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F42-1/52/L5(3-1-DR)

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REPORT NO. R-1597

DATE 1 March 1940

SUBJECT

FR-1597

Test on Model TC 67 (T-105) Aircraft Radio

Transmitting Equipment

DECLASSIFIED by NRL Contract Declassification Team
Date: 13 MAY 2016
Reviewer's name(s): A. THOMPSON, P. HANNA
Declassification authority: NAVY DECLASS MANUAL, 11 DEC 2012, 02 SERIES, 06 SERIES

BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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NRL Report No. 1597
Test on Model TC 67 (T-105) Aircraft Radio
Transmitting Equipment

1 March 1940

NRL Report No. R-1597
BuEng. Prob. A9-12R

NAVY DEPARTMENT

[redacted]

Report on

Test on Model TC 67 (T-105) Aircraft Radio Transmitting Equipment

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

No. of Pages:	Text - 7	Tables - 9	Plates - 4
Authorization:	BuEng. let. NOs F42-1/52(9-28-R6) of 29 Sept. 1939.		
Date of Tests:	November 6 to January 26, 1940		

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____
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APPENDIX A

Data in the Form of Tables and Plates Appended to this Report are as follows:

Weights and Dimensions	Table	1
Power Output		2
Calibration Accuracy		3
Overall Audio Frequency Response		4
Audio Frequency Distortion		5
Frequency Drift at Constant Temperature		6
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Frequency Drift at Constant Temperature	Plate	1
Frequency Drift with Variable Temperature MO-Voice		2
Frequency Drift with Variable Temperature MO-CW.		3
Frequency Drift with Variable Humidity MO-CW		4

APPENDIX B.

Naval Air Station Flight Test Report. (without enclosures)

AUTHORIZATION FOR TEST

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a). Additional references pertinent to these tests are listed as references (b) and (c).

Reference: (a) BuEng. let. Nos. F42-1/52(9-28-R6) of 29 Sept. 1939.
(b) Specifications RE-13A-541B
(c) NAS Anacostia let. F42-1/52(8)/NA6(410)Ser.No. 39174 of 6 Nov. 1939.

OBJECT OF TEST

2. The object of these tests was to determine the compliance of the equipment with the requirements of the specifications, reference (b), and to determine its adaptability for use in the Naval Aircraft Service.

ABSTRACT OF TEST

3. The equipment was tested for mechanical construction, electrical performance, and its adaptability for installation and operation in Navy planes and suitability for use in the Naval Service. The equipment was bench and flight tested.

4. The test covered the following points:

(a) Mechanical

(1) Workmanship
(2) Material used
(3) Size and weight
(4) Shock mounting
(5) Ruggedness

(b) Electrical Performance

(1) Power Output
(2) Frequency Range
(3) Calibration accuracy
(4) Overall audio frequency response
(5) Audio frequency distortion
(6) Frequency stability with variable temperature and humidity

CONCLUSIONS

(a) The following conclusions were reached as a result of these tests:

(1) The equipment is not suitable for use in the Naval Aircraft Service in its present form.

(2) The equipment does not resonate with antennae of the half "V" or full "V" types at frequencies below 3000 kilocycles.

(3) At 12 volts the starting relay is sluggish and at times fails to operate. Above 12 volts the operation is satisfactory.

(4) For CW transmission the oscillator is in operation in the key up position. As a result transmission and reception on the same frequency are not practicable.

(5) The 0 to 1.5 ampere radio frequency meter has insufficient range for all conditions.

(6) The reaction between circuits is excessive and as a result detracts from simplicity of tuning and adaptability for remote control.

(7) The frequency change of the master oscillator under conditions of variable temperature and/or humidity and vibration is excessive, in the latter to such an extent as to impair the intelligibility of voice communication.

(8) No provision is made for side tone or interphone.

(9) Condensers of the electrolytic type are used in the equipment.

(10) The receiver antenna binding post is not grounded when keying but assumes an open circuit position.

(11) The markings of the crystal holder sockets and the selector switch are not in agreement.

(12) The numbering of the antenna tuning inductance tap switch is such that an increase of the numbers results in a decrease of frequency.

(13 The master oscillator tuning dial operates too freely and is not provided with a locking device.

(14) The frequency stability of the crystal oscillator under all conditions is excellent and vibration has no measurable effect on the signals.

(15) The equipment is of simple design and covers a wide range of frequency without the use of plug-in coils and operates with a large variety of antennae.

(16) Since the primary purpose of the equipment is for voice communication with the crystal oscillator the defects noted for the master oscillator, which is an emergency circuit in the event of crystal failure, will not seriously detract from satisfactory operation of the equipment.

(17) The instruction book is too brief and lacks much pertinent information.

RECOMMENDATIONS

(a) Since practically complete redesign would be necessary before the equipment would be satisfactory for use in the Naval Aircraft Service as required by the specifications, reference (b), it is recommended that this equipment be considered unsatisfactory for use in Naval Aircraft.

EAUIPMENT UNDER TEST

5. The equipment under test, known as the Model T-105 Aircraft Radio Transmitting Equipment and manufactured for the U.S. Coast Guard by the Telephonics Corporation of New York, New York, consists of a transmitter unit, dynamotor unit and associated cables. The transmitter consists of an oscillator circuit employing an 807 tube, power amplifier circuit employing an 807 tube and a modulator circuit employing two 807 tubes in push-pull. It is designed for both self oscillator or crystal oscillator control and for CW and voice communication. It covers a frequency range from approximately 2417 to 8540 kilocycles except for a slight gap from 4496 to 4537 kilocycles. The primary power supply is the airplane's 12 volt battery.

METHOD OF TEST

6. All tests were made with a 13 volt primary source unless otherwise noted.

7. The primary current drain was determined by means of an ammeter in series in the connecting lead from the battery to the dynamotor.

8. The power output was determined with the use of various artificial antennae of known characteristics connected across the output terminals with a radio frequency ammeter in the ground side. The transmitter was tuned for maximum output at several frequencies throughout the range. The radio frequency current was recorded, and with the known value of resistance the output power was determined.

9. The calibration accuracy was determined with the use of crystal frequency indicator. The transmitter was tuned according to the calibration chart and the actual frequency then measured.

10. The overall audio frequency response was determined with the use of a rectifier, output voltmeter, oscillograph, beat frequency oscillator and a mixer. The output of the transmitter was coupled to the rectifier and to the oscillograph, the purpose of the latter was to determine the percentage of modulation. The output of the rectifier was connected through a potentiometer to the output voltmeter. The beat frequency oscillator was coupled through the mixer to the microphone jack of the transmitter. Maintaining the input voltage to the modulator at a constant value, the output voltage was measured at various modulation frequencies and the output with reference to that at 1000 cycles was determined.

11. The audio frequency distortion was determined with the same apparatus as above with the addition of a wave analyzer. The output of the rectifier was coupled to the wave analyzer. With the modulation frequency held constant, the output as recorded by the wave

analyzer at the successive harmonics of the modulation frequency was observed and the distortion calculated as the r-m-s sum total.

12. The frequency stability at constant ambient temperature was determined with the use of a crystal frequency indicator. From a cold start the frequency was measured at regular intervals for a period of one hour.

13. The frequency stability with a variation of ambient temperature was determined with the use of a temperature control chamber and a crystal frequency indicator. After a half-hour warm-up period the temperature was varied over a wide range and the frequency measured at regular intervals.

14. The frequency stability with variable humidity conditions was determined with the use of the same apparatus as above. Humidity conditions from a low value of approximately 100 per cent were introduced in the temperature control chamber. The equipment was allowed to stabilize at 40°C. Maintaining a constant temperature of this value the percentage of humidity was varied and the frequency measured at regular intervals.

15. To determine the effect of vibration on the output, the equipment was mounted on a vibration t able and the signal observed with the use of receiving equipment.

DATA RECORDED DURING TEST

16. Data recorded in the form of tables and charts are appended to this report and are discussed in results.

DISCUSSION OF PROBABLE ERRORS.

17. Following is a list of the apparatus used with the manufacturer's guarantee of accuracy:

Weston D.C. Ammeter	Model 45	Ser.No. 42393	Accuracy ±0.5
Weston R.F. Ammeter	Model 425	Ser.No. 26117	Accuracy 2.0
Gen.Rad. Output Voltmeter	Type 483-F	Ser.No. 67	Accuracy 5.0
Crystal Frequency Indicator	Type LM-2	Ser.No. 1	Accuracy 0.001
Gen.Rad. Electron Oscillograph	Type 687-A	Ser.No. 132	
Gen.Rad. Best Frequency Oscillator	Type 713-B	Ser.No. 499	Accuracy 2.0
Gen.Rad. Wave Analyzer	Type 636-A	Ser.No. 318	Accuracy 5.0
Mixer	NRL		
Temperature Control Box	Frigidaire		Accuracy 1°C
Hygrometer	G. Luff		Accuracy 15.0%
Vibration Table	NRL		

RESULTS OF TEST

18. The subject equipment is of such design as not to be applicable in its entirety to the specifications, reference (b). These specifications were used as a comparative rather than a governing basis.

19. The results will be discussed in the order of the paragraphs to which they are applicable and the paragraph numbers will be in agreement.

2 The construction of the equipment conforms in general to Navy specifications. Good material and workmanship are found.

3-2 While the equipment is not applicable to this paragraph the weight and dimensions are shown on Table 1 appended to this report.

3-3 The starting relay fails to operate satisfactorily at less than 12 volts. The maximum current drain is 12.8 amperes at 13 volts.

3-4 The equipment does not meet the power output of this paragraph. The results of this test are shown on Table 2.

3-5 The equipment is capable of operation over the range of 2417 to 8540 kilocycles with the exception of a 40 kilocycle hiatus at 4500 kilocycles with self oscillator control or with crystal oscillator control on any frequency within this range, for which crystals are available.

3-6
3-7 The equipment is designed for local control only and for CW and voice transmission.

3-9 There was no measurable frequency change of the crystals under variable temperature and humidity conditions or when exposed to severe vibration. Under the same conditions the frequency change when in the self oscillation position was excessive. The results of these tests are shown on Tables 6, 7, 8, and 9 and Plates 1, 2, 3, and 4.

3-11 The reaction between circuits for self oscillator control is excessive.

3-12 The overall audio frequency response does not meet the requirements of this paragraph. The transmitter can be modulated up to 20,000 cycles. The results are shown on Table 4.

3-13 The equipment does not meet the audio frequency distortion requirements. The results are shown on Table 5.

3-14 The equipment is capable of 100 per cent modulation with a standard Navy type microphone.

3-15 The carrier noise level is 42 db down.

3-16 The equipment must be retuned for each change of frequency. This may be accomplished within 1 minute with the aid of a calibration chart

20. The calibration accuracy is shown on Table 3. The frequency of the self oscillator will vary somewhat when retuning without reference to a calibration chart, due to reaction between amplifier and antenna circuits and the self oscillator circuit. However, carefully resetting with a calibration chart containing all control setting and with identical antennae, the frequency change is very slight.

21. Under conditions of vibration, the signals for self oscillator operation are so effected as to seriously impair voice communication. The signals for crystal oscillator control operation are excellent under all conditions.

CONCLUSIONS

22. The following conclusions were reached as a result of these tests:

(1) The equipment is not suitable for use in the Naval Aircraft Service in its present form.

(2) The equipment does not resonate with antennae of the half "V" or full "V" types at frequencies below 3000 kilocycles.

(3) At 12 volts the starting relay is sluggish and at times fails to operate. Above 12 volts the operation is satisfactory.

(4) Fow CW transmission the oscillator is in operation in the key up position. As a result transmission and reception on the same frequency are not practicable.

(5) The 0 to 1.5 ampere radio frequency meter has insufficient range for all conditions.

(6) The reaction between circuits is excessive and as a result detracts from simplicity of tuning and adaptability for remote control.

(7) The frequency change of the master oscillator under conditions of variable temperature and/or humidity and vibration is excessive, in the latter to such an extent as to impair the intelligibility of voice communication.

(8) No provision is made for side tone or interphone.

(9) Condensers of the electrolytic type are used in the equipment.

(10) The receiver antenna binding post is not grounded when keying but assumes an open circuit position.

(11) The markings of the crystal holder sockets and the selector switch are not in agreement.

(12) The numbering of the antenna tuning inductance tap switch is such that an increase of the numbers results in a decrease of frequency.

(13) The master oscillator tuning dial operates too freely and is not provided with a locking device.

(14) The frequency stability of the crystal oscillator under all conditions is excellent and vibration has no measurable effect on the signals.

(15) The equipment is of simple design and covers a wide range of frequency without the use of plug-in coils and operates with a large variety of antennae.

(16) Since the primary purpose of the equipment is for voice communication with the crystal oscillator the defects noted for the master oscillator, which is an emergency circuit in the event of crystal failure, will not seriously detract from satisfactory operation of the equipment.

(17) The instruction book is too brief and lacks much pertinent information.

TABLE I.

WEIGHTS AND DIMENSIONS

Unit	Weight	Length	Width	Height
Transmitter (with tubes and mounting base)	19.0 Lbs	13 3/4"	10 1/8"	10 5/8"
Dynamotor (with mounting base	12.87 "	8 7/8"	5 3/16"	8"
Battery Cable	.87 "	72"		
Transmitter to Dynamotor Cable	1.312"	72"		
Total	34.052"			

FREQUENCY RANGE

Low Band	2417.5 to 4496.0 KC
High Band	4537.0 to 8540.0 KC

CURRENT DRAIN

At 13 Volts   Voice Position 12.8 Amps.   CW Position 10.5 Amps.

TABLE 2

POWER OUTPUT

Frequency kilocycles	Antenna Ohms	Antenna Cap. MMF.	Ant. Watts: MO CW	Ant. Watts: MO Voice	Ant. Watts: Crystal CW	Ant. Watts: Crystal Voice
Full V Ant.						
3105	1.73	100	2.28	1.9	2.28	1.9
4200	2.11	120	4.43	3.82	4.43	3.82
5340	2.78	150	5.05	5.05	3.05	3.05
6210	3.8	230	11.6	9.73	7.0	5.9
8400	10.0	-250	10.0	8.1	3.6	2.5
Half V Ant.						
3105	1.3	68	1.72	1.44	1.72	1.3
4200	1.4	70	2.55	2.03	2.37	2.03
5340	1.6	72	2.91	2.5	1.6	1.3
6210	1.9	80	5.17	3.8	2.73	2.3
8400	3.0	115	4.32	3.3	1.08	0.75
20 Ohm 250 MMF Ant.						
3105	20	250	14.4	11.2	14.4	9.8
4200	20	250	16.2	12.8	16.2	11.2
5340	20	250	16.2	14.4	7.2	6.0
6210	20	250	18.0	16.2	7.2	6.0
6400	20	250	14.4	11.2	5.0	1.8

TABLE III

CALIBRATION ACCURACY

Calibration Frequency KC	Measured Frequency	
	XTAL	MO
2670	2670.0 KC	2675.5 KC
3105	3105.65	3107.85
4050		4053.0
4200	4200	4199.0
5340 (2670 Doubled)	5340	5352.0
6210 (3105 Doubled)	6210	6206.0
8400 (4200 Doubled)	8400	8418.0

TABLE IV

OVERALL AUDIO FREQUENCY RESPONSE

4200 KC

Audio Frequency	Crystal Oscillator		Master Oscillator	
Cycles	Volts	DB	Volts	DB
200	7.3	-5.0	7.3	-4.74
300	9.0	-3.2	8.9	-3.0
400	10.4	-1.93	10.1	-1.9
500	11.2	-1.3	11.0	-1.17
600	11.9	-0.8	11.7	-0.65
800	12.5	-0.35	12.3	-0.2
1000	13.0	0	12.6	0
1500	13.5	+0.33	13.2	+0.4
2000	13.8	+0.5	13.3	+0.47
2500	14.5	+0.95	13.3	+0.47
3000	14.5	+0.95	13.4	+0.55
4000	14.3	+0.8	13.4	+0.55

TABLE V

AUDIO FREQUENCY DISTORTION

Harmonics		Percent of Output	
		MO	XTAL
2		18.5	20.0
3		17.0	12.0
4		1.8	1.5
5		4.0	6.5
6		1.0	1.2
7		5.5	5.5
8		0.5	0.3
9		2.0	2.2
10		0	0
11		1.1	1.0
12		0.15	0.2
13		1.3	1.3
14		0	0
15		0.15	0.5
	RMS	26.25	25.05

NOISE LEVEL

100% Modulation	12.5V	
Carrier	0.1V	Ratio .008 = -42 DB

TABLE VI

FREQUENCY DRIFT

CONSTANT TEMPERATURE

Time Min.	3105 KC Master Oscillator CW	3105 KC Master Oscillator Voice	8400 KC Master Oscillator CW	8400 KC Master Oscillator Voice
0	3108.7 KC	3.08.25 KC	8396.6	8398.0
5	3108.65	3108.1	8395.0	8396.6
10	3108.55	3107.8	8393.8	8396.2
15	3108.45	3107.6	8393.2	8395.8
20	3108.35	3107.35	8392.6	8395.4
25	3108.2	3107.2	8392.2	8395.0
30	3108.1	3107.05	8391.8	8394.6
35	3107.95	3106.9	8391.4	8394.0
40	3107.6	3106.85	8391.0	8393.6
45	3107.45	3106.65	8390.8	8393.2
50	3107.35	3106.55	8390.4	8392.8
55	3107.2	3106.45	8390.0	8392.4
60	3107.1	3106.35	8389.6	8392.0
Total Change	1.6 KC	1.9 KC	7.0 KC	6.0 KC
PCT change	0.051	0.061	0.08	0.071

There was no measurable drift of the crystal oscillator at any frequency.

TABLE VII

FREQUENCY DRIFT VARIABLE TEMPERATURE

8400 KC

MO - VOICE

Time Min.	Temp. °C	Freq. KC	Time Min	Temp. °C	Freq. KC
0	+24.0	8401.6	180	-13.0	8404.6
5	21.0	8401.8	210	14.5	8405.0
10	17.0	8401.4	240	-15.5	8405.0
15	15.0	8401.2	270	+ 1.0	8404.0
20	13.0	8401.0	300	21.0	8402.2
25	10.0	8401.4	330	31.0	8399.6
30	8.0	8401.6	360	45.0	8394.0
45	3.5	8402.2	370	50.0	8390.8
60	- 1.0	8402.8	390	44.0	8388.8
90	5.0	8403.4	420	24.0	8389.2
120	8.5	8404.0	450	+24.0	8396.6
150	-11.0	8404.2			

Maximum change over any 20° (+28° to +48°) = 9.4 KC = .112%

Maximum change over any 50° (0° to +50°) = 15.2 KC = .18%

In crystal position the drift was less than 100 cycles.

TABLE VIII

FREQUENCY DRIFT VAIRABLE TEMPERATURE

8400 KC

MO			CW		
Time Min	Temp. °C	Freq. KC	Time Min	Temp. °C	Freq. KC
0	+25.0	8394.2	180	-13.0	8400.8
5	23.0	8394.4	210	15.5	8401.2
10	22.0	8394.6	240	- 9.0	8401.0
15	18.0	8394.8	270	0	8400.2
20	15.0	8395.4	300	+12.0	8398.8
25	11.0	8395.6	330	21.0	8397.8
30	9.0	8396.0	360	36.0	8395.0
45	+ 3.0	8397.2	390	48.0	8387.2
60	- 1.0	8398.0	400	50.0	8386.0
90	6.0	8399.2	420	43.0	8385.0
120	9.0	8399.9	450	+25.0	8389.4
150	-11.5	8400.4			

Maximum change over any 20° (+30° to +50°) = 10.0 KC = .119%

Maximum change over any 50° (+4 to +46°) = 14.9 KC = .177%

In crystal position there was no measurable drift.

TABLE IX

FREQUENCY DRIFT WITH VARIABLE HUMIDITY.

8400 KC

MO - CW

The equipment was allowed to stabilize at 40°C for approximately one hour before introducing a change of humidity.

Time Min	Temp. °C	Humidity %	Frequency KC
0	41	43	8388.8
10	41	43	8387.6
20	42	44	8386.2
30	42	53	8385.2
40	42	78	8385.0
50	42	84	8385.0
60	42	100	8385.0

Total drift 3.8 KC - .045%

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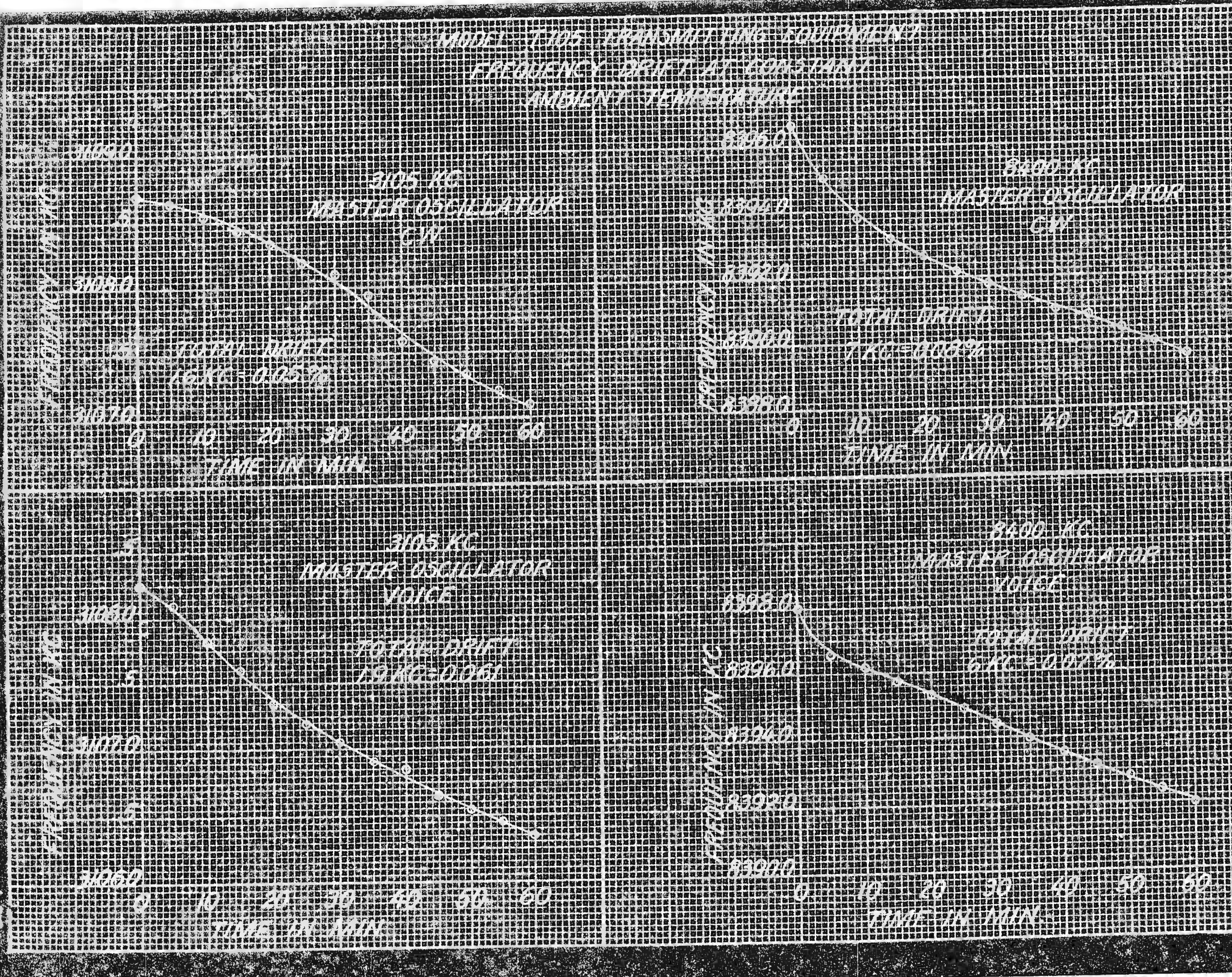
DATE



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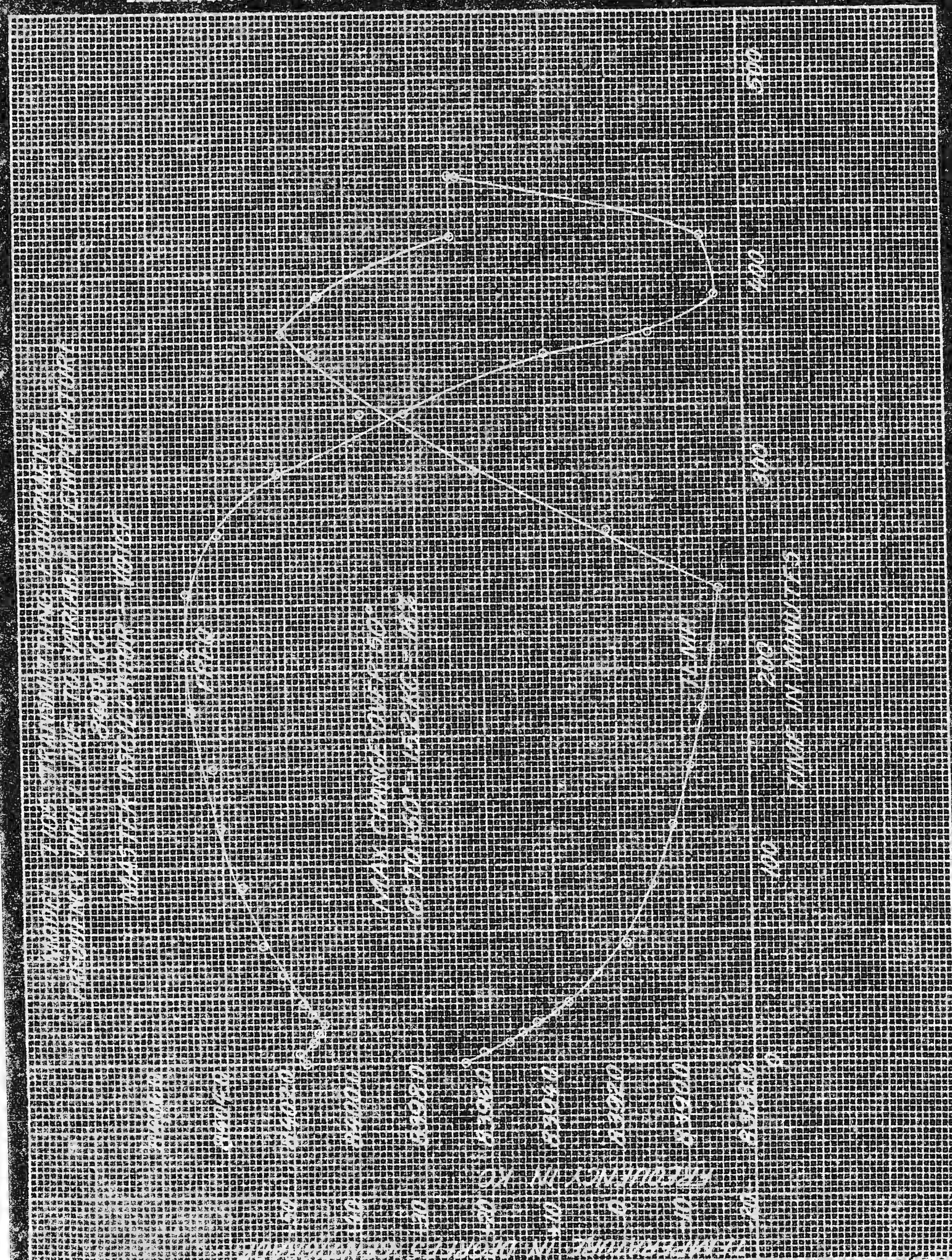
BELLEVUE, D. C.

DATE



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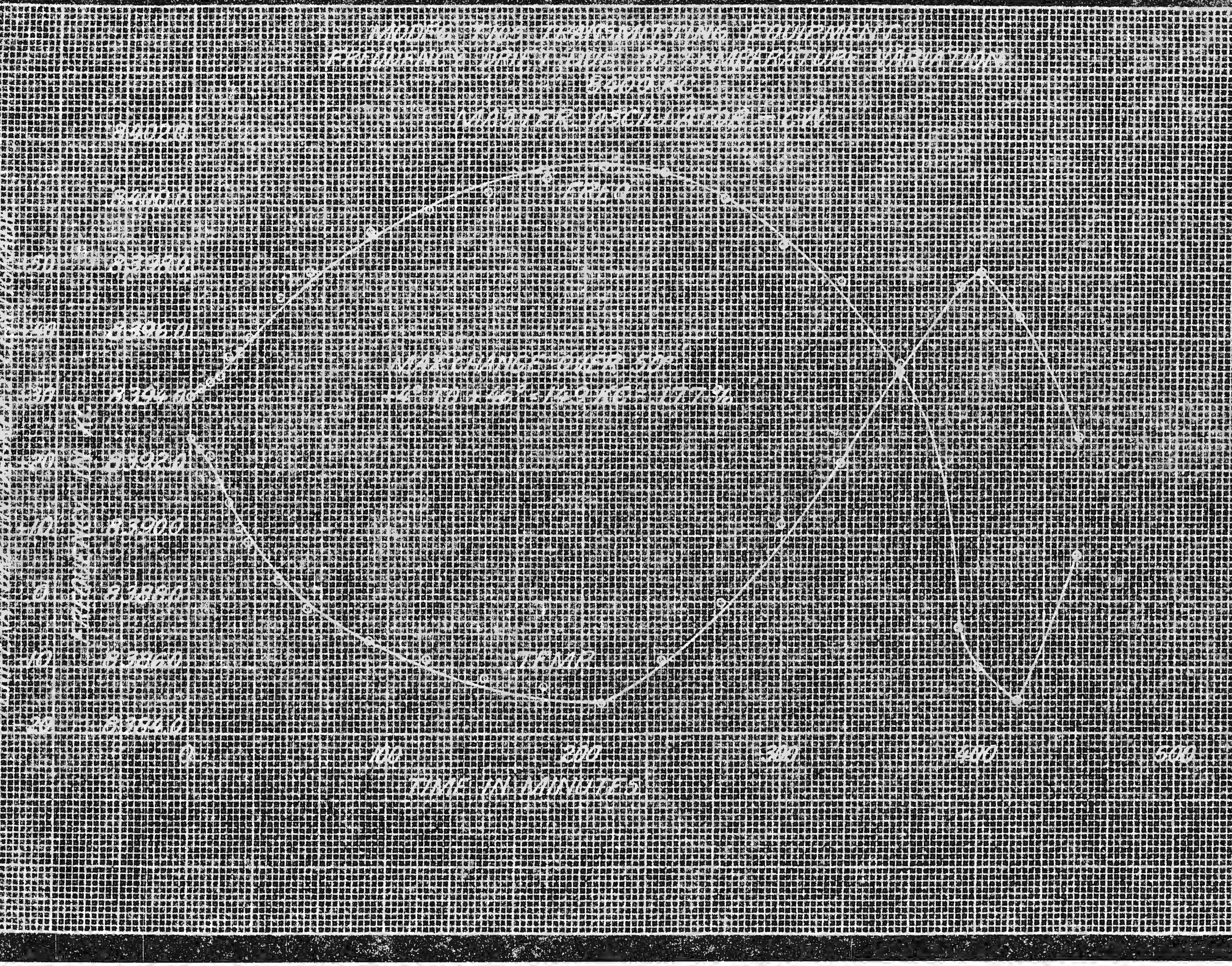

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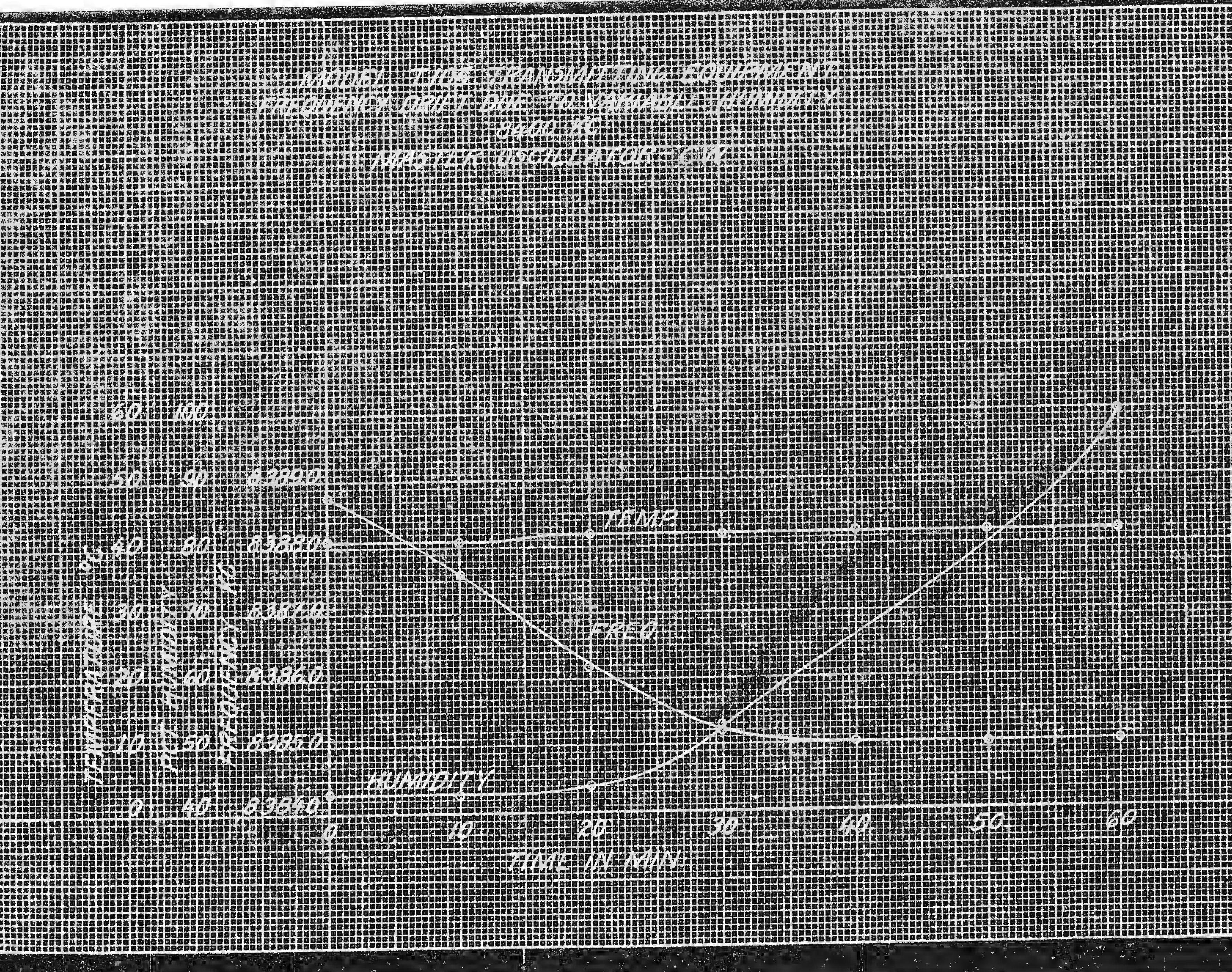

Serial No. 39174

U. S. NAVAL AIR STATION

Refer to No.
F42-1/52(8)/
NA6(410)

ANACOSTIA, D. C.

6 Nov. 1939

[redacted]

From: Commanding Officer.
To : The Chief of the Bureau of Engineering.

Subject: Aircraft Radio - U. S. Coast Guard Transmitter, Type T-105, Contract TCG-30137-Report on Tests of

Reference: (a) Bu.Eng.Ltr.En8/370-39/Avia (724-R5) of 27 July, 1939, to Bureau of Supplies & Accounts, Copy to Naval Air Station, Anacostia, D. C.
(b) U. S. Coast Guard Detail Specifications for Aircraft Radio Transmitter, RTS-239.
(c) U.S.Coast Guard Contract TCG-30137.
(d) BuAero.Shipment Order 1857.
(e) BuEng.Ltr. F42-1/52 (9-28-R6) of 29 September, 1939 to Naval Research Laboratory, Copy to Naval Air Station Anacostia.

Enclosures: (A) Photograph AN-54235, U.S.Coast Guard Transmitter, Model T-105 - Complete Equipment.
(B) Photograph AN-54236, U.S.Coast Guard Transmitter, Model T-105 - Top View.
(C) Photograph AN-54237, U.S.Coast Guard Transmitter, Model T-105 - Bottom View.
(D) Photograph AN-54238, U.S.Coast Guard Transmitter, Model T-105 - Right Side View.
(E) Photograph AN-54239, U.S.Coast Guard Transmitter, Model T-105 - Dynamotor and Interior view of Dynamotor Filter.
(F) Photograph AN-54240, U.S.Coast Guard Transmitter, Model T-105 - Schematic Circuit Diagram.

1. The subject equipment has been checked in accordance with reference (a). Two units of the required equipment, Serial Nos. 18 and 19, have been delivered to this station without damage in transit. No crystals were furnished as none were required by the governing contract but crystals were obtained from the Coast Guard for test purposes. Each unit of the subject equipment consists of the following component parts as required by reference (c).

F42-1/52(8)/
NA6(410)
Serial No. 39174

U. S. NAVAL AIR STATION
Anacostia, D. C.

[redacted]

Subject: Aircraft Radio - U.S.Coast Guard Transmitter, Type T-105, Contract TCG-30137 - Report on Tests of.

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1 Model T-105 Transmitter complete with shock mounting.
1 Model DM-519-L Dynamotor, complete with shock mounting.
1 Transmitter to Dynamotor 6 Conductor Cable.
1 Dynamotor to Battery 2 Conductor Cable.
4 Type 807 Vacuum Tubes.
1 Set Spare Parts.

2. Brief flight and laboratory tests were made to determine the suitability of the equipment for Naval Service. Such information which is considered to be of value is submitted herewith.

A. Description of Circuit.

The circuit of the T-105 transmitter consists of an 807 oscillator, an 807 power amplifier and two 807 modulator tubes which provide plate modulation for the output of the power amplifier. The frequency range extends from approximately 2400 to 8600 kc with a 40 kc hiatus at 4500 kc. Either self-oscillating or crystal controlled cw or voice operation can be obtained but no provisions are made for tone modulated telegraphy. No remote control of circuits is provided and no provision is made for sidetone on either voice or cw operation. The circuit diagram is shown in enclosure (F).

B. Weights and Dimensions.

Unit	Weight	Dimensions (overall)	
Dynamotor with Shock Mount	13.2	H L W	8 8-7/8 5-1/8"
Transmitter with Shock Mount	19.3	H L W	10-3/4 10-23/32 10-1/8
Battery Cable	0.9	L	72"
Dynamotor to Transmitter Cable	1.4	L	73"
Total	34.8 pounds		

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C. Power Input

Supply Voltage - 12 volts.

	T-105	GF-5
Key up CW	6.5 amps	4.2 amps
Key down CW	9.6 amps	7.3 amps
Voice Stand-by	2.1 amps	4.2 amps
Voice Operation	12.5 amps	7.0 amps

The T-105 dynamotor is inoperative in the voice stand-by condition.

D. Power Output

Comparative figures are given for the T-105 transmitter and GF-5 transmitter. The antenna constants correspond to the full vee antenna except the last measurement which corresponds to the half vee antenna. The GF-5 transmitter cannot be tuned into the full vee constants at 8400 kc. Supply voltage was 12.0 volts.

			Ant. Watts.			
			T-105		GF-5	
Frequency (kc)	Antenna (ohms)	Antenna Cap. (MMFD)	CW	Voice	CW	Voice
3105	1.5	105	2.3	1.8	2.3	1.2
4200	2.5	125	5.0	4.2	5.0	2.7
6210	6.0	275	10.1	8.0	6.6	3.0
8400	10.0	-125	10.0	6.4	-	-
8400	3.0	115	5.1	3.6	5.0	2.6

E. Range of Antenna Circuits.

This equipment will operate into either full vee or half vee fixed antennas above 3000 kc. It will also resonate quarter wave and three quarter wave trailing antennas. This range of antenna circuits is considered very good.

F. Tuning of Equipment.

Tuning of equipment is not like any Navy transmitter and is very confusing until the operator becomes familiar with the set and

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Transmitter Serial #18.

Oscillator Setting	Calibrated Frequency	Measured Full Power
1633.4	3100	3107.5
3625.5	4050	4055.0
4022.0	4200	4202.0
4109.1	4230	4233.0
4224.3	8100	8108.0
4702.0	8400	8405.0
4810.5	8460	8460.7

A test made in flight on 3005 kc using transmitter Serial #19 gave a frequency change of 5 kc when removing the antenna. An identical test with the GF-3 transmitter caused a frequency shift of only 300 cycles. Data of the type given in the preceding table are quite variable due to the fact that slight tuning adjustments affect the frequency but do not noticeably affect the power output. It is even possible with the aid of a frequency meter to tune the T-105 transmitter so that removal of the antenna does not shift the frequency but the procedure is not practicable. The setting of the emergency oscillator condenser is controlled by well-designed gears which eliminate backlash almost entirely and would provide very good reset if the power amplifier and antenna circuits did not react so seriously on the emergency oscillator frequency. In order that the full value of the emergency oscillator design be utilized it appears advisable in future equipments to reduce the reaction between circuits to a negligible amount.

I. Use of Emergency Oscillator.

Providing the desired crystal fails to oscillate after the set has been fully tuned it is possible to switch to the emergency oscillator and adjust for maximum output with the results indicated below. The procedure was to tune up the transmitter for optimum operation using the crystal oscillator and then switch to the emergency oscillator and adjust it for maximum output without changing any other settings.

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The results:

Crystal Frequency	Emergency Oscillator Frequency
2670	2672.0
3105	3104.7
4200	4195.0
5340	5320
6210	6174
8400	8475

It is necessary to record the emergency oscillator settings which correspond to the crystal frequencies at the upper end of the band.

J. Modulation Characteristics.

Modulation characteristics are generally good but the audio characteristic is considered much too wide. The audio characteristic of Navy aircraft equipment normally does not extend beyond 3500 cycles. The T-105 transmitter can be modulated up to 20000 cycles.

K. Operation at Altitude.

Satisfactory operation was obtained on one flight up to an altitude of 25000 feet on 3005 kc. Frequency stability under conditions approaching continuous locked key were as indicated below.

Altitude in feet.	Temp. °F	Frequency kc
25000	36	3005.9
24000	36	3005.8
23000	36	3005.7
22000	37	3005.4
21000	37	3005.0
20000	35	3005.1
19000	33	3005.1
18000	32	3005.0
17000	32	3004.9
16000	32	3004.9
15000	33	3004.9

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Altitude in Feet	Temp. °F	Frequency kc
14000	37	3004.9
13000	39	3004.8
12000	41	3004.9
11000	42	3004.9
10000	45	3004.9
9000	47	3004.9
8000	49	3005.0
7000	55	3005.1
6000	50	3005.2
5000	50	3005.2
4000	50	3005.2
3000	50	3005.2
2000	50	3005.2
1000	50	3005.2

3 The following deficiencies were also observed during tests.

(a) The control of the emergency oscillator operated too easily and was not provided with a lock to prevent accidental change in setting.

(b) No markings were provided for the tube sockets. The crystal holder positions were not properly marked.

(c) The 1.5 ampere radio frequency meter is too small. A 2 ampere meter of the expanded lower range type would be suitable.

(d) Dynamotor starting relay failed to operate with a 12 volt supply.

(e) Self oscillations were observed in power amplifier when power amplifier was tuned to the maximum frequency. When this condition was present the antenna ammeter registered antenna current without any antenna connected to the transmitter.

(f) Numerous fuses were blown during tests. A 3/8 ampere fuse instead of a 1/4 ampere fuse is desirable.

(g) CW transmission and reception on the same frequency is not feasible due to the oscillator operating in the key up position.

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(h) The antenna tuning tap switch is so connected that the higher settings come at the lower frequencies and vice versa.

(i) Frequency range is not continuous. The actual frequency range is as indicated:

Serial #18	2417-4498;	4537-8540
Serial #19	2416-4507;	4540-8552

It will be noted that a gap of approximately 40 kc is present in both equipments.

(j) The arrangement of component parts has not been such so as to secure the shortest possible radio frequency leads on the maximum accessibility for servicing.

(k) The instruction book is somewhat inadequate. A more elaborate description of the electrical circuits comprising this equipment would be of value. Data showing representative operating voltages and currents, power input and power output are also desirable. Typical settings for several frequencies and if practicable a calibration for each individual equipment should be provided. An error appears on page 12 of the instruction book under the heading CAUTION. The 10 second interval necessary for the modulator heaters to respond is required when shifting from cw to voice and not when shifting from voice to cw as indicated.

4. CONCLUSIONS:

(a) One significant advantage of this equipment is that it is possible after becoming familiar with its operation to shift frequency under service conditions in not over thirty seconds when using crystals and only slightly longer than that when using precalibrated settings of the emergency oscillator.

(b) The reaction of the power amplifier and antenna coupling circuit on the frequency of the emergency oscillator is excessive.

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(c) The equipment in its present form is capable of good service but would require fairly extensive modification to meet the needs of Naval military service. It does possess the advantage of providing a wide range of frequencies which can be tuned in to a large variety of fixed antennas without the use of plug in coils.

(d) Changes in the basic design of the transmitter which would make it more adaptable to Navy Aircraft requirements include the following:

1. Provision of remote control circuits.

2. Provision of sidetone and interphone in conjunction with a Navy receiver.

3. Provision of MCW.

4. Stopping of the oscillator in the key up position. This necessitates keying the crystal.

5. A frequency range from 3000 to 9050 would be preferable to that supplied.

5. Serial #19 of the subject equipments with two sets of spare parts but no crystals, has been transferred to the Naval Aircraft Factory, Philadelphia in accordance with reference (d), Serial #18 minus spare parts but with two sets of crystals has been transferred to the Naval Research Laboratory as directed by reference (e).

S. P. GINDER

CC: Bueng. (1 and 4)
Buaero.
NRL Bellevue