephone cords provided with the Model XTBT equipment. The microphone cap retaining ring is of ferrous material, nickel or chromium plated. On one of the units provided this plating started to peel and signs of rust were visible. It is recommended that all retaining rings be fabricated from non-ferrous materials, equipped with a light knurl and finished in a dull non-reflecting finish. A press to talk switch is incorporated in the handgrip. The plate furnished with one unit did not fit properly; care should be exercised to provide properly fitting plates in all units. The telephone cord is covered with a reversed coil spring to take up the slack when the handset is in its cradle. During the time of these tests the cord sagged to an extent sufficient to interfere with closing the cover, if such a cover is provided for exposed locations. In its original condition the cord remained in the recess provided, but after use the tension of the spring decreased sufficiently to permit the cord to sag. A retaining strip across the bottom of the recess would prevent this difficulty. During speech tests it was noted that movement of the handset cord caused noises due to "Squeegee" action. These noises were of sufficient intensity to produce about 30% modulation. While this unwanted modulation was insufficient to interfere with the received signals, conditions may arise where such modulation may be undesirable. Some method of damping or eliminating this noise should be provided if possible. The handsets were not marked with type numbers.

210. Par. 4-16. The chest microphone (Item B) is equipped with a 5-1/2 foot two conductor cord and a four circuit plug, two circuits of which are used. The 5-1/2 foot length is considered more satisfactory than the 4-foot length specified. The microphone cap retaining ring is of nickeled brass. The bakelite cap does not present a very workmanlike appearance, probably due to being adapted for use to this particular purpose. The recommendation regarding use of a light knurl and dark finish, together with elimination of extraneous noises, as discussed in paragraph 209 above, also apply. The chest microphone bore the type number CAU-51010.

211. Par. 4-17. The extension combination handset is similar to the local handset in all respects with the exception that is is equipped with a 20 foot 5-conductor cord and a 5 contact plug. This plug has several unsatisfactory features as follows:

(a) The cord clamping retainer ring is a screw type that is readily loosened and is easily mistaken for the main body retaining ring.

(b) The contact retainer insulator is held in the main body by means of a 1/8" x 4-40 set screw tapped into the bakelite insulator.

(c) The cord protecting spring on the plug end does not fit properly; by comparison the spring provided on the handset end is of superior design

(d) The cord locking arrangement does not offer sufficient protection against strain.

It is recommended that connectors in accordance with specifications AN-9534 be considered for use in this connection. The earphone diaphragms as supplied with these items are of different quality and size than those supplied with Item A. The diaphragms of Item C are too small for the earpiece. This results in irregularities in sound level between units. The earcaps do not clamp these diaphragms evenly, resulting in bending and distortion. The earpiece does not fit its housing properly, thereby allowing it to rotate. The extension handset was not provided with a type number.

212. Par. 4-18. The extension chest set (Item D) includes a microphone similar to that supplied in Item B except that it is provided with a single contact press-to-talk switch. The chestset is equipped with a 20 foot 5 conductor cord, rubber covered and color coded. This cord is equipped with a five contact plug similar to that discussed in paragraph 211 above. The criticisms contained in paragraphs 209 and 211 also apply to Item D. A single circuit jack to accommodate a standard phone plug is clamped to the breastplate. The microphone leads, leads to headphone jack and extension cord terminate in a connector block secured to the breastplate. The connector block as supplied is not considered suitable for the following reasons:

(a) Three holes are drilled in the top, only two of which are used. Water may readily enter through the unused hole.

(b) The microphone cord enters through a hole that has been enlarged to accommodate this cord. In doing this the cord clamping ridges have been cut away.

213. Par. 4-19. The handset holder on the remote telephone unit consists of a hook-switch support which holds the handset in a vertical position. The retaining spring intended to hold the handset securely in place broke during vibration tests in the unit used during these tests. The rubber buffers provided for handset protection are slipped over the hook ends. This rubber hardened and cracked during the course of the tests, offering little or no protection. A more suitable grade of rubber should be provided. The hook switch is so designed that when the handset is in place the microphone and carrier control circuits are transferred to the local and extension jacks, and the handset earphone circuit is opened. When the handset is removed the microphone and carrier control circuits are transferred to the handset and the handset earphone circuit is closed. The hook switch does not affect the earphone circuits of the jacks referred to in paragraphs 4-4(5) and (6). The holder assembly is located along the left hand side of the unit and is fastened in place in a recess in the front panel, where the handset is in a readily accessible position.

Unit Chassis and Cases.

214. Par. 4-20. All controls and indicating devices are located on the front panel of the unit and all integral parts are assembled on the rear thereof. The panel may be removed as a unit. The panel is hinged on the right hand side. Two 1/4-20 machine screws are used to hold the cover in place. No limiting device or door-stop is provided to prevent strains from being placed on the hinges when the panel is in the open position. It is recommended that such a device be included in the assembly. A suitable stop would provide protection to both equipment and personnel, particularly in rough weather.

215. Par. 4-21. The remote telephone unit cases accompanying the preliminary model XTBT equipment were not supplied with watertight covers. The cases, however, are so designed that covers may be applied when required. The cases are designed for bulkhead mounting and the present overall dimensions are as follows:

Height - 17-7/8" Width - 9-1/2" Depth - 5-7/8".

When water tight covers are provided, provision must be made to allow clearance from the front panel to the inside of the cover of at least 1-5/8". As provided, the bottom of the cases are tapped for five terminal tubes to accommodate incoming cables. Plugs were provided to close unused entrance holes and thus render the unit watertight. It is understood that the Bureau intends to omit the entrance tubes drilling in the case and in lieu thereof provide a portable watertight plate suitable for drilling at the time of installation. Such a plate, in order to accommodate the maximum number and sizes of cables which the Bureau intends to designate, would have to be of sufficient size to accommodate the following types of Navy terminal tubes:

1 - Type "L" tube for THFA-19
1 - Type "J" tube for THFA-10
1 - Type "C" tube for TTHFA-3
1 - Type "C" Tube for THFA-2
1 - Type "B" tube for TTHFA-1

The minimum overall dimensions required to accommodate the above terminal tubes is 2-1/2" x 8-1/2". The dimensions of the bottom of the remote telephone unit are such that a portable plate somewhat larger than the above dimensions can be accommodated. Mounting lugs, cast integral with the case, one at each corner, are provided for securing the unit to a bulkhead. It is recommended that these mounting lugs be increased in size to provide greater strength. Lugs 1-3/4" high x 1-5/8" wide x 3/4" deep drilled for passage of a 1/2" bolt are suggested. These lugs should include a 1/8" boss on the rear for clearance of irregularities in the bulkhead. The panel is secured by two 1/4" machine screws threaded into bosses cast in the case. It is recommended that these bosses be strengthened and drilled for a 3/8" machine screw in place of the present 1/4" screws.

216. Par. 4-22. The Remote Telephone Units accompanying the preliminary Model XTBT equipment are intended for installation in protected locations and are finished in black wrinkle finish.

217. Par. 4-23. The interior of the remote telephone units are finished in a natural aluminum color.

Specifications RE 13A 557D

218. Par. 6-1. In general, the power conversion equipment supplied with the Model XTBT equipment is capable of operating the equipment as required. Such items of construction or features of operation which are not considered wholly suitable for the needs of the Naval service are discussed in detail under appropriate paragraph references.

219. Par. 6-2. The Model XTBT equipment as supplied was designed to obtain its main power from a 440 volt 3 phase, 60 cycle source.

(a) The total power required by the Model XTBT transmitter unit under various conditions of operation is listed in Table No. 57. In all cases the power required is well within the 2000 watt limit imposed by the specifications.

(b) A bulkhead mounted control circuit transformer has been provided. The primary of the transformer is designed to operate from either 220 or 440 volts, single phase, 60 cycles, by selection of the proper terminals. The secondary winding delivers a nominal potential of 115 volts. The transformer is rated at 250 voltamperes. Table No. 58 itemizes the load which this transformer may be called upon to deliver. It will be noted that this load may reach a maximum of 285 va, which is in excess of the rated load. It may be stated, however, that at no time during the course of the test did this transformer show signs of overheating, even though operated at ambient temperatures as high as 50 degrees C. The transformer is equipped with six terminal leads which are brought out through grommeted holes. No terminal panel is provided and the transformer core and windings are immersed in compound. This method permits strains to be imparted to the wiring itself and should the wiring fail within the compound filled enclosure, difficulty would be experienced in effecting repairs. It is recommended that the Bureau consider the advisability of requiring a transformer fitted with a terminal board equipped with suitable terminals marked in a legible manner to indicate the purpose of each lead. Entrance for incoming cables is provided by means of knockouts in the transformer case. The transformer is fitted with a removable cover, held in place by machine screws.

(c) Since the equipment submitted for test was not designed for DC operation, the adequacy of the starting and temperature control circuits with DC supply could not be determined.

220. Par. 6-4. The power conversion equipment for the Model XTDT equipment consists of a motor generator unit.

(a) This unit consists of a generator provided with two armatures mounted on a single shaft. Additionally, the 275 volt armature is equipped with slip rings for furnishing a nominal 60 cycle potential at 115 volts. The motor supplied is rated at 1.5 HP, 220/440 volts, 60 cycles, 3 phase. The exciter unit, rated at 275 volts, supplies the necessary DC for use in connection with the keying relay.

(b) The total load applied to the motor generator equipment under various conditions of operation is itemized in Table 59. It will be noted that the high voltage armature and the exciter armature are operated within their power ratings, but over voltage is present under certain conditions. As previously mentioned, the temperature characteristic of the motor generator is such that when the motor generator is started the output voltages are in excess of the rated voltage. The high voltage armature is rated at 435 volts, while the exciter is rated at 275 volts. Upon starting, these voltages may be as high as 485 volts and 305 volts respectively, at ambient temperatures of 20 to 25 degrees C. The output voltages required for full power operation of the transmitter are 457 and 282 volts respectively. Thus it will be seen that the generator is required to produce higher voltages than the normal rating. It is recommended, therefore, that steps be taken to provide a generator capable of delivering the required voltage and that provision be made to prevent over voltages when starting or when the equipment is operating at ambient temperatures as low as zero degrees Centigrade. In order to accomplish this it is suggested that a compensating field resistor of the proper resistance temperature characteristic be given consideration. It will further be noted that while the slip rings are rated to accommodate the normal continuous load, operation of the antenna drive motor causes an additional load of 71.5 watts, or a 56% overload. When the transmitter is in "Tune" position, but the antenna drive motor is not energized, the fields of the synchro generators consume 21.5 watts or an overload of 16%. While these overload conditions did not cause damage during the course of the tests conducted, it is felt that under shipboard conditions occasions may arise where such an overload may

be serious. It is recommended therefore that motor generator equipment with sufficient slip ring capacity be provided to afford a suitable safety factor.

221. Par. 6-5. The power conversion equipment as supplied was subjected to numerous tests at full power key-locked transmitter load without failure or signs of overheating. Attention is invited, however, to the overload conditions which may be present as outlined in paragraph 220 above.

222. Par. 6-6. The total power required from the supply mains for operation of the Lonel XTDT equipment, including all auxiliaries, is considered to be the practicable minimum in accordance with good engineering practice.

223. Par. 6-7. The motor generator equipment supplied is of the two unit, four bearing type. The generator employs two armatures on a single shaft while the length of the generator armature shaft assembly is 22 inches.

224. Par. 6-8. The flexible coupling between the motor and generator is of the conventional leather disk type so designed that no parts project which might constitute a hazard. The coupling is not protected by a guard. In equipments of recent design coupling guards have been specified.

225. The motor and generator are mounted on a common rigid bedplate of cast aluminum alloy. The plate is of sufficiently rigid construction to permit moving the unit about and supporting it at the extreme ends without distortion. The dowels by means of which the motor and generator are aligned are inserted from the bottom of the frame. Thus, no evidence is visible, when the equipment is installed, that dowels have been used. The dowels furnished are not equipped with square heads. It is recommended that the conventional manner of inserting the dowels from the top be employed and that all dowels be furnished with square heads of sufficient size to facilitate removal. No special provision has been made for lifting the individual units and no eyebolts or lifting bails have been provided for lifting the motor generator as a single unit.

226. Par. 6-10. The frames of the motor and generator are bolted to the bedplate, thus grounding these frames when the bedplate is grounded to the ship's hull. The terminal boxes provided on the motor and generator are securely mounted and grounded to the generator and motor frames and are of sufficient strength to support a weight of 250 pounds. The terminal box on the motor is cast iron; the generator terminal box is cast aluminum alloy with a brass spacer between it and the generator housing. The field resistors are mounted in a cast iron box secured to the generator housing. This box is also provided with a brass spacer piece. The cover of the generator terminal box is held in place by means of four machine screws. Since the generator fuses are contained in this box rapid servicing would be facilitated if the cover were secured by means of thumb screws which would not require the use of tools. No terminal board is provided for the motor leads. As supplied these leads are provided with lugs which may be

bolted to the connecting cables. It is recommended that a suitable terminal block be provided to remove the possibility of strains being applied to and breaking the motor leads.

227. Par. 6-11. The weight and overall dimensions of the motor generator unit are shown in Table 8. The weight and dimensions are within the specification limits.

226. Par. 6-12. The motor and generator are equipped with self-aligning ball bearings.

229. Par. 6-13. Each bearing is equipped with screw type grease cups and nameplates are affixed to the unit indicating the type of lubricant to be employed.

230. Par. 6-14. The word "Radio" and the model letters of the equipment were not stamped on the ends of the armature shafts in the preliminary model.

231. Par. 6-15. Fuses have been provided to protect the motor generator as described in paragraph 28 above. As indicated in this paragraph (Par. 28), the disruption of the 275 volt fuse causes undesirable conditions to be present. Fuses in the generator may be replaced by removing the terminal box cover. In order to simplify this procedure the use of thumb screws is recommended as outlined in paragraph 226 above. Fuses are so mounted as to minimize accidental short circuits.

232. Par. 6-16. The motor generator supplied is of drip proof construction.

233. <u>General Notes on Motor Generator Equipment</u>

(a) Inspection of the motor revealed that the portion of the shaft not covered by the rotor had rusted. It is recommended that a suitable finish be applied to this portion of the shaft to prevent corrosion.

(b) Each high voltage commutator is equipped with two radial brushes. The brushes for the 435 volt commutator are 1/4" x 1/2" x 3/4" in size, while the brushes for the 275 volt commutator are 5.16" x 3/4" x 1-1/8" in size. The slip rings have two radial, slightly stubbing brushes, 5/16" x 5/8" x 1-1/8" in size. The pig tails on the 275 volt DC and on the 115 volt AC brushes are secured under screws on the brush holder. The pig tails on the 435 volt dc brushes end in a washer, i.e., conventional fan motor type construction. Phenolic insulation is employed for all brush holders

(c) Each armature is provided with a two pole salient field.

234. A summary of defects noted in the Model XTDT Transmitting Equipment, and such items as do not comply with the requirements of the governing specifications, together with suggestions for improvement, are listed below. At the end of each comment reference is made to the paragraph number of this report which discusses these items in detail.

(1) Non-refillable fuses (440 volts or lower) furnished; disruption of 275 volt generator fuse causes unsatisfactory condition. (Par. 28(a). Bulkhead mounted Transformer T-110 not provided with fuse protection. (Par. 28(b). Protective circuits of motor starter present an undesirable condition. (Par. 28(c). Motor starter is equipped with magnetic door latch. (Par. 28(d). No trip indicator provided on overload relay. (Par. 28(e). Thermal overload devices in motor starter functioned erratically (Par. 28(f). Master Oscillator compartment not provided with thermal protection. (Par. 28(g); P.A.blower motor noisy and difficult to lubricate. (Par. 29).

(2) Inadequate ground facilities provided on transmitter unit. (Par. 31).

(3) Location of master start relay undesirable from safety standpoint. (Par. 34).

(4) Leakage of wax from condenser C-139 caused relay K-103 to cease functioning. (Par. 35).

(5) Insulation defects exist in coil forms of master oscillator, crystal calibrator and 1st amplifier circuits. (Par. 36).

(6) Wiring and terminal board defects exist. (Par. 38 and 88).

(7) Indicator lights unsatisfactory during vibration; fitted with polished bezels. (Par. 39).

(8) Contact difficulties experienced in connection with various switches. (Par. 40, 106(a), 112).

(9) No voltmeters are provided with the equipment. (Par. 42).

(10) Cable entrance holes in unit not suitable. (Par. 47(1), 47(2), 47(4), 144).

(11) Gamewell type lever switches show signs of corrosion and are not securely assembled. (Par. 56).

(12) Various vacuum tube sockets require corrective action (Par. 62).

(13) Greater accuracy of re-set indicated for Control "C". (Par. 67).

(14) Extra calibration cards not provided (Par. 70).

(15) Excessive backlash exists in certain controls. (Par. 73(b).

(16) Circuit symbol markings are not provided. (Par. 79).

(17) Finish on nameplates not satisfactory. (Par. 80).

(18) Finish of all units not in accordance with latest specification requirements. (Par. 84, 85, 86)

(19) Meters are secured by means of nuts and lock washers rather than by tapped holes in panel. (Par. 89)

(20) Errors noted in preliminary instruction book; (Par. 90). Instructions to be expanded. (Par. 109).

(21) Short and open circuiting of antenna causes overheating of P.A. tubes. (Par. 93).

(22) As originally submitted, vacuum tubes in the transmitter were subjected to overloads. (Par. 94).

(23) Use of rubber gasket on M.O compartment appears unsuitable. (Par. 95).

(24) Resistors of unsuitable characteristics are used in the equipment. (Par. 98 and 208).

(25) P. A. Blower motor derives power from bulkhead transformer in violation of specifications. (Par. 100).

(26) Number of calibrator check points considered insufficient. (Par. 106(b). Calibrator capacitor control should be modified and signal levels of 0.03 milliwatts should be considered as suitable minimum value. (Par. 106(c). Calibration chart provided not considered suitable (Par. 106(d).

(27) M.O. heater loses control at Zero Deg. C. (Par. 108).

(28) Instruction books should emphasize procedure to be followed when changing tubes in M.O. compartment. (Par. 111).

(29) Master oscillator compartment strikes transmitter frame during vibration. (Par. 112).

(30) Type 829 P.A. Tube had faulty plate weld. (Par. 115).

(31) Insufficient overlap provided between master oscillator ranges 4 and 5, and 7 and 8. (Par. 121).

(32) Motor generator "Hunts". (Par. 125).

(33) Changes in carrier control circuits recommended (Par. 131).

(34) P.A.Grid switch violates par. 3-17 of specifications; trip switches S-114 and 115 should be eliminated. (Par. 135).

(35) Transmission line termination violates transmitter dimensions. (Par. 136).

(36) Mounting bolt clearance of transmitter inadequate. (Par. 137).

(37) Transmitter unit cannot be mounted with its back flush against a bulkhead. (Par. 139).

(38) Adequacy of internal shielding may be insufficient to prevent harmonic radiation. (Par. 141 and 126).

(39) The Modulation meter zero is displaced by 5% due to unblocked dc. (Par. 145(7).

(40) Defects encountered in Transmission lines (Par. 146(a); shouldered solder pins recommended for inner conductor (Par. 146(b).

(41) Unsuitable mechanical features in Antenna Unit. (Par. 150).

(42) "Remote-Local" switch does not entirely disconnect remote functions when in "Local position". (Par. 155).

(43) Mounting of 4-wire start-stop switch on transmitter unsatisfactory. (Par. 158). Maintaining contact switches for 4-wire control not supplied with remote telephone units. (Par. 166).

(44) No-load voltage on control rectifier exceeds 14 volts. (Par. 185).

(45) Carrier relay draws 190 MA instead of 75 MA required by specifications. (Par. 188).

(46) Indicating lamps not in strict accordance with Type CS-5. (Par. 198(2).

(47) 12-Volt relay in Remote Telephone Unit developed intermittent open circuit. (Par. 204).

(48) Carrier on indicator lamp in Remote Telephone Unit requires additional support. (Par. 205).

(49) Terminal boards in Remote Telephone Unit are not labelled with identification numerals; terminal board mounting means does not conform with specifications. (Par. 206).

(50) Start-Stop indicator lamp and series resistor in Remote Telephone Unit not satisfactory. (Par. 208).

(51) Numerous component parts of Remote Telephone Units possess undesirable characteristics. (Par. 209, 210, 211, 212, 213).

(52) Panel of Remote telephone unit not provided with door stop (Par. 214); mounting and securing means provided for Remote Telephone Unit should be strengthened. (Par. 215).

(53) Bulkhead transformer operates at overload; no terminal block provided. (Par. 219(b).

(54) Slip ring circuit subjected to overloads; motor generator subjected to overvoltage. (Par. 220(b) and 108).

(55) Motor generator coupling not protected by guard. (Par. 224).

(56) Dowel pins and method of installation unsuitable (par. 225); generator base is cast aluminum alloy (Par. 225); no provision made for lifting units. (Par. 225); contact is permitted between brass and aluminum parts (Par. 226); generator terminal box cover held by machine screws (par. 226); No terminal board provided for motor leads (Par. 226); The word "Radio" and model letters are not stamped on armature shafts (Par. 230); Motor shaft rusted during tests (Par. 233(a).

CONCLUSIONS

235. Detailed tests and measurements show that the power output delivered by the Model XTBT equipment under various conditions of operation complies with the requirements of the governing contract and specifications.

236. The frequency stability and accuracy of the transmitter under the various specified conditions, including re-set, 2-hour locked key operation, temperature variations, humidity variations, line voltage variations, tube changes and vibration, falls within the limits of 0.012% (without vibration) and 0.017% (with vibration) as required by the governing specifications. Additional tests not definitely specified, were conducted to determine the influence or effect of inclination, shock, back lash in controls, detuning of circuits, dial locks, tune-operate control and intermittently keyed operation. The equipment withstood these tests in a manner comparable with the results obtained with other Naval transmitting equipment of good design operating in the lower frequency ranges. In connection with the calibration and re-set accuracy of the transmitter, further consideration is indicated in order that the facilities furnished may best meet the requirements of the Naval Service in a manner to be designated by the Bureau of Ships.

237. In general, the antenna and transmission line system as submitted functioned successfully and satisfactorily when subjected to a wide variety of test conditions. However, it must be realized that test procedure under laboratory conditions cannot duplicate Naval shipboard operating conditions in all respects and hence the final estimate of the suitability of the Model TBT equipment to fulfill service needs afloat is contingent upon Fleet trials and experience. Additionally, tests and inspection revealed that the antenna and transmission line system requires certain mechanical modifications to improve its suitability and reliability.

238. While the quality of workmanship and materials employed in the design and construction of the Model XTBT equipment is good, a number of modifications and changes are required to further improve safety, maintenance and servicing features. Certain modifications were accomplished by representatives of the Contractor during the course of the tests conducted at the Naval Research Laboratory, but other modifications which can best be made at the factory must still be accomplished.

Table 1
Model XTBT Transmitting Equipment
CHECK OF COMPOSITION RESISTORS

Res. No.	Rated Ohms	Rated Watts	Type No.	
R101	100000	1/2		See Note 1
R102	4.7 meg.	1/2		See Note 1
R104	5600	1		
R105	100	2		See Note 2
R107	6800	2		
R108	100000	2		
R109	10000	2		
R110	100000	1		
R111	33000	1		
R113	150	2	63474	
R114	47000	2	63474	
R115	47000	2	63474	
R117	200	2		See Note 3
R118	200	2		See Note 3
R119	400	3	(suppressor)	
R120	27000	3	63289	
R121	27000	3	63289	
R123	2000	3	63289	
R124	1500	2	(suppressor)	
R127	3300	2		
R129	220000	1/2		
R130	220000	1/2		
R131	100	?		See Note 4
R132	8200	2		
R133	15000	2		
R134	120000	1		
R135	120000	1		
R136	1500	2		
R139	56000	1/2		
R140	680000	1/2		
R141	15000	1		
R142	12000	1		
R143	47000	1		
R144	50000	3	63289	
R145	2200	1/2		
R148	2.7 meg.	1/2		
R150	2200	1/2		
R156	50000	3	63289	
R157	180	2	63474	
R158	12000	1		
R159	270	1		
R160	270	1		
R162	18000	2		See Note 5
R163	68000	2		See Note 6

(Continued)

Table 1 (cont'd)

Res. No.	Rated Ohms	Rated Watts	Type No.	
R164	56	1/2		
R165	56	1/2		
R166	820000	2		
R167	820000	2		
R168	100	2		
R169	100	2		
R170	100	3	63289	
R171	100	1/2		
R172	100	1/2		
R173	330	2		
R174	6800	2		
R175	56000	2		
R176	100	1/2	(suppressor)	
R177	100	1/2		
R178	2200	2		
R179	2200	2		
R180	3300	2		
R181	6600	2		See Note 7
R182	6600	2		See Note 7
R183	82	1/2		
R184	82	1/2		
R185	82	1/2		
R186	82	1/2		
R187	12000	1		
R188	12000	1		
R189	6800	2		
R190	220	2		
R191	220	2		
R ?	2700	2		See Note 8
R202	620	1/2		
R204	620	1/2		
R206	300	1/2		
R207	620	1/2		
R208	180	2	63474	

It was not feasible, and in some cases impossible, to make actual resistance, voltage and wattage measurements on these resistors. Wattage ratings noted are manufacturers' ratings and not necessarily Navy ratings.

(Continued)

Table 1 (cont'd)

NOTES:

(1) Parts list calls for 1-watt resistor.

(2) Parts list calls for 330-ohm resistor.

(3) Parts list calls for 270-ohm resistor.

(4) Odd make resistor, no identification marks, parts list calls for 1000-ohms, 3-watt Globar Type A.

(5) Parts list calls for 22,000 ohms (Changed by Manufacturer's Representative, during the course of the tests, to 18,000 ohms)

(6) Parts list calls for 120,000 ohms. (Changed by Manufacturer's Representative, during the course of the tests, to 68,000 ohms)

(7) Parts list calls for 9,000 ohms. (Changed by Manufacturer's Representative, during the course of the tests, to 6,600 ohms.)

(8) Not on parts list. Added in series with R180 and R181 by Manufacturer's Representative during the course of the tests.

Table 2
Model XTBT Transmitting Equipment
CHECK OF WIRE-WOUND FIXED RESISTORS
Reference Specifications: RE 13A 372J

Res. No.	Rated Ohms	Style	Type No.	Permitted by Specs. Watts	Volts	Max. R.	Measured Watts	Volts	Res.
R106	100	E	00000D	25	350	175	1.3	11	100.9
R112	600	E	-		350		1.6	31	587.6
R116(1)	400	C	63067E	28	775	700	8.0	62	400.
R122	500	C	-		775		8.5	65.5	513.8
R125	10000	D	63090		625		6.3	265	1013.0
R126	100	E	63514D	25	350	175	1.4	11.2	101.0
R137	4000	D	-		625		5.6	138	3906.0
R146	1200	B	-		1200		26.9	170	1194.0
R147	500	D	63070D	60	625	500	1.2	76	507.1
R151(2)	90	E	-		350		5.1	21.8	90.8
R153	400	B	63133D	150	1200	1500	79.4	172	400.8
R154	800	D	-		625		2.4	46.0	806.7
R155	800	D	-		625		2.2	41.5	789.4
R161	450	C	-		775		5.	48.5	468.2
R201	4000	D	-		625		5.8(3)	155	3972.

NOTES: (1) Was originally 225 ohms, replaced by manufacturer's representative with 400 ohms. The 400-ohm resistor "opened" during tests and was temporarily replaced with a Laboratory resistor.

(2) A 100-ohm resistor is called for in the parts list.

(3) Measured at applied potential of 230 volts. See Par. 208 of this report.

(4) Resistors R112, R125, R154, and R155 are covered with a low temperature compound.

Table 3
Model XTBT Transmitting Equipment
CHECK OF MISCELLANEOUS RESISTORS

Resistor No.	Rated Ohms	Use
R-138	10000	Potentiometer
R-152	100	Potentiometer
R-203	200	Attenuator

Resistor No.	Circuit Application	Measured Ohms	Measured Watts
R-128	(Ohmspun) 115-v, 1-Amp. MO Heater.		
None	High voltage generator field series resistor.	229.2	10.1
None	High voltage generator field series resistor.	113.2	3.4

NOTE: Above field resistors are Tab type with slider adjustment, which violates par. 16-5 of specifications RE 13A 372J.

Table 4
Model XTBT Transmitting Equipment
LIST OF FUSES AND HEATER TYPE CIRCUIT BREAKERS

Name Plate	Quantity	Location		Max. Current Under Normal Condition	Voltage of Circuit	Fuse Rating	
		Physical	Electrical			Volts	Amps.
None	2	Generator Terminal Box	Slip Ring Output	2.2 Amps.	115	250	3
None	1	Generator Terminal Box	+275 D-C	0.295 Amps.	290	1000	0.5
None	1	Generator Terminal Box	+435 D-C	0.730 Amps.	460	1000	1.0
See Note (2)	1	Motor Starter	Line 1 Preceeding Contactor	13 Amps.	440	250	20
See Note (2)	1	Motor Starter	Line 2 Preceeding Contactor	13 Amps.	440	250	20
See Note (3)	1	Motor Starter	Contactor Coil Circuit	0.6 Amps.	110	250	10
See Note (4) and (5)	1	Motor Starter	Line 1 Between Contactor and Motor	13 Amps.	440		3 to 3.5A range, H 211
See Note (4) and (5)	1	Motor Starter	Line 2 Between Contactor and Motor	13 Amps.	440		3 to 3.5A range, H 211

(Continued)

Table 4 (Cont'd)

NOTES:

(1) No circuit part numbers were supplied for any of the fuses in the XTBT equipment.

(2) Motor Circuit
Load 2.3 A
Fuse Rating 20 A

(3) Pilot Circuit
Load 0.8 Amp.
Fuse Rating 10 Amp.

(4) Use with heater H 211.

(5) Heater Type Circuit Breaker.

Table 5

Model XTBT Transmitting Equipment
DC Potentials and Currents Applied to Tube Electrodes
OUTPUT FREQUENCY 180 MCS.

Tube	Navy Type	Control Grid		Screen Grid		Plate	
RF TUBES		Volts	MA	Volts	MA	Volts	MA
MO	807	-	-	192	0.6	200	14.
1st AMP	807	86.	1.75	219	2.3	401	49.
2nd AMP	807	117.	1.6	199	4.0	400	67.
3rd AMP	829	133.	5.5	178	6.8	371	110.
PA	829	67.	10.5	155	25.0	425	180.
AUDIO TUBES							
Auto. Gain Control	84 (1)	-	-	-	-	-	.002 to .004
Input AMP. and Auto. Gain Control	6D6 (1)	3.3	0	67	0.93	248	3.7
Speech Amp.	76 (1)	15.	0	-	-	250	6.0
Modulators	807						
Left Tube, No Modulation		14.1	-	250	4.4	448	36.
Left Tube, 95% Tone Mod.		23.0	-	250	4.3	448	81.
Right Tube, No Modulation		14.1	-	250	4.4	448	37.5
Right Tube, 95% Tone Mod.		23.0	-	250	4.3	448	87.
CONTROL TUBE AND	6A6 (1)	-	-	-	-	230	10.5
AUDIO OSCILLATOR		-	-	-	-	248	9.8
CO and MIXER	6A6 (1)	-	-	-	-	225	5.8
OUTPUT TUBE (GRID AND PLATE CONNECTED TOGETHER)	955	-	-	-	-	100	0.7

Notes:

(1) Noted on Navy list of 2 Jan. 1941 as "not to be incorporated in new equipment without specific approval of the Government Department concerned."
(2) Control grid voltages are total from grid to cathode.
(3) There are two tubes in the second amplifier; values noted are per tube.
(4) CO and Mixer plate current is total to tube.

(Continued)

Table 5 (Cont'd)

TUBE HEATER VOLTAGES

Tube	Measured Voltage	Rated Voltage	Per cent over Rating
Master Oscillator	6.35	6.30	0.8
1st Amplifier	6.58	6.30	4.4
2nd Amplifier (2 tubes)	6.58	6.30	4.4
3rd Amplifier	13.35	12.60	5.9
Power Amplifier	13.35	12.60	5.9
Auto Gain Control	6.48	6.30	2.8
Input Amplifier (2 tubes)	6.44	6.30	2.2
Speech Amplifier (2 tubes)	6.46	6.30	2.5
Modulator, Left Tube	6.49	6.30	3.0
Modulator, Right Tube	6.49	6.30	3.0
Control and Audio Oscillator	6.49	6.30	3.0
Crystal Oscillator & Mixer	6.51	6.30	3.3
Output tube	6.59	6.30	4.6

Notes: Above measurements made with 117 volts applied to the primaries of the filament transformer, since this is the voltage delivered by the slip rings of the motor generator under normal operating conditions.

All of the above tubes have filaments of the heater type on which the Manufacturer allows a voltage tolerance of plus and minus 10%.

Table 6
Model XTBT Transmitter Equipment
LIST OF CONTROLS AND METERS

Control Designation	FUNCTION
A	"Osc. Range," switch, 8-position.
B	"Osc. Tuning," 0-2500 divisions, limited at 0 and at 2490. Has .1 vernier scale.
C	"Osc. Plate Tuning," 0-90 divisions.
D	"1st Ampl. Tuning," switch, 3-position.
E	"1st Ampl. Tuning," 0-90 divisions.
F	"2nd Ampl. Tuning," 4000 divisions, limited at 0030 and 2123; 2093 divisions.
G	"3rd Ampl. Tuning," 9000 divisions, limited at 0005 and 8031; 8026 divisions.
H	"P.A. Grid Tuning," 9000 divisions, limited at 0537 and 7494; 6957 divisions.
(1) I	"P.A. Plate Tuning," 9000 divisions, limited at 0258 and 6751; 6493 divisions.
J	"R.F. Output Coupling," 9000 divisions, limited at 8041 and 6460; 7419 divisions.
K	"Antenna Tuning," 60-90 mcs. - every 1 mc. 90-140 mcs. - every 2 mcs. 140-165 mcs. - every 5 mcs. 165-200 mcs. - Same point.
(1) L	"P.A. Grid Current," switch, 4-position, arrow shows rotation to "Increase." (Changed to 5-position)
	"Osc. Reset," screwdriver adjustment, 360°.
	"Control Switch," "Local," down; "Remote," horizontal.
	"Osc. Filament Standby," "On," up; "Off," down.
	"Tuning Switch," "Operate," up; "Tune," down.

(Continued)

"Motor Generator," "Stop," upper red; "Start," lower black.

"Emergency," "Stop," upper black button with red ring on plate; "On," lower pearl-topped button.

"Overload Reset;" horizontal tab with "Lift" engraved on it.

"Test Key," "Lock," up; "Off," horizontal; "Momentary," down.

"Osc. Reset Audio," jack.

"Chest Microphone," jack.

"Keying Relay."

M.O. Thermometer 68° - 72°.

Calibration Charts, two; one roller type for M.O. and one card type for controls A to L with spaces for 8 frequencies.

(1) P.A. grid current also controlled by switches on P. A. tank.

Indicator Lights

"Oscillator Filament," Blue.
"Master Start," Red.
"Oscillator Heater," Amber.
"Antenna Control," White.

Meters (all Westinghouse make - 2.5" diameter)

"M.O. Plate Current"	0-50MA	CAY 22057
"1st Ampl. Grid Current"	0-2MA	CAY 22049
"Per Cent Modulation"	0-100	Type MC Rectox
"1st Ampl. Plate Current"	0-100MA	CAY 22038
"2nd Ampl. Grid Current"	0-10MA	CAY 22053
"2nd Ampl. Plate Current"	0-200MA	CAY 22064
"3rd Ampl. Grid Current"	0-10MA	CAY 22053
"3rd Ampl. Plate Current"	0-200MA	CAY 22064
"P.A. Grid Current"	0-20MA	Type MX
"P.A. Plate Current"	0-300MA	CAY 22238
"R.F. Output Indicator"	0-1MA	CAY 22153

(Continued)

Table 6 (Cont'd)

Remote Telephone Units

"Start," "Off," red; "On," green.

"Earphone Circuit," "On," up; "Off," down.

"12-v. Control Circuit," "On," up; "Off," down.

"Key Circuit," "On," up; "Off," down.

"Noise Suppressor," "Off Push."

"Earphone Level," arrow indicates "Increase."

Microphone Control, "Local Chest Mic.," lock-up, momentary-down; "Extension"-horizontal.

"Local Headset," jack.

"Local Chest Mic.", jack.

"Extension," five-point female receptacle.

Carrier Control, push-button on handset.

Carrier Control Switch, plunger rod on handset cradle.

Indicator light, "Master Start," Blue.

Indicator light, "Carrier On," Red.

Table 7

Model XTBT Transmitter Equipment
LIST OF NAMEPLATES
SIZE, MATERIAL, AND LOCATION

Motor Generator

(Etched on natural-finish metal. Data Stamped.)
(3-1/2" x 2-3/8")

Electric Specialty Co.
Stamford, Conn., U.S.A.
A.C. Motor Serial No. 120854
Type BL51 Volts 220-440 P.F.
Phase 3 Cycles 60 H.P. 1.5 Amps. 5-2.5
RPM 3500 Wind'g. - Duty - Cont.
Cont. No.
Accepted by Date 1939

(Etched on natural-finish metal. Data Stamped.)
(3-1/2" x 2-3/8")

Electric Specialty Co.
Stamford, Conn., U.S.A.
D.C. Generator Serial No. 500579
Type MG353 Volts 435 P.F.
Phase __ Cycles __ H.P. __ Amps. .81
RPM 3500 Wind'g - Comp. Duty - Cont.
Cont. No.
Accepted by Date 1939

(Etched on natural-finish metal. Data Stamped.)
(3-1/2" x 2-3/8")

Electric Specialty Co.
Stamford, Conn., U.S.A.
D.C. Generator Serial No. 500579
Type MG353 Volts 275 P.F.
Phase __ Cycles __ H.P. __ Amps. .3
RPM 3500 Wind'g - Shunt Duty - Cont.
Cont. No.
Accepted by Date 1939

(Continued)

Motor Generator

(Etched on natural-finish metal. Data Stamped.)
(3-1/2" x 2-3/8")

Electric Specialty Co.
Stamford, Conn., U.S.A.
A.C. Generator Serial No. 500579
Type MG353 Volts 115 P.F. 90%
Phase 1 Cycles 60 H.P. — Amps. 1.1
RPM 3500 Wind'g - Shunt — Duty -
Cont. No.
Accepted by Date 1939

(Etched on natural-finish metal.)
(One on each end of motor generator.)
(3" x 7/8")

Lubricate bearings every six months with Grade A grease. Remove drain plugs before greasing. Spin shaft during and after greasing and before replacing drain and filling plugs.

(Etched on natural-finish metal.)
(One on each end of motor generator.)
(3" x 7/8")

Rotation

Transmitter Unit

(Continued)

Table 7 (cont'd)

Transmitter Unit

(Reverse-etched)
(4" x 4-1/2")

Model _____ Serial _____

_____

Supply _____

Equipment consists of following units:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

See License Notice Inside

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NAVY DEPARTMENT
Bureau of Engineering
Contractor
RCA Manufacturing Co., Inc.
Camden, N.J., U.S.A.
Contract NOs _____ Contract Date __

(Continued)

Table 7 (cont'd)

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

5 of the following nameplates furnished:
- 1 on transmitter unit.
- 1 on remote telephone unit.
- 1 on bulkhead transformer.
- 1 on 12-v. control unit lid.
- 1 on each breast mic.

Type CRV _____

Weight _____ Serial _____

Unit of Model _____ Equipment

Manufactured for
Navy Department
Bureau of Engineering
by
RCA Manufacturing Co., Inc.
Camden, N.J., U.S.A.

Contract NOs _____ Contract Date ___

Cover of Motor Control Unit

(Engraved on natural-finish metal.)
(Data Stamped.)
(3-3/4" x 2-3/8")

Type 14333.14-1 A.C. Starter
For radio and sound equipment
Contract
S.O. H72192 Serial 72192A1
H.P. 1.5 Volts 440 Amps. 2.3
Ph. 3 Cy. 60 USS
BuEng. Insp. Date 1939
Made by
Ward Leonard Electric Co.
Mount Vernon, New York

(Continued)

Table 7 (cont'd)

Lid of Bulkhead Transformer

(Reverse-etched. Data Stamped.)
(2-1/2" x 1-1/4")

Transformer
Type MC KVA Output 0.25 Cycles 60
220/440-v. Pri. Sec. 110-v.
1 Phase AMER-TRAN Diag. No. 44780
Spec. No. 27419 276080 Ser. No.
American Transformer Co.
Newark, N. J., U.S.A.

Table 8

Model XTBT Transmitting Equipment
LIST OF DIMENSIONS AND WEIGHTS
Test as per par. 1-8 and 3-18 of Specifications RE 13A 557D

Transmitter Unit		Measured	Specifications
Height:		47-1/2"	48"
Width:	(see note #1)	30-1/8"	24"
Depth:		18-1/4"	24"

Weight: 360 pounds

Master Oscillator Unit

Height:	14-1/2"	
Width:	9-1/8"	
Depth:	15-3/8"	(Knobs add additional 1-5/8")

Weight of removable unit: 21-1/4 pounds.

Motor Generator Unit

Height:	11-5/8"	12"
Length:	35-1/4"	48"
Depth:	15-3/8"	18"

Weight: 181 pounds

Motor Starter

Height:	17-1/2"
Width:	14-3/4"
Depth:	9-1/4"

Weight: 44-1/2 pounds

12-Volt Rectifier Unit

Height:	16-1/2"
Width:	10-5/8"
Depth:	7-5/8"

Weight: 54-1/2 pounds

Bulkhead Transformer

Height:	8-3/4"
Width:	5"
Depth:	5-7/8"

Weight: 17 pounds

(Continued)

Table 8 (Cont'd)

	Measured	Specifications
Remote Telephone Unit (without cover)		
Height:	18"	
Width:	9-5/8"	
Depth:	7-1/2"	
Weight:	26 pounds, 2 ounces.	
Modulator Unit (part of transmitter)		
Height:	8-5/8"	
Width:	21-7/8"	
Depth:	15"	
Accessories		
Extension Hand Set:	2-1/4 Pounds	
Extension Chest Set:	2/3/4	
Local Chest Set:	1/3/4	
Loud Speaker Unit:	39-1/2	
Antenna		
Length, overall:	12'-2"	
Length from top of radiator shield to insulator:	50"	
Length from top of radiator to control box:	7'-9"	
Length of control compartment:	15-1/4"	
Length of matching section:	37-3/4"	
Length of ground rods (Max)	34-1/2"	
Control compartment: 7-1/2" wide x 5-1/4" deep		
Matching section: 1-7/8" diameter		
Radiator shield: 1" diameter		
Insulator: 3-1/8" diameter		
Ground rods: 3/8" diameter		
Weight:	95 pounds.	

Note No. 1: The 30-1/8" width dimension of the transmitter unit includes the transmission line fitting as described in paragraph 136 of the text. That actual width of the transmitter frame is 24".

(Continued)

Table 8 (cont'd)

Note No. 2: Since the Modulator Unit swings out from the panel of the transmitter for a distance of approximately 13" and since the Master Oscillator Unit must be withdrawn from the transmitter, a clear space of approximately 20" is required in front of the transmitter to accommodate these units.

Table 9

Model XTBT Transmitting Equipment

Summary of Specification Frequency Stability Tests showing per cent deviation from assigned frequency.

Par. of Specs. RE 13A 557D	Output Frequency: M. O. Frequency:	135 MC 7.5 MC	180 MC 5 MC	180 MC 10 MC
3-3(1)	Re-set	0.00059	0.00075	0.00096
3-3(2)	2-Hour Locked Key	0.00347	0.00230	0.00290
3-3(3)	Temperature variations	0.00200	0.00365	0.00205
3-3(4)	Humidity variations	0.00237	0.00215	0.00216
3-3(5)	Line voltage variations	0.00200	0.00350	0.00130
3-3(6)	Tube Changes	0.00119#	0.00135#	0.00156#
3-3(7)	Vibration	0.00133	0.00090	0.00630
Arithmetic sum WITH VIBRATION:		0.01295	0.01460	0.01723
Arithmetic sum WITHOUT VIBRATION:		0.01162	0.01370	0.01093

Average of 3 frequencies, WITH VIBRATION: 0.01492

Average of 3 frequencies, WITHOUT VIBRATION: 0.01208

Specification requirements, WITH VIBRATION: 0.017%

Specification requirements, WITHOUT VIBRATION: 0.012%

# denotes combined measured and estimated values; see paragraph 111 of text.

Table 10

Model XTBT Transmitting Equipment
ACCURACY OF CALIBRATION TEST
Test as per Par. 3-3 (1) of Specifications RE 13A 557D
Measurements at Frequency of M.O. Plate Circuit

Control A MO Band Switch	Control B MO Dial	Nominal Frequency kcs.	Actual Frequency kcs.	Deviation Cycles	Accuracy of Calibration Per Cent	Notes
1	339.0	10,000.000	10,000.075	+75	.00075	1
1	1138.4	10,500.000	10,500.768	+768	.0073	
2	550.7	11,000.000	11,000.070	+70	.00064	
3	321.5	12,000.000	12,000.056	+56	.00047	
3	1171.8	13,000.000	13,000.842	+842	.0065	
4	35.7	12,500.000	12,500.354	+354	.0028	
4	613.4	13,000.000	13,000.122	+122	.00094	
4	1281.2	13,500.000	13,500.204	+204	.00151	
5	43.5	14,000.000	13,999.962	-38	.00027	
5	1124.2	15,000.000	15,000.088	+88	.00059	1
5	1985.1	15,500.000	15,500.655	+655	.0042	
6	330.8	15,500.000	15,499.475	-525	.0034	
6	330.8	15,500.000	15,500.395	+395	.0025	2
6	803.3	16,000.000	16,000.783	+783	.0049	2
6	1407.4	16,500.000	16,500.866	+866	.0053	
6	1407.4	16,500.000	16,500.901	+901	.0055	2
7	365.8	17,000.000	16,997.409	-2591	.0152	
7	365.8	17,000.000	16,997.859	-2141	.0126	4
7	365.8	17,000.000	16,998.559	-1441	.00849	2
7	802.0	17,500.000	17,498.350	-1204	.00688	2
7	1347.5	18,000.000	17,999.109	-891	.00495	
7	1347.5	18,000.000	17,999.209	-791	.0044	2
7	2180.9	18,500.000	18,499.072	-928	.00501	
7	2180.9	18,500.000	18,499.022	-978	.0055	2
8	10.3	18,500.000	18,499.447	-553	.00299	
8	10.3	18,500.000	18,498.772	-1228	.0066	2
8	416.2	19,000.000	18,998.910	-1090	.0053	2
8	814.0	19,500.000	19,500.497	+497	.0025	2
8	1307.1	20,000.000	20,000.160	+160	.0008	1, 2
8	1307.1	20,000.000	20,000.300	+300	.0015	2, 3

(Continued)

Table 10 (cont'd)

Notes: (1) MO adjusted to zero beat with crystal oscillator calibrator contained in the XTBT Transmitter Unit.

(2) Band Switch "A" carefully positioned in center of detent.

(3) Return to a calibration point following other calibration checks, but without readjusting calibrating capacitor.

(4) Return and recheck, following taking of other points.

Table 11

Model XTBT Transmitting Equipment
Accuracy of Reset to Previously Calibrated Frequencies
Test as per Par. 3-3-1 of Specifications RE 13A 557D

Trial No.	MO Plate Circuit Freq. KCS	Time Seconds	Deviation in Frequency	
			Cycles	Per Cent
Original	20,000.280			
1	.210	50	70	.00035
2	.050	35	230	.00115
3	.025	30	255	.00128
4	.050	30	230	.00115
5	.110	38	170	.00085
		Average:	191	.00096

CONTROLS A, B, C, D, E OPERATED FOR ABOVE TESTS.

Table 12

Model XTBT Transmitting Equipment
LOCKED KEY OPERATION FOR TWO HOURS
Test as Per Par. 3-3-(2) of Specifications RE 13A 557D
Output freq. - 135 Mcs.; M.O. freq. - 7.5 Mcs.; Measured at 15 Mcs.

Time	Temp. °C.	M.O. Plate Circuit Freq. kcs.	M.O. Fil. Supply Volts	Power E_p Volts	Amps. I_p MA	Line Volts
0824	Transmitter Started					
0825	21.3	15,001.075	116.2	483	212	447
0830	21.3	15,000.725	116.7	478	210	447
0835	21.2	.690	116.5	475	210	447
0840	21.0	.670	116.8	472	208	447
0845	20.8	.660	116.0	472	208	447
0850	20.2	.650	116.2	469	206	447
0855	20.5	.645	116.8	468	205	448
0900	21.8	.640	116.2	467	205	447
0905	22.0	.625	117.0	467	205	448
0910	22.0	.622	116.0	467	205	445
0915	22.0	.615	116.0	467	204	445
0920	22.0	.610	116.1	465	202	442
0925	22.0	.595	116.2	465	202	447
0930	22.0	.595	115.8	464	202	447
0935	22.2	.592	116.2	464	202	447
0940	23.0	.590	116.2	464	202	445
0945	24.0	.580	115.5	464	200	445
0950	24.2	.575	115.8	464	202	446
0955	24.0	.570	115.2	463	202	444
1000	23.0	.565	115.0	463	200	443
1005	22.0	.565	115.8	463	200	445
1010	21.2	.560	115.2	463	200	444
1015	21.0	.555 (1)	114.8	462	200	440
1020	21.2	.560	115.2	462	200	444
1025	21.0	.560	115.2	462	200	443

(1) Maximum frequency change = 520 cycles per second or 0.00347%.

Table 13

Model XTBT Transmitting Equipment
LOCKED KEY OPERATION FOR TWO HOURS
Test as per Par. 3-3-(2) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.

Time	Ambient Temp. °C.	M.O. Plate Circuit Freq. kcs.	M.O. Fil. Supply Volts	Power Amp.. E_p Volts	I_p MA	Line Volts
1335	23.5	10,000.550	115.2	466	188	442
1340	23.6	.440	115.0	462	188	442
1345	23.2	.410	115.5	462	189	444
1350	23.0	.400	115.5	461	189	444
1355	22.8	.395	114.8	458	188	442
1400	22.5	.385	114.8	458	188	442
1405	23.0	.382	115.0	458	188	442
1410	23.2	.375	114.5	458	189	440
1415	24.0	.370	114.9	458	190	442
1420	24.2	.360	114.5	458	190	441
1425	24.8	.355	115.2	458	189	443
1430	25.0	.345	115.2	458	192	443
1435	24.5	.350	115.6	458	190	446
1440	24.5	.345	116.0	459	192	447
1445	24.0	.338	115.2	458	192	443
1450	24.0	.335	115.2	458	192	443
1455	23.8	.328	115.0	458	192	444
1500	23.8	.332	115.2	459	192	443
1505	23.8	.322	114.5	457	192	442
1510	23.2	.330	115.7	458	192	443
1515	23.2	.320	115.0	458	192	443
1520	23.4	.325	115.8	458	192	444
1525	23.7	.323	115.8	458	192	445
1530	23.9	.320	116.0	458	192	446
1535	24.1	.320 (1)	116.0	458	192	446

(1) Maximum frequency change = 230 cycles per second or 0.0023%.

Table 14

Model XTBT Transmitting Equipment
LOCKED KEY OPERATION FOR TWO HOURS
Test as per Par. 3-3-(2) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. 10 Mcs.; Measured at 20 Mcs.

Time	Ambient Temp. °C.	M.O. Plate Circuit Freq. kcs.	M.O. Fil. Supply Volts	Power Amp. E_p Volts	I_p MA	Line Volts
1040	21.7	20,000.800	116.0	472	188	447
1043	21.7	.500	116.0	472	188	448
1045	21.8	.460	116.0	472	188	448
1050	22.0	.405	116.2	471	188	448
1055	22.5	.375	116.2	467	188	448
1100	23.2	.355	116.2	467	188	448
1105	24.0	.345	117.0	466	188	449
1110	24.6	.315	117.0	465	188	449
1115	24.5	.305	116.5	465	188	447
1120	24.0	.310	116.3	465	188	447
1125	23.6	.310	116.2	464	188	447
1130	23.0	.300	116.2	463	188	447
1135	23.0	.300	116.2	463	188	448
1140	23.0	.295	116.2	462	188	447
1145	22.8	.270	117.2	462	188	449
1150	23.0	.250	117.5	463	188	453
1155	23.5	.240	117.2	462	188	452
1200	23.8	.230	118.2	463	188	455
1205	24.0	.225	117.8	462	188	453
1210	24.5	.225	118.0	462	188	454
1215	24.8	.230	118.0	462	188	454
1220	24.5	.230	118.0	461	188	454
1225	24.3	.230	118.0	462	188	453
1230	23.8	.220 (1)	118.0	461	189	454
1235	23.7	.235	118.2	462	188	453
1240	23.3	.240	118.0	462	187	453
1245	23.4	.260	116.7	462	188	448

(1) Maximum frequency change = 580 cycles, or 0.0029%.

Table 15

Model XTBT Transmitting Equipment
VARIATION OF AMBIENT TEMPERATURE
Test as per Par. 3-3-(3) of Specifications RE 13A 557D
Output freq. - 135 Mcs.; M.O. freq. - 7-1/2 Mcs.; Measured at 15 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power Ep Volts	Amp. Ip MA	Output Meter Rdg.
0830	50.5	24	15,000.670	70.88	458	212	.49
0845	51.0	30	.625	.91	453	210	.48
0900	50.7	30	.600	.92	451	210	.46
0915	50.5	30	.580	.93	451	210	.46
0930	50.2	30	.550	.92	449	210	.45
0945	39.8	23	.585	.85	451	210	.46
1000	40.0	22	.635	.80	452	210	.46
1015	40.0	22	.625	.80	452	210	.46
1030	40.4	25	.620	.81	453	210	.46
1045	40.0	25	.610	.81	453	210	.46
1100	30.8	28	.655	.74	455	210	.46
1115	29.8	32	.690	.71	458	210	.47
1130	29.5	32	.705	.70	459	212	.47
1145	29.8	32	.715	.70	459	212	.47
1200	29.8	32	.715	.70	459	212	.47
1215	23.0	28	.740	.67	460	212	.47
1230	19.5	29	.790	.64	462	213	.47
1245	19.0	29	.810	.62	462	213	.47
1300	19.5	29	.815	.61	464	214	.47
1315	19.2	29	.810	.61	469	215	.47
1330	15.0	27	.835	.59	469	216	.47
1345	9.0	38	.875	.57	466	216	.47
1400	10.0	38	.880	.55	467	217	.48
1415	9.8	38	.875	.54	469	218	.48
1430	10.0	38	.875	.53	470	219	.48
1445	1.0	43	.900	.46	472	220	.48
1500	0.3	43	.905	.42	472	220	.48
1515	0.0	59	.890	.13	472	220	.48
1530	0.0	59	.865	69.88	473	220	.48
1545	0.5	59	.850	69.76	476	221	.48

(Continued)

Table 15 (cont'd)

SUMMARY

Temperature Change °C.	Cycles Change	Per Cent Change
50 to 40	60	0.00040
40 to 30	105	0.00070
30 to 20	95	0.00063
20 to 10	65	0.00043
10 to 0	25	0.00017
50 to 0	300	0.002

Table 16

Model XTBT Transmitting Equipment
VARIATION OF AMBIENT TEMPERATURE
Test as per Par. 3-3-(3) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power E_p Volts	Amp. I_p MA	Output Meter Rdg.
0830	51.0	18	10,000.470	70.86	462	180	.53
0845	48.0	18	.465	.90	458	185	.52
0900	50.2	21	.400	.93	454	182	.52
0915	51.0	21	.385	.94	451	182	.52
0930	50.8	21	.370	.95	451	182	.52
0945	40.8	23	.415	.90	453	183	.52
1000	40.5	22	.435	.86	454	183	.52
1015	40.0	22	.445	.85	455	183	.52
1030	40.7	22	.460	.85	455	183	.52
1045	32.0	23	.480	.81	456	184	.52
1100	29.5	23	.530	.77	458	183	.52
1115	29.4	23	.540	.76	459	183	.52
1130	29.8	23	.530	.76	459	184	.52
1145	30.2	23	.550	.76	461	185	.52
1200	23.0	31	.555	.75	461	185	.52
1215	19.9	31	.605	.71	462	184	.53
1230	19.0	31	.595	.69	465	186	.53
1245	19.2	31	.620	.69	465	186	.53
1300	19.7	31	.625	.68	466	186	.53
1315	10.0	38	.650	.65	472	185	.54
1330	10.0	38	.670	.62	469	187	.54
1345	9.5	39	.680	.61	470	187	.54
1400	9.8	39	.675	.60	469	186	.54
1415	9.8	38	.690	.60	470	187	.54
1430	1.0	59	.690	.59	473	187	.54
1445	0.7	59	.730	.53	473	188	.54
1500	0.5	59	.730	.42	474	189	.54
1515	0.5	-	.725	.18	476	190	.54
1530	0.5	-	.735	.05	476	189	.55

(Continued)

Table 16 (cont'd)

SUMMARY

Temperature Change °C.	Cycles Change	Per Cent Change
50 to 40	90	0.00090
40 to 30	90	0.00090
30 to 20	75	0.00075
20 to 10	65	0.00065
10 to 0	45	0.00045
50 to 0	365	0.00365

Table 17

Model XT3T Transmitting Equipment
VARIATION OF AMBIENT TEMPERATURE
Test as per par. 3-3-(3) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. - 10 Mcs.; Measured at 20 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power Amp. Ep Volts	Power Amp. Ip MA	Output Meter Rdg.
0830	50.0	20	20,000.660	70.85	457.5	180	.54
0845	48.5	20	.585	.90	452.3	182	.52
0900	49.0	20	.560	.90	451.0	182	.52
0915	49.0	23	.530	.90	449.0	182	.52
0930	49.0	24	.510	.90	448.0	182	.52
0945	44.2	21	.525	.91	448.0	182	.51
1000	41.5	23	.560	.85	450.0	183	.51
1015	40.5	21	.585	.82	450.0	183	.52
1030	40.8	21	.600	.81	451.0	185	.52
1045	40.7	21	.610	.80	452.0	185	.52
1100	40.8	21	.610	.80	451.0	185	.52
1115	31.5	28	.665	.76	453.0	186	.52
1130	30.0	32	.720	.72	455.0	185	.52
1145	30.0	32	.745	.72	457.0	187	.52
1200	31.0	32	.750	.71	457.0	187	.52
1215	31.0	32	.750	.71	458.0	187	.52
1230	17.0	36	.810	.67	458.0	187	.53
1245	18.5	34	.865	.63	440.0	190	.53
1300	19.8	29	.890	.61	457.0	190	.52
1315	19.5	23	.900	.61	462.0	190	.53
1330	19.5	23	.905	.61	469.0	190	.53
1345	10.0	38	.920	.56	467.0	190	.53
1400	10.3	38	.960	.55	467.0	194	.54
1415	10.3	38	.970	.53	467.0	192	.54
1430	10.0	38	20,001.005	.51	467.0	193	.54
1445	10.0	38	20,001.010	.51	467.0	195	.54
1500	1.0	59	20,000.940	.49	469.0	195	.54
1515	0.0	-	.945	.28	471.0	197	.54
1530	2.0	-	.930	.19	472.5	198	.54
1545	1.0	-	.920	.02	472.4	198	.54
1600	-1.0	-	.920	69.90	474.0	199	.54

(Continued)

Table 17 (cont'd)

SUMMARY

Temperature Change °C.	Cycles Change	Per Cent Change
50 to 40	100	0.00050
40 to 30	140	0.00070
30 to 20	155	0.00077
20 to 10	105	0.00052
10 to 0	90	0.00045
50 to 0	410	0.00205

Table 18

Model XTBT Transmitting Equipment
VARIATION OF HUMIDITY
Test as per Par. 3-3-(4) of Specifications RE 13A 557D
Output freq. - 135 Mcs.; M.O. freq. - 7-1/2 Mcs.; Measured at 15 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power E_p Volts	Amp. I_p MA	Output Meter Rdg.
1100	40.0	27	15,000.995	70.81	457	212	.48
1115	40.2	29	.970	.81	457	212	.47
1130	40.2	29	.955	.81	457	212	.47
1145	41.5	93	.870	.90	457	213	.47
1200	42.5	97	.810	.91	455	215	.46
1215	42.5	93	.735	.89	455	213	.46
1230	41.5	97	.685	.86	454	213	.46
1245	41.5	97	.640	.85	455	214	.46
1300	41.0	97	.600	.82	455	214	.46
1315	41.5	50	.580	.79	455	213	.47
1330	40.5	34	.610	.75	455	213	.48
1345	41.0	32	.595	.76	455	213	.48
1400	41.3	30	.585	.77	456	212	.48
1415	41.5	32	.555	.80	456	212	.48

SUMMARY

Relative Humidity Change	Cycles Change	Per Cent Change in Frequency.
29% to 97%	355	0.00237
97% to 32%	45	0.00030

Table 19

Model XTBT Transmitting Equipment
VARIATION OF HUMIDITY
Test as per Par. 3-3-(4) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power E_p Volts	Amp. I_p MA	Output Meter Rdg.
0845	39.8	26	10,000.828	70.83	461	182	.52
0900	40.0	31	.785	.85	457	180	.52
0915	40.0	31	.795	.85	457	182	.52
0930	46.0	90	.675	.95	457	185	.50
0945	40.0	93	.695	.89	457	183	.51
1000	39.5	93	.665	.87	457	183	.51
1015	39.0	93	.635	.86	457	184	.51
1030	39.0	96	.607	.85	458	184	.51
1045	39.0	96	.580	.84	457	185	.51
1100	37.5	80	.570	.81	457	185	.51
1115	39.5	34	.585	.78	458	178	.52
1130	39.0	32	.590	.78	458	178	.52
1145	41.0	32	.575	.82	458	178	.52
1200	40.0	34	.565	.82	458	178	.52
1215	40.2	34	.565	.82	458	178	.52

SUMMARY

Relative Humidity Change	Cycles Change	Per Cent Change in Frequency.
31% to 96%	215	0.00215
96% to 34%	15	0.00015

Table 20

Model XTBT Transmitting Equipment
VARIATION OF HUMIDITY
Test as per Par. 3-3-(4) of Specifications RE 13A 557D
Output freq. - 180 Mcs.; M.O. freq. - 10 Mcs.; Measured at 20 Mcs.

Time	Ambient Temp. °C.	Rel. Hum. %	M.O. Plate Circuit Freq. Kcs.	M.O. Comp. Temp. °C. Avg.	Power E_p Volts	Amp. I_p MA	Output Meter Rdg.
1245	40.0	35	20,000.700	.79	457	180	.52
1300	38.5	31	.670	.80	457	181	.52
1315	38.0	30	.672	.80	457	178	.52
1330	41.0	93	.500	.86	458	182	.52
1345	40.0	96	.405	.87	458	182	.52
1400	39.5	96	.345	.85	457	182	.52
1415	40.0	93	.290	.83	457	181	.52
1430	40.0	93	.240	.83	458	180	.52
1445	41.5	41	.240	.79	457	180	.52
1500	41.0	35	.300	.76	456	181	.52
1515	40.0	31	.325	.76	457	180	.52
1530	41.0	31	.315	.78	457	180	.52
1545	40.0	31	.320	.78	457	180	.52

SUMMARY

Relative Humidity Change	Cycles Change	Per Cent Change in Frequency.
30% to 93%	432	0.00216
93% to 31%	80	0.00040

Table 21

Model XTBT Transmitting Equipment
VARIATION OF SUPPLY LINE VOLTAGE
Test as per Par. 3-3-(5) of Specifications RE 13A 557D

Line Voltage	MO Plate Supply Voltage	PA Plate Supply Voltage	Slip Ring Voltage (1)	Output Meter Reading	Freq. Kcs.	Freq. Change Cycles	Freq. Change %
(Output freq. - 60 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.) (Minus to plus 5% in one minute.)							
418	281	455	117.0	.36	10,000.420	-	-
440	282	457	117.2	.36	.610	190	.00190
462	283	458	117.5	.36	.770	350	.00350
(Minus to plus 5% in five minutes.)							
418	281	455	116.8	.36	10,000.430	-	-
440	282	455	117.0	.36	.660	230	.00230
462	282	457	117.0	.36	.770	340	.00340
(Output freq. - 139.5 Mcs.; M.O. freq. - 7.75 Mcs.; Measured at 15.5 Mcs). (Minus to plus 5% in one minute.)							
418	279	453	116.	.48	15,000.420	-	-
440	280	454	116.3	.48	.675	255	.00165
462	281	455	116.8	.48	.730	310	.00200
(Minus to plus 5% in five minutes.)							
418	280	454	116.3	.48	15,000.545	-	-
440	281	455	116.8	.48	.700	155	.00100
462	282	458	117.2	.48	.700	155	.00100
(Output freq. - 180 Mcs.; M.O. freq. - 10 Mcs.; Measured at 20 Mcs.) (Minus to plus 5% in one minute.)							
418	280	455	116.3	.58	20,000.500	-	-
440	283	455	117.0	.58	.760	260	.00130
462	284	457	117.0	.58	.710	210	.00105

(Continued)

Table 21 (cont'd)

Line Voltage	MO Plate Supply Voltage	PA Plate Supply Voltage	Slip Ring Voltage (1)	Output Meter Reading	Freq. Kcs.	Freq. Change Cycles	Freq. Change %
		(Minus to plus 5% in five minutes.)					
418	280	455	116.2	.57	20,000.460	-	-
440	282	457	116.6	.58	.710	250	.00125
462	282	457	116.8	.58	.610	150	.00075

Note: (1) Supplies all filaments except MO.

Table 22

Model XTBT Transmitting Equipment
VARIATION OF SUPPLY LINE VOLTAGE

Line Voltage	MO Plate Supply Voltage	PA Plate Supply Voltage	Slip Ring Voltage (1)	Output Meter Reading	Freq. Kcs.	Freq. Change Cycles	Freq. Change %
(Output freq. - 60 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.) (Minus to plus 10% in one minute.)							
396	279	453	116.0	.36	10,000.220	-	-
440	282	455	117.0	.36	.960	740	.00740
484	283	457	117.5	.36	10,001.260	1040	.01040
(Minus to plus 10% in five minutes.)							
396	280	453	116.2	.36	10,000.300	-	-
440	282	457	117.2	.36	10,001.075	775	.00775
484	283	458	117.7	.36	10,001.200	900	.00900
(Output freq. - 139.5 Mcs.; M.O. freq. - 7.75 Mcs.; Measured at 155 Mcs.) (Minus to plus 10% in one minute.)							
396	278	450	115.5	.48	15,000.150	-	-
440	281	455	116.2	.48	15,001.100	950	.00613
484	282	457	117.0	.48	15,001.175	1025	.00662
(Minus to plus 10% in five minutes.)							
396	278	452	115.8	.48	15,000.180	-	-
440	281	455	117.0	.48	.530	350	.00226
484	282.5	458	117.4	.48	.490	310	.00200
(Output freq. - 180 Mcs.; M.O. freq. - 10 Mcs.; Measured at 20 Mcs.) (Minus to plus 10% in one minute.)							
396	278	452	115.2	.57	20,000.130	-	-
440	280	455	116.4	.58	20,001.000	870	.00435
484	282	457	117.0	.58	20,001.050	920	.00460

(Continued)

Table 22 (cont'd)

Line Voltage	MO Plate Supply Voltage	PA Plate Supply Voltage	Slip Ring Voltage (1)	Output Meter Reading	Freq. Kcs.	Freq. Change Cycles	Freq. Change %
		(Minus to plus 10% in five minutes.)					
396	278	452	115.3	.58	20,000.240	-	-
440	280	455	116.2	.58	20,001.275	1035	.00518
484	282	457	117.0	.58	20,001.025	785	.00393

Note: (1) Supplies all filaments except MO.

Table 23

Model XTBT Transmitting Equipment
FREQUENCY SHIFT WITH CHANGE OF TUBES
Test as per Par. 3-3-(6) of Specifications RE 13A 557D

Tube No.	M.O. Plate Circuit Frequency - kcs.	Deviation from Mean Frequency Cycles	Per Cent
1	15,005.500	1476	0.00983
2	9.450	2474	0.0165
3	9.260	2274	0.01515
4	9.530	2554	0.01705
5	7.050	574	0.00382
6	1.075	5901	0.0393
1	5.125		

Mean (not including last reading):
15,006.976

Average: 2542 0.017

Note 1: Change of tubes in the first amplifier circuit produced an average variation from the mean of 0.00052% at an MO plate circuit frequency of 15 MC.

Note 2: Change of tubes in following circuits produced a negligible effect, 0.0001% or less, as compared with a frequency drift of approximately 0.0015% occasioned by shutting down the transmitter while making tube change.

Note 3: No re-adjustment of the master oscillator calibrating capacitor was made for the above tests.

Table 24

Model XTBT Transmitting Equipment
VIBRATION TEST
Test as per Par. 3-3-(7) of Specifications RE 13A 557D
(Output freq. - 135 Mcs.; M.O. freq. - 7.5 Mcs.; Measured at 15 Mcs.)

Time		Test	Frequency at	
From	To	Condition	Start of 5 min. period	End of 5 min. period
1310	1315	Stationary	15,002.475	15,002.475
1315	1320	Vib. 700 Cycles (1)	.475	.475
1320	1325	" 800 "	.475	.475
1325	1330	" 900 "	.475	.500
1330	1335	" 1000 "	.500	.375
1335	1340	" 1100 "	.375	.435
1340	1345	" 1200 "	.435	.475
1345	1350	" 1300 "	.475	.475
1350	1355	" 1400 "	.475	.450
1355	1357	" 1500 "	.450	.450
1357	1400	" 1800 "	.450	.425
1400	1402	" 980 "	.425	.275
1402	1405	Stationary	.275	.230

Maximum set in frequency: 200 cycles, or .00133%.

Maximum variation in freq. during test: 200 cycles, or .00133%.

Maximum variation in freq. prior to vibration at 950 cycles: 50 cycles, or .00033%.

NOTES: (1) Vibration expressed in cycles per minute.

(2) Natural period of M.O. compartment is approximately 950 cycles per min. When the compartment strikes the transmitter frame, the M.O. frequency jumps badly.

(3) M.O. Band switch on Position 5.

Table 25

Model XTBT Transmitting Equipment
VIBRATION TEST
Test as per Par. 3-3-(7) of Specifications RE 13A 557D
(Output freq. - 180 Mcs.; M.O. freq. - 5 Mcs.; Measured at 10 Mcs.)

Time		Test	Frequency at	
From	To	Condition	Start of 5 min. period	End of 5 min. period
1125	1130	Stationary	10,000.475	10,000.475
1130	1135	Vib. 700 Cycles (1)	.470	.475
1135	1140	" 800 "	.475	.470
1140	1145	" 900 "	.460	.530
1145	1150	" 1000 "	.505	.500
1150	1155	" 1100 "	.500	.495
1155	1200	" 1200 "	.505	.530
1200	1205	" 1300 "	.505	.505
1205	1210	" 1400 "	.515	.500
1210	1215	" 1500 "	.500	.500
1215	1217	" 1800 "	.500	.500
1217	1218	" 950 "	.500	.550
1218	1223	Stationary	.550	.540

Maximum set in frequency: 75 cycles, or .00075%.

Maximum variation in freq. during test: 90 cycles, or .00090%.

Maximum variation in freq. prior to vibration at 950 cycles: 25 cycles, or .00025%.

NOTES: (1) Vibration expressed in cycles per minute.

(2) Natural period of M.O. compartment is approximately 950 cycles per min. When the compartment strikes the transmitter frame, the M.O. frequency jumps badly.

(3) M.O. Band change switch on Position 1.

Table 26

Model XTBT Transmitting Equipment
VIBRATION TEST
Test as per Par. 3-3-(7) of Specifications RE 13A 557D
(Output freq. - 180 Mcs.; M.O. freq. - 10 Mcs.; Measured at 20 Mcs.)

Time		Test	Frequency at	
From	To	Condition	Start of 5 min. period	End of 5 min. period
1320	1325	Stationary	20,000.900	20,000.885
1325	1330	Vib. 700 Cycles (1)	.890	.870
1330	1335	" 800 "	.870	.860
1335	1340	" 900 "	.820	.830
1340	1345	" 1000 "	.600	.730
1345	1350	" 1100 "	.290	.250
1350	1355	" 1200 "	.250	.200
1355	1400	" 1300 "	.200	.210
1400	1405	" 1400 "	.210	.205
1405	1410	" 1500 "	.205	.205
1410	1412	" 1800 "	.205	.205
1412	1413	" 950 "	M.O. Compt. strikes frame.	
1413	1418	Stationary	19,999.640	19,999.640

Maximum set in frequency: 1260 cycles; 0.0063%.

Maximum variation in freq. during test: 1260 cycles; 0.0063%.

Maximum variation in freq. prior to vibration at 950 cycles: 695 cycles; 0.0035%.

NOTES: (1) Vibration expressed in cycles per minute.

(2) Natural period of M.O. compartment is approximately 950 cycles per min. When the compartment strikes the transmitter frame, the M.O. frequency jumps badly, probably 5 to 10 kcs.

(3) M.O. Band change switch on Position 8; contact is erratic.

Table 27

Model XTBT Transmitting Equipment
RANGE OF MO CALIBRATION CAPACITOR
Measurements at Frequency of M.O. Plate Circuit

Control A MO Band Switch	Control B MO Dial	Position of Calibration Capacitor	Indicated Freq. Kcs.	Range - Kcs. CW	Range - Kcs. CCW	Range - Kcs. Total	RATIO CW/Total
1	339.0	Cal. Position	5000.00				
1	247.8	Max. CW	4969.20	30.80			
1	449.1	Max. CCW	5037.85		37.85	68.65	.449
5	1124.2	Cal. Position	7500.00				
5	994.5	Max. CW	7448.56	51.44			
5	1308.9	Max. CCW	7565.27		65.27	116.71	.441
8	1307.1	Cal. Position	10000.00				
8	1152.7	Max. CW	9929.28	70.72			
8	1515.1	Max. CCW	10083.58		83.58	154.30	.458

Table 28

Model XTBT Transmitting Equipment
CHECK OF OPERATION OF M.O. TEMPERATURE CONTROLLED CABINET

Ambient Temp. °C.	MO Cab. Temp. °C. Max.	MO Cab. Temp. °C. Min.	Length of Heater Cycle Seconds	% of Time Heater Stays "On"	MO Plate Circuit Frequency Change During Heat Cycle Cycles	MO Plate Circuit Frequency Change During Heat Cycle Per Cent
	(135 Mcs. Output; MO on 7.5 Mc.; MO Plate Circuit on 15 Mc.)					
50	70.94	70.90	27.	14.8	30	.00020
40	.83	.79	17.4	35.6	35	.00023
30	.72	.68	15.7	54.1	30	.00020
20	.63	.59	19.0	73.7	35	.00023
10	.56	.50	25.5	84.3	35	.00023
0	69.76	-	Cont.	100.	-	-
	(180 Mcs. Output; MO on 5 Mc.; MO Plate Circuit on 10 Mc.)					
50	70.97	70.92	24.	16.5	20	.00020
40	.87	.83	17.	35.3	30	.00030
30	.78	.74	14.	57.1	15	.00015
20	.70	.66	19.	73.7	15	.00015
10	.62	.58	32.5	89.3	20	.00020
0	69.98	-	Cont.	100.	-	-
	(180 Mcs. Output; MO on 10 Mc.; MO Plate Circuit 20 Mc.)					
50	70.92	70.88	24.	16.5	40	.00020
40	.82	.78	17.	35.3	35	.00018
30	.73	.69	16.	50.0	40	.00020
20	.63	.59	16.	68.7	35	.00018
10	.53	.49	41.0	91.5	40	.00020
0	69.90	-	Cont.	100.0	-	-

NOTES: (1) Above data taken after an ambient temperature had been maintained at indicated value for one hour.

(2) Line voltages during above tests:

Line Voltage	Frequencies
452	7.5 - 15 - 135.
451	5 - 10 - 180.
452	10 - 20 - 180.

(Continued)

Table 28 (cont'd)

Model XTBT Transmitting Equipment
OPERATION OF MO COMPARTMENT
HEATER UNDER NORMAL ROOM CONDITIONS

Room Ambient °C.	Heat Cycle Indicating Thermometer, °C.		Time Cycle		
	High	Low	Sec. On	Sec. Off	% of Time On
20	70.72	70.69	6	8	43

NOTES: Room Conditions, with still air.

Table 29

Model XTBT Transmitting Equipment
INCLINATION TEST

Output freq. - 135 Mcs.; M.O. freq. - 7.5 Mcs.; Measured at 15 Mcs.

Time	Minimum Frequency	Difference (cycles)	Maximum Frequency	Test Condition
		Inclination: Front to Back		
1455	15,000.370			Stationary
1455	.330	135	15,000.465	Inclination
1500	.360	100	.460	"
1505	.385	100	.485	"
1510	.395	100	.495	"
1515	.400	80	.480	"
1520	.400	75	.475	"
1525	.400	75	.475	"
1525	.405			Stationary
1530	.405			"

Maximum frequency change from stationary condition at start of test: 125 cycles, or .00083%.

Maximum frequency change from stationary condition at end of test: 90 cycles, or .00060%.

Maximum frequency change noted during test, maximum to minimum: 135 cycles, or .00090%.

		Inclination: Side to Side		
1305	15,000.445			Stationary
1305	.450	35	.485	Inclination
1310	.450	40	.490	"
1315	.440	40	.480	"
1320	.450	40	.490	"
1325	.460	30	.490	"
1330	.480	30	.510	"
1335	.470	30	.500	"
1335	.460			Stationary
1340	.455			"

Maximum frequency change from stationary condition at start of test: 65 cycles, or 0.00043%.

(Continued)

Table 29 (cont'd)

Maximum frequency change from stationary condition at end of test: 50 cycles, or 0.000333%.

Maximum frequency change noted during the test, 40 cycles, or 0.000267%.

NOTES: (1) Inclination at the rate of 5 complete cycles per minute.

(2) MO Band Switch on Position 5.