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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Tests of Model TBA-1A Transmitting Equipment
(After modification by mfgr.)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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Prepared by:

O. C. Dresser, Assistant Radio Engineer.

Reviewed by:

R. B. Meyer, Assoc. Radio Engr. (Chief of Section).

A. Hoyt Taylor, Physicist, Superintendent, Radio Division.

Approved by:

H. R. Greenlee, Captain, USN, Director.

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Recommendations

It is recommended:

(a) That the Model T.B.A.-1A transmitter be supplied with a switch by means of which it would be possible to open the filament circuit of the master oscillator tube when the transmitter is not being used and it is still desirable to permit the temperature control circuits to operate.

(b) That the present Model T.B.A.-1A design be considered as unsuitable for perpetuation in future designs of equipment of this particular type.

(c) That the Model T.B.A.-1A equipment be considered suitable for installation on board a Naval vessel, since only one model of this particular transmitter is in existence and it would require a complete rebuilding of the transmitter in order to obtain greatly improved performance.

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DESCRIPTION OF MATERIAL UNDER TEST

5. The material under test consisted of one complete Model T.B.A.-1A transmitter, Serial No. 33, manufactured by the General Electric Company. This transmitter had previously been tested by this Laboratory and returned to the manufacturer for correction. The results of the previous test of this transmitter were reported in reference (a).

METHOD OF TEST

6. At the beginning of the test period it was noted that the oscillations in the master oscillator circuit were unstable or ceased altogether throughout a considerable portion of the frequency range. Excessive line ripple was apparent in the emitted note. The general performance was so unsatisfactory that frequency measurements were abandoned as reported in reference (c).

7. A representative of the manufacturer corrected the instability of the master oscillator circuit by utilizing the grid generator output for the master oscillator plate potential. The master oscillator plate was formerly fed from the 230 volt DC line. This voltage was too low for stable operation and, due to inadequate filters, the modulation caused by line ripple was excessive. A further objection to this method was the fact that the master oscillator, when fed from the line oscillated continuously, being entirely controlled by means of the master oscillator compartment heater switch. With the present arrangement, oscillations cease in the master oscillator when the grid generator is not running. However, the master oscillator filament continues to burn as long as the heater switch is closed.

8. Frequency changes and drifts were checked by means of the L.H. visual frequency indicating equipment.

9. Determinations of the temperature coefficient of the transmitter were made at full power output over the temperature range of zero to fifty degrees Centigrade. The temperature control facilities of the U. S. Bureau of Standards were utilized for these tests, frequency observations being taken on the L.H. visual frequency indicating equipment. The transmitter key was opened during the period while the temperature was being changed, the key being locked for one hour and ten minutes at each test temperature in order to permit the transmitter to reach temperature equilibrium.

10. Model RAB receivers were used to determine the quality of emission.

DATA RECORDED DURING TEST

11. Complete data was recorded on all tests and this information is contained in Tables 1 to 15 and Plates 1 to 6, inclusive.

DISCUSSION OF PROBABLE ERRORS

12. Every effort was made to eliminate errors in the results obtained during the tests recorded herein. The visual frequency measuring equipment used to determine frequency drift is accurate to within one or two cycles in 1,000,000.

13. All meters used during the tests were of the precision type.

RESULTS OF TEST

14. Upon receipt of the T.B.A.-1A equipment it was noted that the filter condenser (part No. 508) had been damaged. The oil filler plug has been torn out of the condenser case and there was no oil in the condenser. As the plug could not be found in the packing case and there was very little evidence of spilled oil in the packing it was assumed that the damage had occurred previous to packing for shipment. This condenser was repaired by the Laboratory before installing in the equipment.

15. When the transmitter was placed into commission it was found that the emitted note was severely modulated by line voltage ripple. This modulation was so intense that no frequency measurements could be undertaken. Investigation revealed that this modulation was caused by radio frequency feed-back and that the filter included in the equipment was inadequate to suppress this condition.

16. When received, the transmitter derived the necessary voltage to operate the master oscillator circuit from the 230 volt line. In order to overcome the objectionable ripple, radio frequency chokes were inserted in the 230 volt line which reduced the ripple to such a low level that the emitted signal no longer suffered from any objectionable modulation.

17. When this modification had been made and tests were resumed it was discovered that the master oscillator failed to oscillate over a considerable portion of the frequency range. A condition existed where the factors governing oscillations were so critical that a small drop in line voltage caused the circuit to cease operation. For instance, it was noted that when the heater circuit was energized oscillations ceased; although feeble oscillations were present before the heater circuit was energized. It should be understood that the heater circuit operated from the 230 volt DC line through the same switch which supplied the master oscillator circuit. It was also noted that oscillations could be secured at certain dial settings when the master circuit was cold, but these oscillations ceased when the master compartment temperature rose to approximately 70° Centigrade, which is the normal operating temperature designated by the manufacturer.

18. In view of the fact that this equipment is required to operate on line voltages ranging between the limits of plus and minus 10% of normal (230 volts), a series of tests was conducted at line voltages of 207, 230 and 253 volts. Table 1 shows the results of these tests. It will be noted that oscillations ceased over large portions of the range when the line voltage was 10% below normal and that some gaps still

remained at normal 230 volts. Oscillations in some parts of the frequency range were none too stable even when the line voltage was increased to 10% above normal, although at this voltage it was possible to excite the succeeding stages over the entire frequency range.

19. The above conditions were corrected by a representative of the manufacturer by obtaining the master oscillator plate potential from the grid bias generator. This voltage is sufficiently high to insure stable master oscillator operation and there is no objectional line ripple.

20. Previous to the modification wherein the potentials for the master oscillator circuit were obtained from the grid bias generator, it had been necessary to maintain the master oscillator tube in an oscillating condition continuously whenever the temperature control circuits were in operation. After the above modification the master tube no longer oscillates when the motor generator equipment is shut down. However, the filament of the master tube remains lighted as long as the heater switch is closed. Due to the length of time it takes for the heater compartment to reach equilibrium it is necessary to keep the heater compartment energized continuously. In the interests of economy and in order to prolong the life of the master oscillator tube, it is recommended that the filament circuit be broken by a switch, through the medium of which the operator would have control of the filament voltage and could thus light the filament only when the transmitter was in operation.

21. Local receiving tests were conducted to determine the quality of emission. The note produced by the transmitter, after the master oscillator circuit was connected to derive plate and screen potentials from the grid motor generator, was found to be good. Key clicks are present to about the same degree as in other equipment of a similar nature. A direct comparison was made between the keying method employed in the Model T.B.A.-1A and the method which has been developed by the Research Section of the Naval Research Laboratory. This comparison indicated that ordinary keying methods produce key click interference of a very considerable magnitude which may be reduced to almost negligible levels if proper precautions are observed. However, these precautions necessitate the use of considerable additional apparatus which could not readily be installed in the present T.B.A.-1A transmitter. The only way to take advantage of this improved keying system would be to provide an additional unit for keying purposes.

22. During the course of the tests one capacitor break-down occurred. This capacitor (part No. 138) is used as part of the H.V. filter system and is subjected to a potential of 3000 volts. Apparently this was a receiving capacitor as it was not marked with voltage rating. This capacitor was replaced by one rated at 5000 volts and no further trouble was experienced from this source.

23. Tests conducted at 4500 kcs. to determine the frequency drift caused by voltage changes of plus and minus 10% of normal voltage in steps of one per cent per minute show that this frequency drift is 70

cycles or .0015%. Part of this drift can be assumed to be independent of voltage effect as a rapid voltage change from 10% below to 10% above normal voltage resulted in a frequency change of only 9 cycles or .0002%. The results of these tests are shown in Table 2.

24. Tables 9 to 15 and Plates 1 to 6 inclusive show the results of the temperature tests conducted at the Bureau of Standards. These tests indicate the present master oscillator design is much superior to that of the previous one in the T.B.A.-1A transmitter. The average temperature coefficient is .00042% per degree Centigrade as compared to .0015% in the original design.

25. The frequency changes caused by the detuning of circuits other than the frequency establishing circuit are negligible.

26. Two hour key locked full power runs were made at frequencies of 3000, 4000 and 4500 kcs. (Tables 3, 4 and 5), showing an average maximum frequency drift, after the first 20 minute key locked period, of .01%.

27. An additional two hour key locked run was made at 4500 kcs. beginning three hours after heat was applied to the master oscillator compartment. The results of this test are shown in Table 6. It will be noted that at the end of the test period the temperature of the master oscillator compartment was still about seven degrees lower than the normal operating temperature. This would account for the large frequency drift of 2390 cycles or .053%. Further tests indicated that the time required to raise the temperature of the master oscillator compartment from room temperature to the normal operating point is at least eight hours.

28. The test conducted at 4500 kcs. to determine the frequency change between the full power condition (key locked for 10 minutes) and the intermittently keyed condition (a single 10 second dash beginning not less than 20 minutes after discontinuing the key locked condition) shows a frequency change of .0003%.

29. The change in frequency between the continuously keyed full power condition and the intermittently keyed condition was found to be .0032%. The master oscillator filament was energized during the idle period in both the above tests. The results of these tests are shown in Table 7.

30. Vibration was applied to the top of the transmitter and observations made at several frequencies (Table 8). Some lilt and roughness of note was observed but in no case was the condition severe enough to prevent solid copy.

31. Most of the items objected to in reference (c) have been corrected as follows:

32. Paragraph 2-3(a). Some of the frame supporting members have been strengthened by the addition of gusset plates and heavier angle material.

(b). Adequate means have been provided for fastening transmitter to deck.

(c). The indicating arms on the shafts of the P.A. tank capacitor and the antenna tuning capacitor have been securely fastened.

33. Paragraph 2-4(a). The I.P.A. plate blocking condenser has been replaced by one of satisfactory design.

(b). Clearance has been provided between the relay compartment door and deck. The contact members carrying the circuits from the first buffer stage to the I.P.A. stage have been replaced by contacts of much more rugged and satisfactory design.

(c). The entire master oscillator compartment has been redesigned. In the previous design a 38165 tube was utilized as a master oscillator. This tube was placed within the temperature controlled compartment and as a result, the heat dissipated by the tube was sufficient to cause the compartment temperature to rise indefinitely when the transmitter was placed in ambient temperatures above 35 degrees Centigrade. The component parts of the circuit were of light construction making an assembly having extremely unstable frequency characteristics. In the present design a 38160 tube is used as a master oscillator placed outside the temperature controlled compartment. Heavier and more rugged circuit parts have been used so that the resultant frequency stability is greatly improved. The master oscillator dial is not provided with a lock but this is not considered a serious defect as the dial is back of the transmitter surface so that accidental movement of the dial is unlikely and the gearing is such that it is believed the dial will remain in adjustment under severe conditions of vibration as the master oscillator compartment is flexibly mounted.

34. Paragraph 2-5. The equipment operates satisfactorily in ambient temperatures between the limits of zero to 50 degrees Centigrade.

CONCLUSIONS

35. The redesign of the master oscillator circuit by the manufacturer has resulted in greatly improved performance.

36. Some frame members have been strengthened making a more rigid assembly.

37. Satisfactory means have been provided for fastening the transmitter to the deck.

38. The improvement of the master oscillator compartment temperature control system has reduced the temperature coefficient to .00042% as compared to .0015% in the original model.

39. The method used by the manufacturer to protect the screen grid and filament by-pass condenser from the effects of the heat generated by the power amplifier tubes has not proven entirely satisfactory. This condenser still exudes wax at high ambient temperatures.

40. The contact members between the first and second P.A. stages have been replaced with contacts of more rugged and satisfactory design.

41. The substitution of the 38160 tube in the master oscillator circuit in place of the 38165, and the removal of this tube from its position within the temperature controlled compartment to a location outside of this compartment, has resulted in improved performance.

42. In general, it may be stated that the modifications incorporated by the manufacturer, subsequent to the first tests of the Model T.B.A.-1A, have resulted in improved performance. Strength and ruggedness have been improved and more satisfactory controls have been provided. As the result of these improvements the Model T.B.A.-1A equipment should be capable of providing good service afloat. It is believed that due to the restrictions imposed by the limiting dimensions of the space available for the master oscillator compartment that no major improvements can readily be made in the present design.

TABLE NO. 1

TBA-1A Transmitter, Serial No. 33

Data showing operation of M.O. at 230, 253, and 207 volts, i.e., normal and ± 10% line voltage.

Line volts	"A" Control	"B" Control	"C" Control	M.O. Plate Current Mils.	Remarks
230	0	1	L.F.	5.5	OK
230	2500	1	L.F.	6.0	OK
230	0	2	L.F.	7.2	OK
230	2500	2	L.F.	6.5	OK
230	0	3	L.F.	8.2	OK
230	2500	3	L.F.	7.5	OK
230	0	4	L.F.	9.6	OK
230	2500	4	L.F.	9.5	OK
230	0	5	L.F.	14.5	No oscillations
230	2500	5	L.F.	14.2	No oscillations
230	0	1	H.F.	6.0	OK
230	2500	1	H.F.	7.2	OK
230	0	2	H.F.	7.0	OK
230	2500	2	H.F.	7.7	OK
230	0	3	H.F.	8.2	OK
230	2500	3	H.F.	7.7	OK
230	0	4	H.F.	10.2	OK
230	2500	4	H.F.	7.5	OK
230	0	5	H.F.	13.5	No oscillations below 645 on "A"
230	2500	5	H.F.	7.5	OK
230	0	6	H.F.	13.5	No oscillations below 540 on "A"
230	2500	6	H.F.	7.6	OK
253	0	1	L.F.	5.2	OK
253	2500	1	L.F.	5.7	OK
253	0	2	L.F.	6.3	OK
253	2500	2	L.F.	6.4	OK
253	0	3	L.F.	7.4	OK
253	2500	3	L.F.	7.0	OK
253	0	4	L.F.	8.5	OK
253	2500	4	L.F.	8.5	OK
253	0	5	L.F.	11.0	OK
253	2500	5	L.F.	11.5	OK
253	0	1	H.F.	6.5	OK
253	2500	1	H.F.	7.6	OK
253	0	2	H.F.	7.5	OK
253	2500	2	H.F.	8.5	OK
253	0	3	H.F.	8.5	OK
253	2500	3	H.F.	8.5	OK
253	0	4	H.F.	10.2	OK

TABLE NO. 1 Cont'd

Line volts	"A" Control	"B" Control	"C" Control	M.O. Plate Current Mils	Remarks
253	2500	4	H.F.	8.5	OK
253	0	5	H.F.	12.5	OK
253	2500	5	H.F.	8.5	OK
253	0	6	H.F.	12.5	OK
253	2500	6	H.F.	8.6	OK
207	0	1	L.F.	6.5	OK
207	2500	1	L.F.	7.0	OK
207	0	2	L.F.	9.5	Unstable-flickering plate current.
207	2500	2	L.F.	8.2	OK
207	0	3	L.F.	12.5	No oscillations.
207	2500	3	L.F.	11.5	Unstable-flickering plate current.
207	0	4	L.F.	12.5	No oscillations
207	2500	4	L.F.	12.5	No oscillations
207	0	5	L.F.	12.5	No oscillations
207	2500	5	L.F.	12.5	No oscillations
207	0	1	H.F.	6.5	OK
207	2500	1	H.F.	7.6	OK
207	0	2	H.F.	8.0	OK
207	2500	2	H.F.	8.5	OK
207	0	3	H.F.	11.2	No oscillations below 1700 on "A"
207	2500	3	H.F.	8.3	OK
207	0	4	H.F.	12.0	No oscillations below 1550 on "A"
207	2500	4	H.F.	7.5	OK
207	0	5	H.F.	12.0	No oscillations below 1140 on "A"
207	2500	5	H.F.	7.0	OK
207	0	6	H.F.	12.0	No oscillations below 950 on "A"
207	2500	6	H.F.	7.0	OK

Note: When it was impossible to excite the buffer amplifier the master oscillator was considered to be in a non-oscillating condition.

TABLE NO. 2

Model TBA-1A, Serial No. 33
Frequency shift at 4500 Kcs. due to voltage change from -10% to +10% normal at the rate of 1% per minute.

Voltage	Frequency Increasing Voltage	Frequency Decreasing Voltage	Frequency Rapid Variation
198.0	4500.733	4500.588	4500.583
200.2	.736	.590	
202.4	.737	.590	
204.6	.736	.590	
206.8	.737	.592	
209.0	.736	.596	
211.2	.739	.600	
213.4	.735	.603	
215.6	.736	.605	
217.8	.727	.604	
220.0	.720	.602	
222.2	.719	.607	
224.4	.717	.604	
226.6	.714	.611	
228.8	.708	.613	
231.0	.704	.618	
233.2	.695	.627	
235.4	.694	.626	
237.6	.680	.640	
239.8	.670	.652	
242.0	.660	.660	4500.592

Note: The 1% per minute variation shows a drift of approximately 70 cycles in each case but the rapid variation shows only a nine cycle variation.

TABLE NO. 3

Model TBA-1A Transmitter, Serial No.33

Two hour run, full power, key locked. Two day preliminary heating period.

Time	°C Cabinet	°C Ambient	Frequency
0930	73.1	25.9	3001.000
40	73.2	26.2	3000.940
50	73.4	26.6	3000.542
1000	73.5	26.9	3000.488
10	73.6	27.0	3000.400
20	74.0	27.3	3000.320
30	74.0	27.7	3000.275
40	74.1	27.8	3000.202
50	74.1	28.0	3000.140
1100	74.3	28.0	3000.100
10	74.6	28.0	3000.010
20	74.6	28.1	2999.980
30	74.6	28.2	2999.958

Maximum variation after first 20 minutes 584 cycles or 0.019.

TABLE NO. 4

27 hour preliminary heating period.

Time	°C Cabinet	°C Ambient	Frequency
1300	73.5	24.5	4000.835
10	73.7	24.5	4000.807
20	73.9	24.5	4000.765
30	73.9	24.8	4000.733
40	74.0	24.8	4000.698
50	74.1	24.8	4000.666
1400	74.3	24.9	4000.630
10	74.5	24.9	4000.588
20	75.0	25.0	4000.558
30	74.9	25.0	4000.530
40	75.0	25.0	4000.502
50	75.0	25.0	4000.530
1600	75.0	25.2	4000.490

Maximum frequency change after first twenty minutes 275 cycles or 0.0069%.

TABLE NO. 5

Model TBA-1A Transmitter, Serial No.33

Two hour run, full power, key locked. 23 hour preliminary heating period.

Time	°C Cabinet	°C Ambient	Frequency
0815	73.0	23.8	4501.000
25	73.0	23.9	4500.966
35	73.0	24.0	4500.933
45	73.1	24.6	4500.900
55	73.1	24.8	4500.880
0905	73.3	24.9	4500.852
15	73.5	25.0	4500.824
25	73.7	24.9	4500.790
35	73.9	24.8	4500.756
45	74.0	23.4	4500.731
55	74.0	23.4	4500.720
1005	74.1	24.5	4500.701
15	74.2	24.8	4500.682

Maximum frequency change after first 20 minutes 251 cycles or 0.0056.

TABLE NO. 6

Two hour run at full power, key locked. Heat turned on at 0930.

Time	°C Cabinet	°C Ambient	Frequency
1250		23.0	4500.480
1300		23.2	4501.000
10		23.7	4501.300
20		23.8	4501.658
30		23.9	4502.130
40	Visible	24.0	4502.520
50		24.1	4502.410
1400	60.0	24.2	4502.130
10	62.0	24.4	4501.570
20	64.0	24.2	4501.080
30	65.5	24.1	4500.676
40	67.0	24.1	4500.375
1450	68.0	24.0	4500.130

Maximum frequency change 2390 cycles or 0.053%.

TABLE NO. 7

Model TBA-1A Transmitter, Serial No.33

Change in frequency between full power, key locked condition and the intermittently keyed condition.

#1		
End of 10 minute key lock	4500.710 cycles	
End of 10 second dash 20 minutes later	.722 cycles	
Change in frequency	12 cycles	0.0003%
#2		
End of 30 minute keying at 40 W.P.M.	4500.682	
End of 10 second dash 20 minutes later during which motor generator ran	4500.825	
	143 cycles	0.0032%

TABLE NO. 8

Model TBA-1A Transmitter, Serial No.33

Vibration Test.

6000 Kc: Vibration test of TBA-1A resulted in resistor falling out of mounting and shutting off screen voltage. Plate lead of 75 watt tube which had previously been soldered together broke off due to vibration. Note good.

12000 KC: Operation OK. Note good; No trouble from vibration.

16000 Kc: Note fair, some lilt; No trouble from vibration.

20000 Kc: Operation stable, note fair; vibration caused little trouble; screen grid resistor fell out again due to clips being too loose to hold resistor in place.

24000 Kc: Arcing in the antenna coupling unit had to be eliminated by smoothing one of the sharp edges of the switching arrangement. Operation of the set became stable only after Control U (screen grid by-pass condenser) had been carefully adjusted. Vibration caused some roughening of the note but not enough to interfere with copying the signal. At this frequency the quality of the note was mediocre.

TABLE NO. 9

TBA-1A Transmitter, Serial No. 33

Effect of change in Ambient Temperature.

Output frequency 4000 kcs.
M.O. frequency 1000 kcs.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0820	25.6	73.5	1000.321	770	229
30	24.8	73.5	.314	780	228
40	25.0	73.8	.309	790	229
50	25.0	73.9	.304	800	230
0900	25.0	74.0	.299	800	228
10	25.0	74.1	.290	800	228
20	25.2	74.3	.284	800	227
30	25.0	74.4	.278	820	229
Key open 10 minutes while temperature was changed.					
0940	14.7	74.6	1000.278	840	231
50	14.8	74.5	.274	770	230
1000	14.7	74.3	.276	770	229
10	15.0	74.0	.286	770	229
20	15.1	73.9	.288	770	229
30	14.7	73.9	.295	770	228
40	15.1	73.5	.300	770	228
50	15.0	73.5	.303	760	228
Key open 10 minutes while temperature was changed.					
1100	10.0	73.5	1000.319	760	228
10	10.0	73.4	.320	760	229
20	10.1	73.1	.323	760	230
30	10.0	73.0	.329	760	230
40	10.0	72.9	.333	760	230
50	10.0	72.7	.338	760	230
1200	10.0	72.6	.341	760	230
10	10.0	72.6	.344	760	230

Key open 10 minutes while temperature was changed.

TABLE NO. 9 Cont'd

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1220	5.4	72.6	1000.354	760	232
30	5.0	72.6	.353	760	231
40	5.0	72.5	.354	760	230
50	5.0	72.3	.357	760	230
1300	5.0	72.3	.359	760	230
10	5.0	72.2	.362	760	230
20	5.0	72.1	.365	760	230
30	5.0	72.1	.367	760	230

Key open 10 minutes while temperature was changed.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1340	0.0	72.1	1000.372	760	230
50	0.0	72.1	.369	760	230
1400	0.0	72.1	.367	760	230
10	0.5	72.2	.366	760	230
20	0.0	72.2	.363	760	230
30	0.0	72.2	.363	760	230
40	-0.1	72.2	.364	760	230
50	0.0	72.2	.364	760	231

Key open 10 minutes while temperature was changed.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1500	24.8	72.2	1000.362	750	226
10	25.4	72.5	.358	760	230
20	25.2	72.9	.346	760	229
30	25.0	73.2	.333	760	229
40	24.6	73.4	.321	760	230
50	25.0	73.7	.309	760	229
1600	25.2	73.9	.296	770	231
10	25.0	74.0	.287	760	231

Difference between readings taken at 0930 and 1050
Ambient temperature - 10.0° Centigrade
Difference in frequency - 25 cycles
Difference in frequency per degree Centigrade - 2.5 cycles
.00025%.

Difference between readings taken at 1050 and 1210
Ambient temperature - 5.0° Centigrade
Difference in frequency - 41 cycles
Difference in frequency per degree Centigrade - 8.2 cycles
.00082%.

TABLE NO. 9 Cont'd

Difference between readings taken at 1210 and 1330
    Ambient temperature - 5.0° Centigrade
    Difference in frequency - 23 cycles
    Difference in frequency per degree Centigrade - 4.6 cycles
    .00046%.

Difference between readings taken at 1330 and 1450
    Ambient temperature - 5.0° Centigrade
    Difference in frequency - 3 cycles
    Difference in frequency per degree Centigrade - 0.6 cycles
    .00006%.

Difference between readings taken at 1450 and 1610
    Ambient temperature - 25.0° Centigrade
    Difference in frequency - 77 cycles
    Difference in frequency per degree Centigrade - 3.1 cycles
    .00031%.

Difference between readings taken at 0930 and 1610
    Ambient temperature - none
    Difference in frequency - 9 cycles
    .0009%.

TABLE NO. 10

TBA-1A Transmitter, Serial No.33

Effect of change in Ambient Temperature.

Output frequency - 4000 kcs.
M.O. frequency - 1000 kcs.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0810	24.7	73.5	1000.313	780	231
20	25.2	73.5	.304	790	229
30	25.1	73.5	.298	770	230
40	24.9	73.6	.294	770	231
50	25.1	73.8	.289	770	228
0900	25.0	74.0	.282	770	228
10	25.0	74.1	.279	780	228
20	25.0	74.4	.270	780	228
Key open 10 minutes while temperature was changed.					
0930	30.0	74.5	1000.263	780	229
40	30.0	74.0	.253	770	227
50	30.0	73.3	.256	770	227
1000	30.0	72.6	.269	770	228
10	30.3	72.6	.300	770	228
20	30.2	73.3	.316	790	228
30	30.2	73.5	.300	780	227
40	30.0	74.0	.290	770	227
Key open 10 minutes while temperature was changed.					
1050	35.0	74.2	1000.286	790	228
1100	35.0	74.5	.269	800	228
10	35.0	74.6	.259	800	228
20	35.0	74.7	.251	790	229
30	35.0	74.9	.245	790	228
40	35.1	74.8	.236	790	229
50	35.0	74.6	.235	790	229
1200	35.0	74.5	.237	790	229
Key open 10 minutes while temperature was changed.					
1210	49.8	74.3	1000.247	770	224
20	49.8	74.3	.248	800	227
30	50.0	74.5	.247	790	227
40	50.2	74.7	.243	790	227
50	50.2	74.8	.235	790	228
1300	50.1	74.9	.232	790	228
10	50.0	74.9	.229	780	227
20	50.0	74.9	.228	780	227

Key open 10 minutes while temperature was changed.

TABLE NO. 10 Cont'd

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1330	25.2	74.6	1000.237	780	231
40	25.0	74.5	.238	750	231
50	25.1	74.3	.241	750	231
1400	25.0	74.0	.246	750	232
10	24.9	73.8	.255	750	232
20	24.9	73.5	.266	750	232
30	24.9	73.2	.275	750	232
40	25.0	72.9	.285	740	229

Difference between readings taken at 0920 and 1040
Ambient temperature - 5.0°Centigrade
Difference in frequency - 20 cycles
Difference in frequency per degree Centigrade - 4 cycles
.0004%.

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0° Centigrade
Difference in frequency - 53 cycles
Difference in frequency per degree Centigrade - 10.6 cycles
.001%.

Difference between readings taken at 1200 and 1320
Ambient temperature - 15.0° Centigrade
Difference in frequency - 9 cycles
Difference in frequency per degree Centigrade - 0.6 cycles
.00006%

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0° Centigrade
Difference in frequency - 57 cycles
Difference in frequency per degree Centigrade - 2.3 cycles
.00023%.

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 15 cycles
.0015%.

TABLE NO. 11

TBA-1A Transmitter, Serial No.33

Effect of Change in Ambient Temperature.

Output frequency - 4000 Kcs.
M.O. frequency - 2000 Kcs.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0810	25.0	74.1	2000.655	790	234
20	25.0	74.1	.619	800	227
30	25.0	74.1	.592	800	231
40	25.1	74.2	.583	800	231
50	25.0	74.5	.570	800	231
0900	25.2	74.5	.548	790	228
10	25.0	74.8	.531	770	228
20	25.0	75.0	.560	740	228
Key open 10 minutes while temperature was changed.					
0930	9.9	75.0	2000.559	750	230
40	9.9	75.0	.537	760	229
50	10.0	75.0	.544	750	229
1000	9.9	74.9	.563	760	232
10	10.0	74.7	.584	760	230
20	10.1	74.5	.605	750	229
30	10.0	74.1	.633	760	232
40	10.0	74.0	.655	760	231
Key open 10 minutes while temperature was changed.					
1050	5.0	73.9	2000.725	790	232
1100	5.0	73.8	.710	760	232
10	5.0	73.7	.719	780	231
20	5.0	73.5	.729	790	232
30	5.0	73.5	.739	790	232
40	4.9	73.4	.746	790	233
50	5.0	73.3	.756	790	233
1200	5.0	73.2	.763	800	234
Key open 10 minutes while temperature was changed.					
1210	-0.2	73.1	2000.815	800	235
20	0.0	73.2	.777	800	235
30	-0.1	73.4	.766	800	235
40	0.0	73.5	.756	770	236
50	-0.2	73.5	.748	760	235
1300	0.0	73.5	.745	750	230
10	0.0	73.5	.757	750	232
20	0.0	73.4	.770	780	230

Key open 10 minutes while temperature was changed.

TABLE NO. 12

TBA-1A Transmitter, Serial No.33

Effect of Change in Ambient Temperature.

Output frequency 4000 Kcs.
M.O. frequency 2000 Kcs.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0810	24.8	74.0	2000.677	750	229
20	25.0	74.0	.650	750	229
30	25.1	74.0	.630	750	230
40	25.0	74.0	.615	760	232
50	25.0	74.0	.603	770	229
0900	25.0	74.1	.598	760	229
10	24.8	74.2	.577	760	229
20	25.0	74.3	.562	750	229
Key open 10 minutes while temperature was changed.					
0930	30.0	74.3	2000.593	770	232
40	29.9	74.6	.547	780	228
50	30.0	74.6	.526	730	231
1000	30.1	74.8	.512	730	228
10	30.0	74.9	.495	720	227
20	30.0	75.0	.486	730	228
30	30.0	75.0	.477	730	228
40	30.0	75.1	.470	730	227
Key open 10 minutes while temperature was changed.					
1050	35.0	75.2	2000.512	740	228
1100	35.0	75.2	.475	730	227
10	35.0	75.2	.453	730	227
20	35.0	75.2	.439	730	228
30	35.1	75.2	.434	740	227
40	35.0	75.5	.427	740	227
50	35.0	75.6	.418	740	227
1200	35.0	75.7	.403	740	227
Key open 10 minutes while temperature was changed.					
1210	50.1	75.7	2000.430	740	226
20	50.1	76.0	.375	750	230
30	50.0	76.0	.359	740	230
40	50.1	75.9	.347	730	228
50	50.0	75.7	.352	730	229
1300	50.0	75.6	.362	730	229
10	50.0	75.4	.376	730	228
20	50.0	75.2	.375	730	229

Key open 10 minutes while temperature was changed.

TABLE NO. 12 Cont'd

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1330	24.7	75.1	2000.478	750	232
40	24.7	75.1	.477	740	232
50	24.8	75.0	.490	740	232
1400	24.8	75.0	.509	740	232
10	25.1	74.9	.517	740	330
20	25.0	74.9	.532	730	232
30	25.0	74.8	.540	730	231
40	25.0	74.7	.547	730	231

Difference between readings taken at 0920 and 1040
Ambient temperature - 5.0° Centigrade
Difference in frequency - 92 cycles.
Difference in frequency per degree Centigrade - 18.4 cycles
.00092%.

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0° Centigrade
Difference in frequency - 67 cycles
Difference in frequency per degree Centigrade - 13.4 cycles
.00067%

Difference between readings taken at 1200 and 1320
Ambient temperature - 15.0° Centigrade
Difference in frequency - 28 cycles
Difference in frequency per degree Centigrade - 1.8 cycles
.00009%.

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0° Centigrade
Difference in frequency - 172 cycles
Difference in frequency per degree Centigrade - 6.9 cycles
.00034%.

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 15 cycles
.00075%.

TABLE NO. 13 Cont'd

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1330	25.2	73.0	1500.272	750	229
40	25.1	73.1	.268	750	228
50	24.9	73.3	.246	750	228
1400	25.1	73.5	.232	750	227
10	24.9	73.7	.221	750	229
20	25.0	73.9	.205	750	230
30	25.0	74.0	.187	750	229
40	25.0	74.1	.172	740	227

Difference between readings taken at 0920 and 1040
Ambient temperature - 15.0° Centigrade
Difference in frequency - 62 cycles
Difference in frequency per degree Centigrade - 4.1 cycles
.00027%

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0° Centigrade
Difference in frequency - 12 cycles
Difference in frequency per degree Centigrade - 2.4 cycles
.00016%

Difference between readings taken at 1200 and 1320
Ambient temperature - 5.0° Centigrade
Difference in frequency - 27 cycles
Difference in frequency per degree Centigrade - 5.4 cycles
.00036%.

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0° Centigrade
Difference in frequency - 115 cycles
Difference in frequency per degree Centigrade - 4.6 cycles
.0003%.

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 38 cycles
.0025%.

TABLE NO. 14

TBA-1A Transmitter, Serial No.33

Effect of Change in Ambient Temperature.

Output frequency - 6000 kcs.
M.O. frequency - 1500 kcs.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0810	25.0	73.1	1500.292	750	236
20	24.8	73.3	.282	740	228
30	25.0	73.2	.275	760	231
40	25.1	73.2	.265	760	230
50	24.9	73.3	.258	770	232
0900	24.8	73.4	.249	770	231
10	25.1	73.6	.237	780	229
20	25.0	73.7	.227	750	230

Key open 10 minutes while temperature was changed.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
0930	30.0	73.8	1500.201	750	230
40	30.0	74.0	.207	750	228
50	29.9	74.0	.196	750	228
1000	30.0	74.1	.182	750	228
10	29.9	74.3	.170	750	229
20	30.0	74.3	.163	750	228
30	30.0	74.4	.160	750	229
40	30.0	74.5	.156	750	230

Key open 10 minutes while temperature was changed.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1050	35.0	74.5	1500.148	750	228
1100	35.1	74.5	.149	750	229
10	35.0	74.6	.138	760	229
20	35.0	74.8	.133	760	232
30	35.0	75.0	.120	760	232
40	35.0	75.0	.115	750	232
50	35.0	75.0	.105	750	232
1200	35.0	74.9	.103	750	232

Key open 10 minutes while temperature was changed.

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1210	50.2	74.8	1500.092	760	233
20	50.0	75.0	.098	750	232
30	50.2	75.0	.089	750	233
40	50.0	75.1	.077	760	230
50	50.0	75.1	.070	750	226
1300	50.2	75.1	.069	750	230
10	50.0	75.0	.068	750	227
20	50.0	75.0	.068	750	228

Key open 10 minutes while temperature was changed.

TABLE NO. 14 Cont'd

Time	Ambient °C	Cabinet °C	Actual Frequency M.O.	Power Amp. Plate Current	Line Volts
1330	25.1	74.9	1500.096	760	232
40	24.9	74.5	.126	760	231
50	25.0	74.0	.149	760	232
1400	25.0	73.8	.171	750	230
10	25.0	73.9	.204	750	232
20	24.9	73.8	.211	750	231
30	25.1	73.7	.214	750	233
40	25.0	73.7	.222	750	228

Difference between readings taken at 0920 and 1040
Ambient temperature - 5.0° Centigrade
Difference in frequency - 71 cycles
Difference in frequency per degree Centigrade - 14.2 cycles
.00095%

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0° Centigrade
Difference in frequency - 53 cycles
Difference in frequency per degree Centigrade - 10.6 cycles
.0007%.

Difference between readings taken at 1200 and 1320
Ambient temperature - 15.0° Centigrade
Difference in frequency - 35 cycles
Difference in frequency per degree Centigrade - 2.3 cycles
.00016%

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0° Centigrade
Difference in frequency - 154 cycles
Difference in frequency per degree Centigrade - 6.1 cycles
.00041%.

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 5 cycles
.00033%.

TABLE NO. 15

Summary of Tables 9 to 14 inclusive.

Temperature range °C	Percentage frequency change per degree Centigrade 1000 Kcs.	1500 Kcs	2000 Kcs
25-15	.00025		
25-10		.00027	.0031
15-10	.00082		
10- 5	.00046	.00016	.001
5- 0	.00006	.00036	.00007
0-25	.00031	.0003	.00046
25-30	.0004	.00095	.00092
30-35	.001	.0007	.00067
35-50	.00006	.00016	.00009
50-25	.00022	.00041	.00034
Average -	.00039	.00041	.00048

Total Average - .00042%

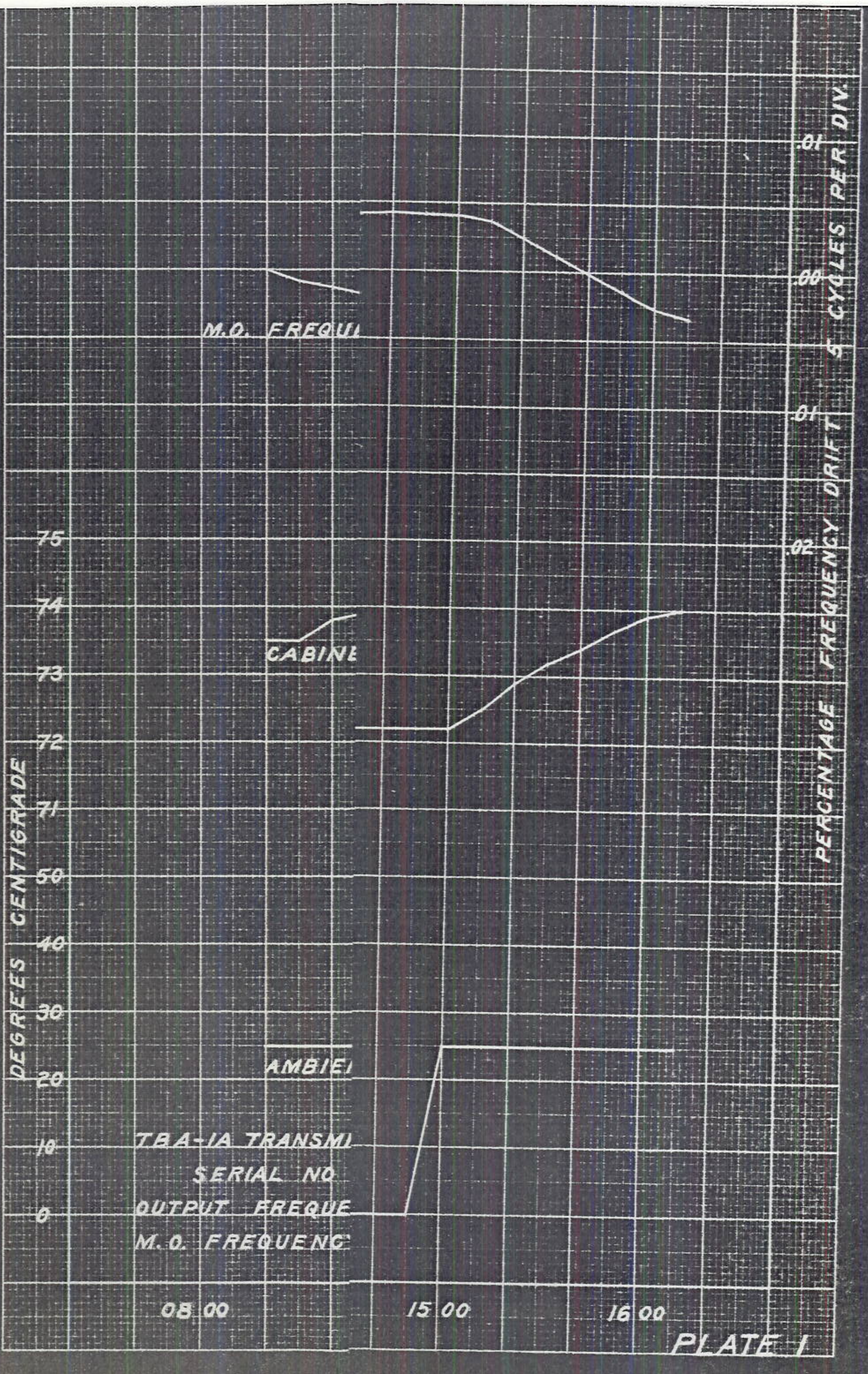


PLATE I

KEUFFEL & ESSER CO. N. Y.

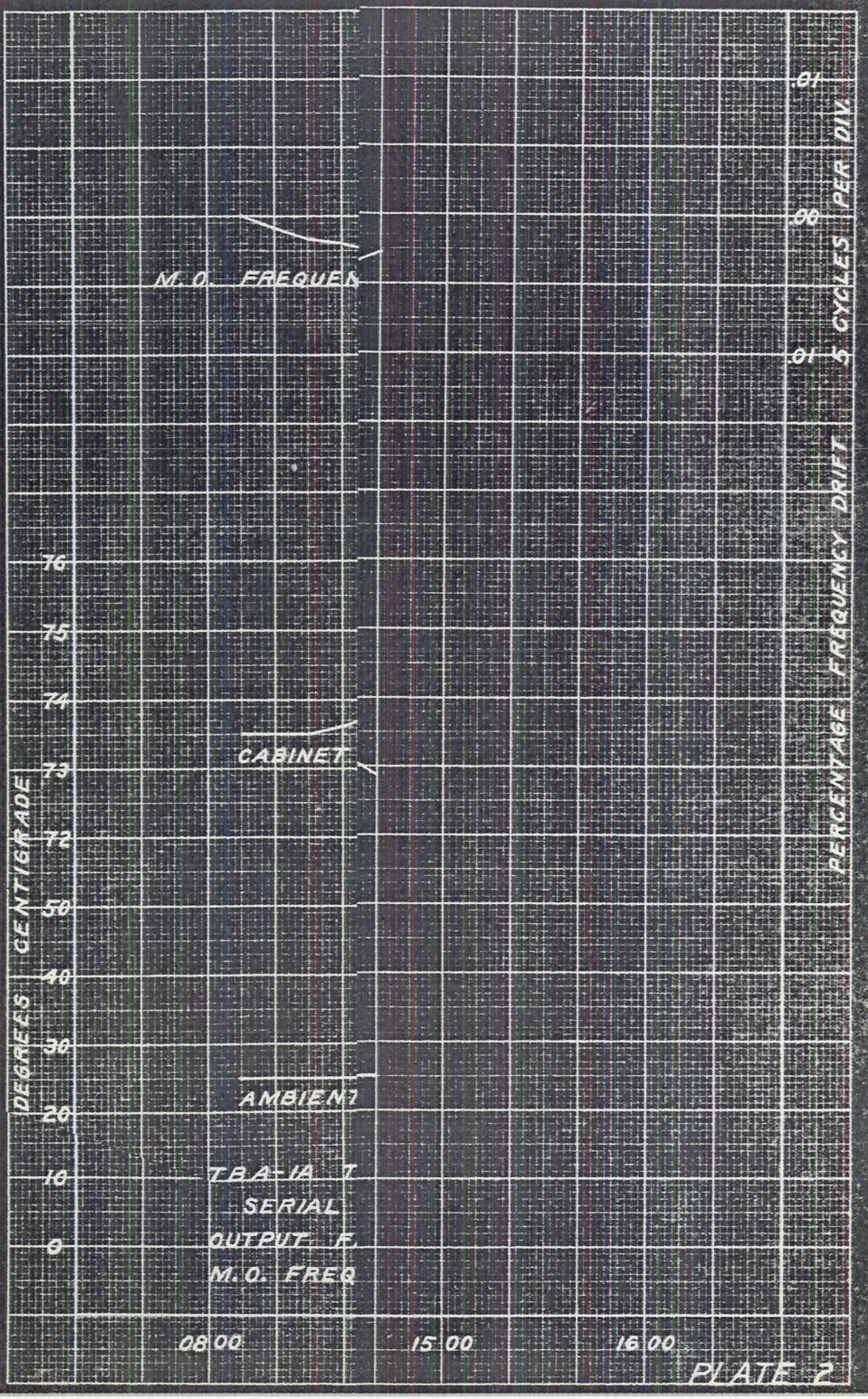

.01
.00
.01
PERCENTAGE FREQUENCY DRIFT 5 CYCLES PER DIV.
M.O. FREQUEN
CABINET
AMBIENT
DEGREES CENTIGRADE
76
75
74
73
72
50
40
30
20
10
0
TBA-IA T
SERIAL
OUTPUT F.
M.O. FREQ
08 00
15 00
16 00

PLATE 2

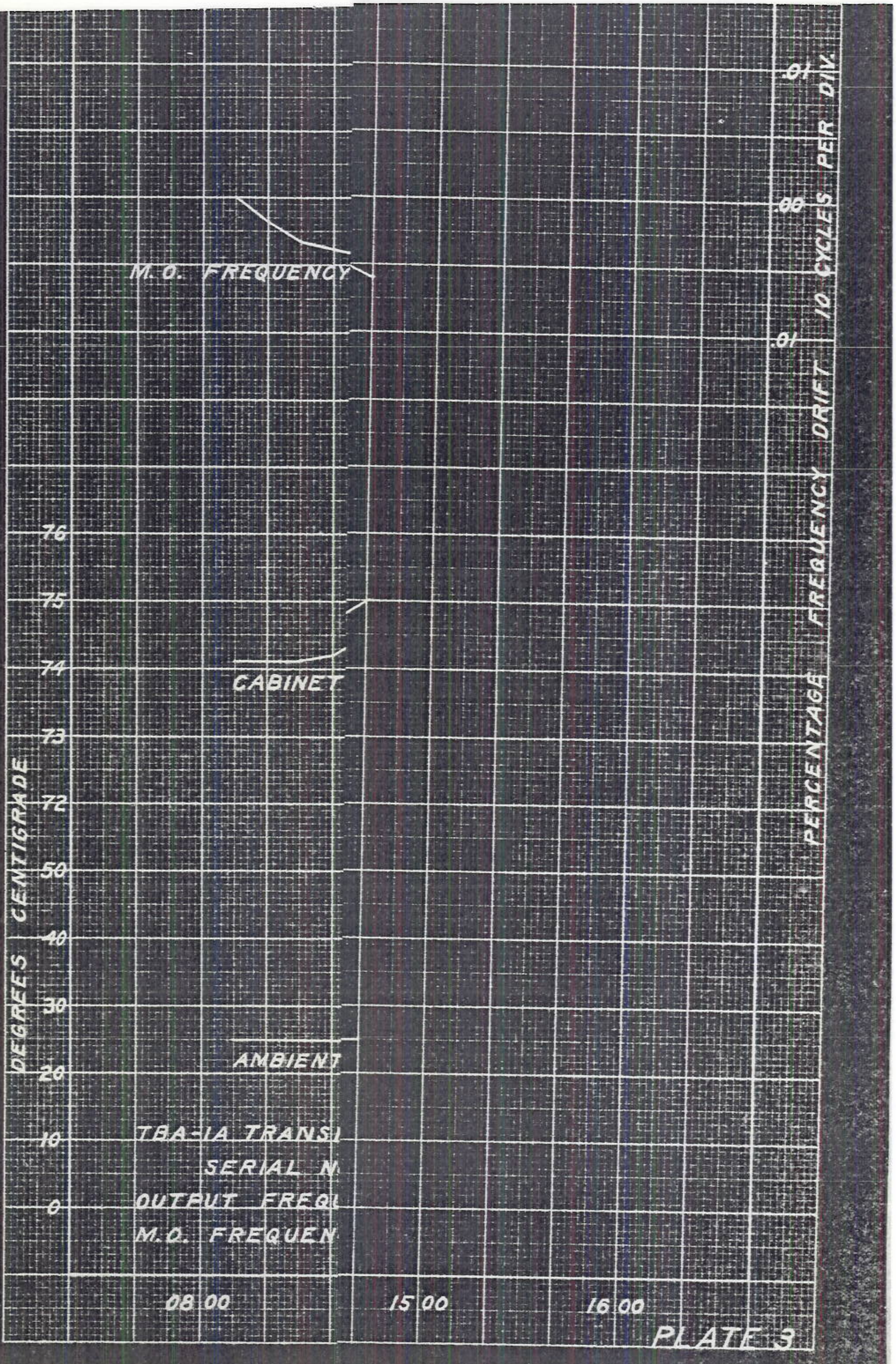
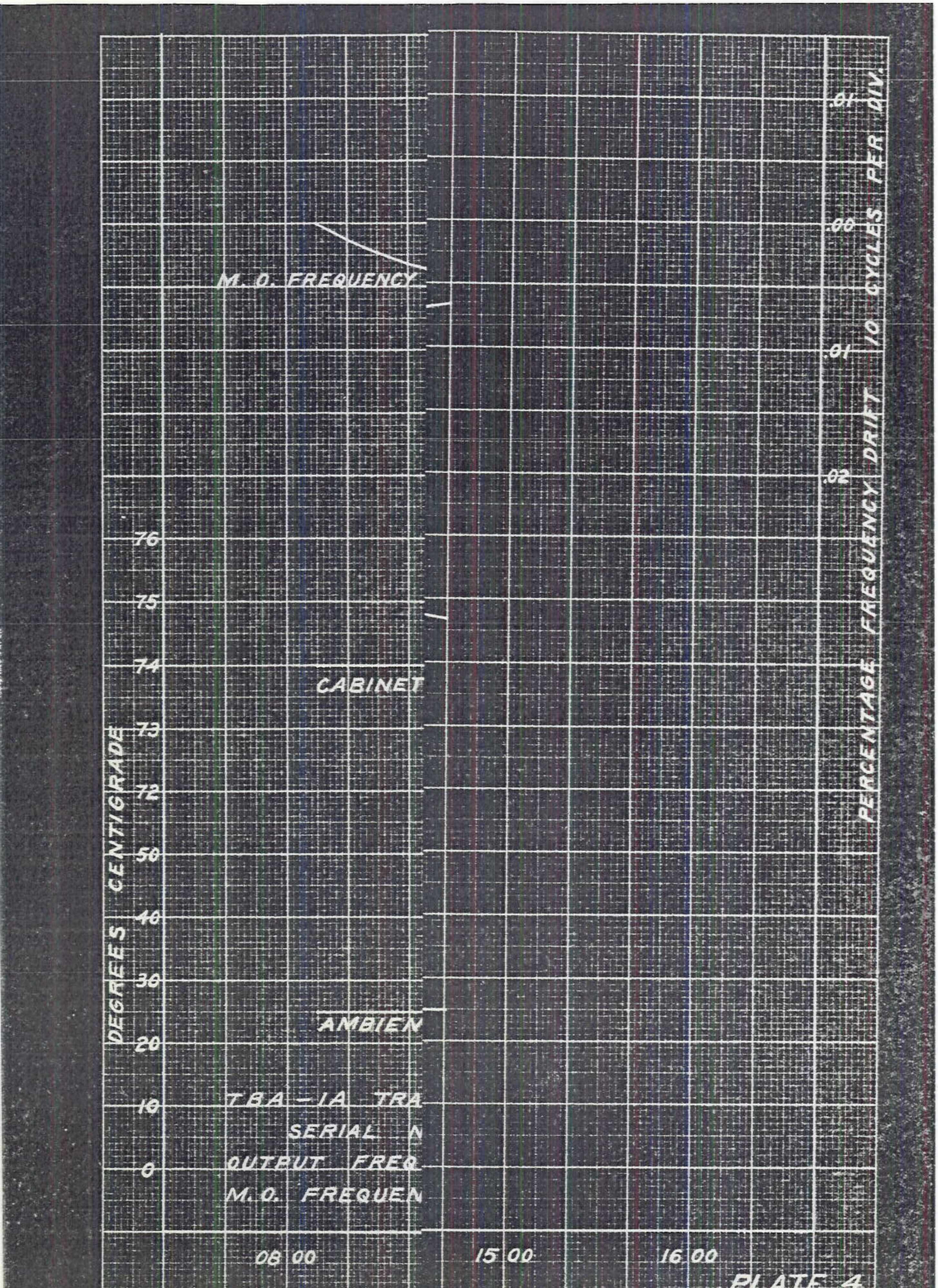


PLATE 3

KEUFFEL & ESSER CO. N. Y.


M. O. FREQUENCY
CABINET
AMBIEN
TBA - IA TRA
SERIAL N
OUTPUT FREQ
M. O. FREQUEN
DEGREES CENTIGRADE
76
75
74
73
72
50
40
30
20
10
0
.01
.00
.01
.02
PERCENTAGE FREQUENCY DRIFT 10 CYCLES PER DIV.
08 00
15 00
16 00
PLATE 4

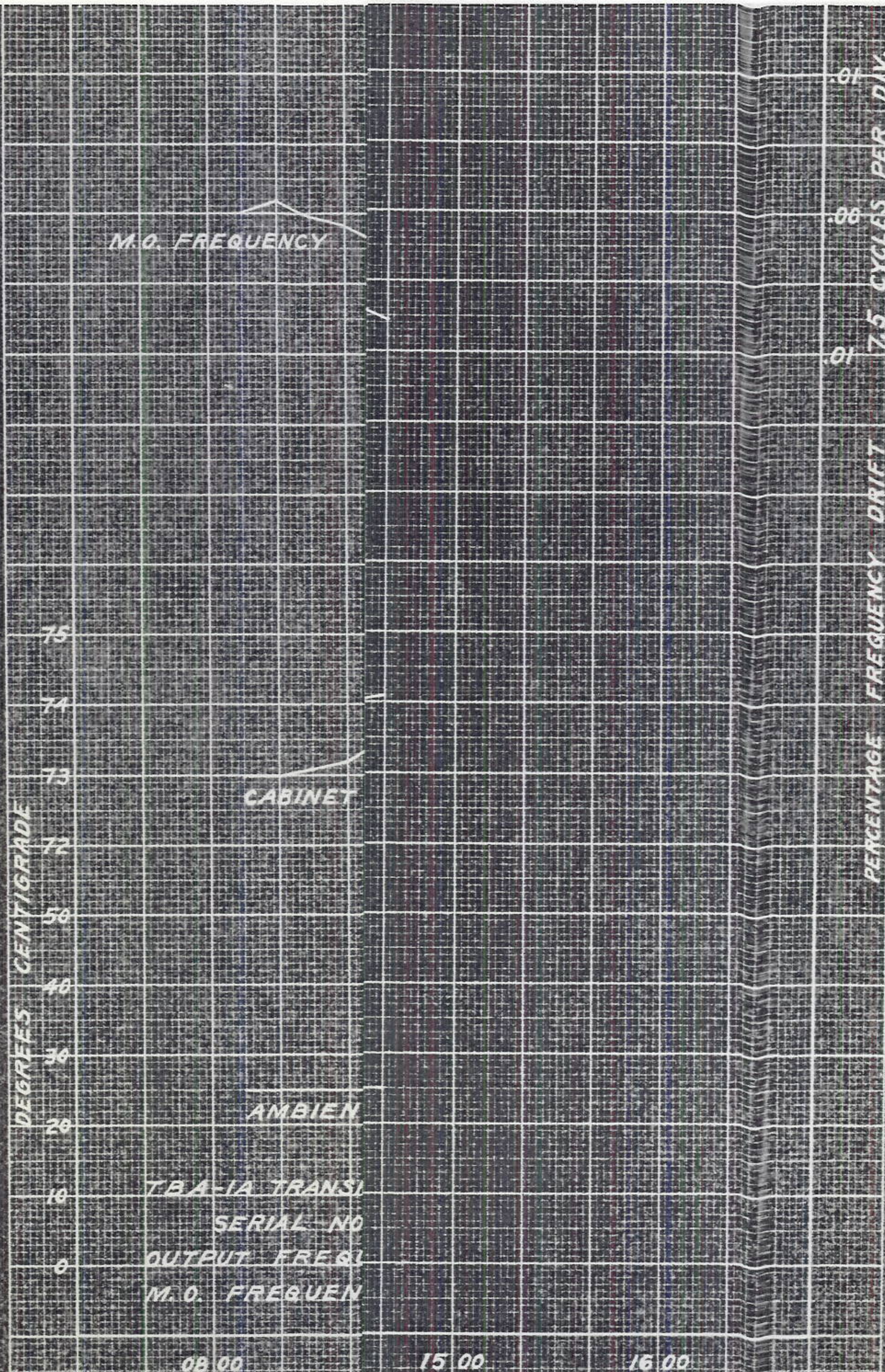
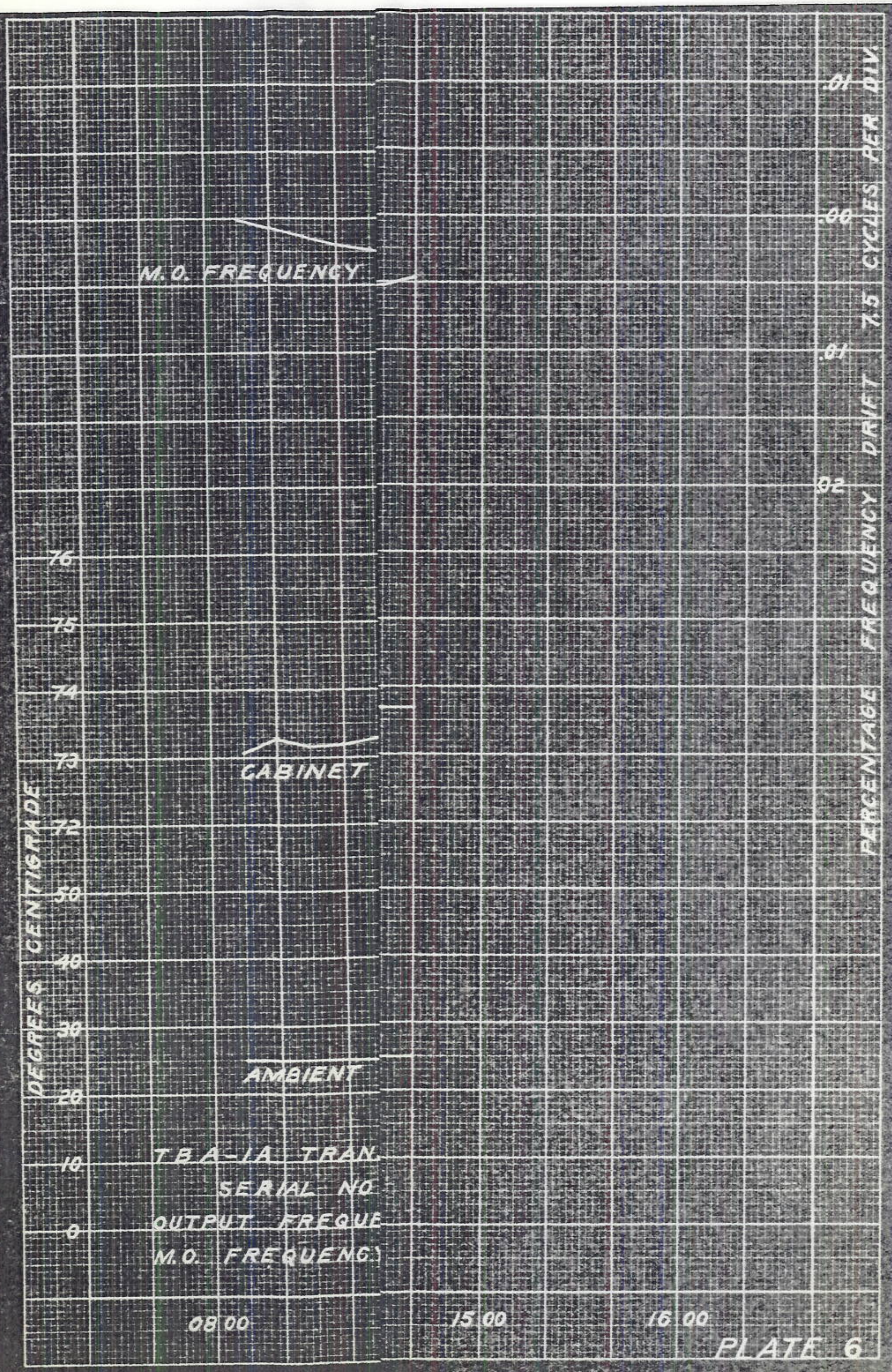
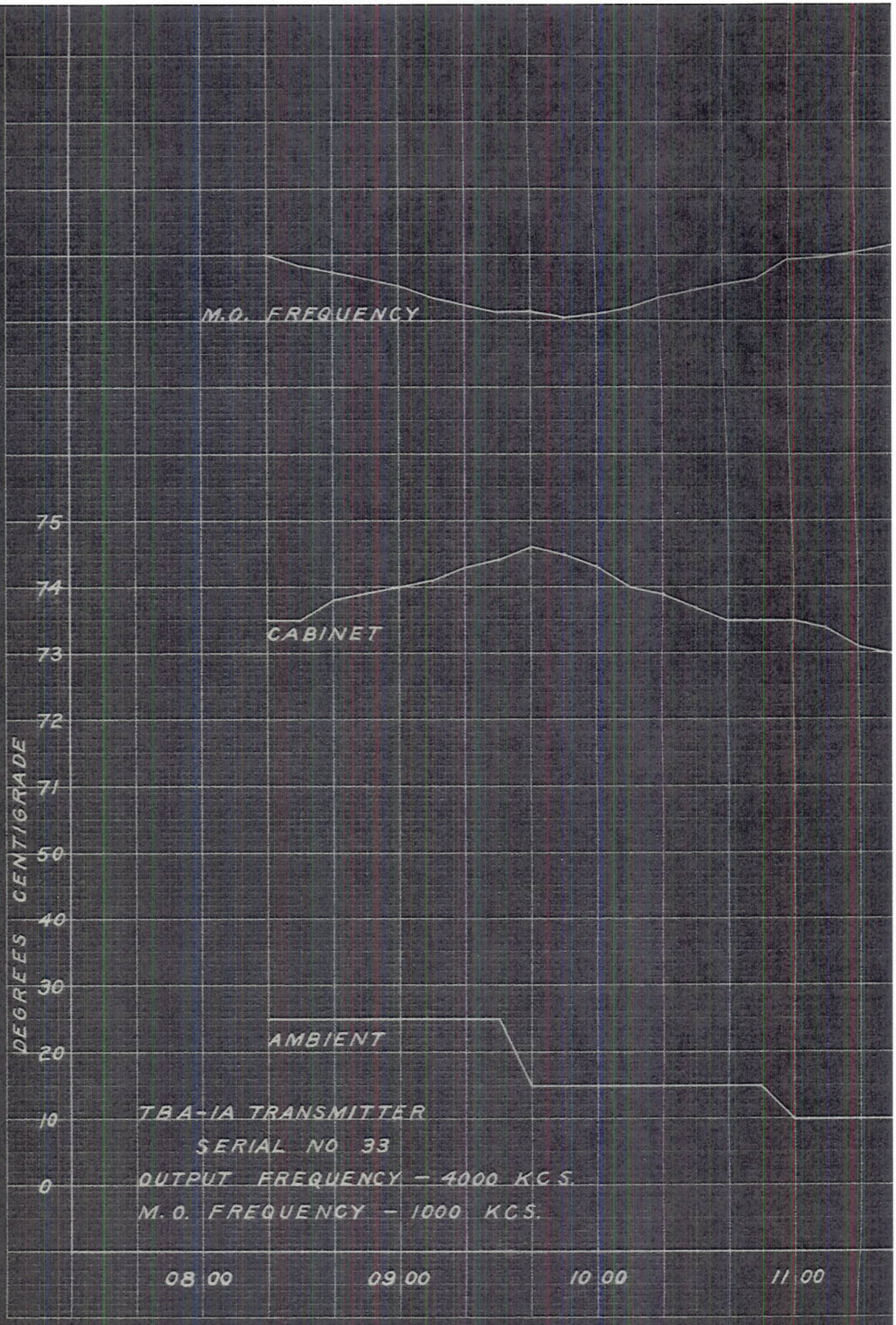
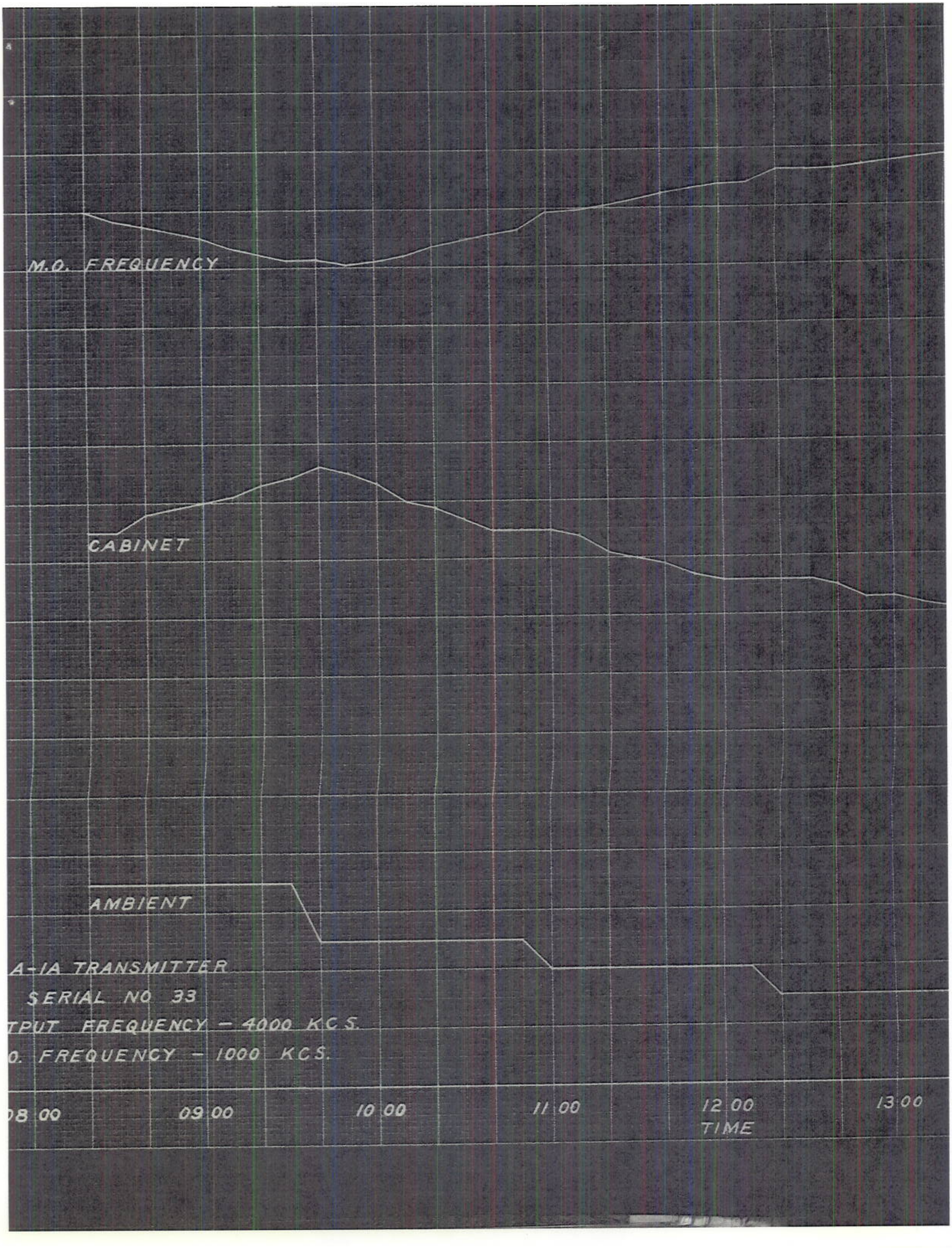


PLATE 5

KEUFFEL & ESSER CO. N.Y.


M.O. FREQUENCY
CABINET
AMBIENT
TBA-1A TRAN.
SERIAL NO
OUTPUT FREQUE
M.O. FREQUENCY
DEGREES CENTIGRADE
76
75
74
73
72
50
40
30
20
10
0
PERCENTAGE FREQUENCY DRIFT 7.5 CYCLES PER DIV.
.01
.00
.01
.02
08 00
15 00
16 00
PLATE 6


M.O. FREQUENCY
CABINET
AMBIENT
DEGREES CENTIGRADE
75
74
73
72
71
50
40
30
20
10
0
TBA-IA TRANSMITTER
SERIAL NO 33
OUTPUT FREQUENCY - 4000 KCS.
M.O. FREQUENCY - 1000 KCS.
08 00
09 00
10 00
11 00


M.O. FREQUENCY
CABINET
AMBIENT
A-IA TRANSMITTER
SERIAL NO 33
TPUT FREQUENCY - 4000 KCS.
O. FREQUENCY - 1000 KCS.
08 00
09 00
10 00
11 00
12 00
13 00
TIME

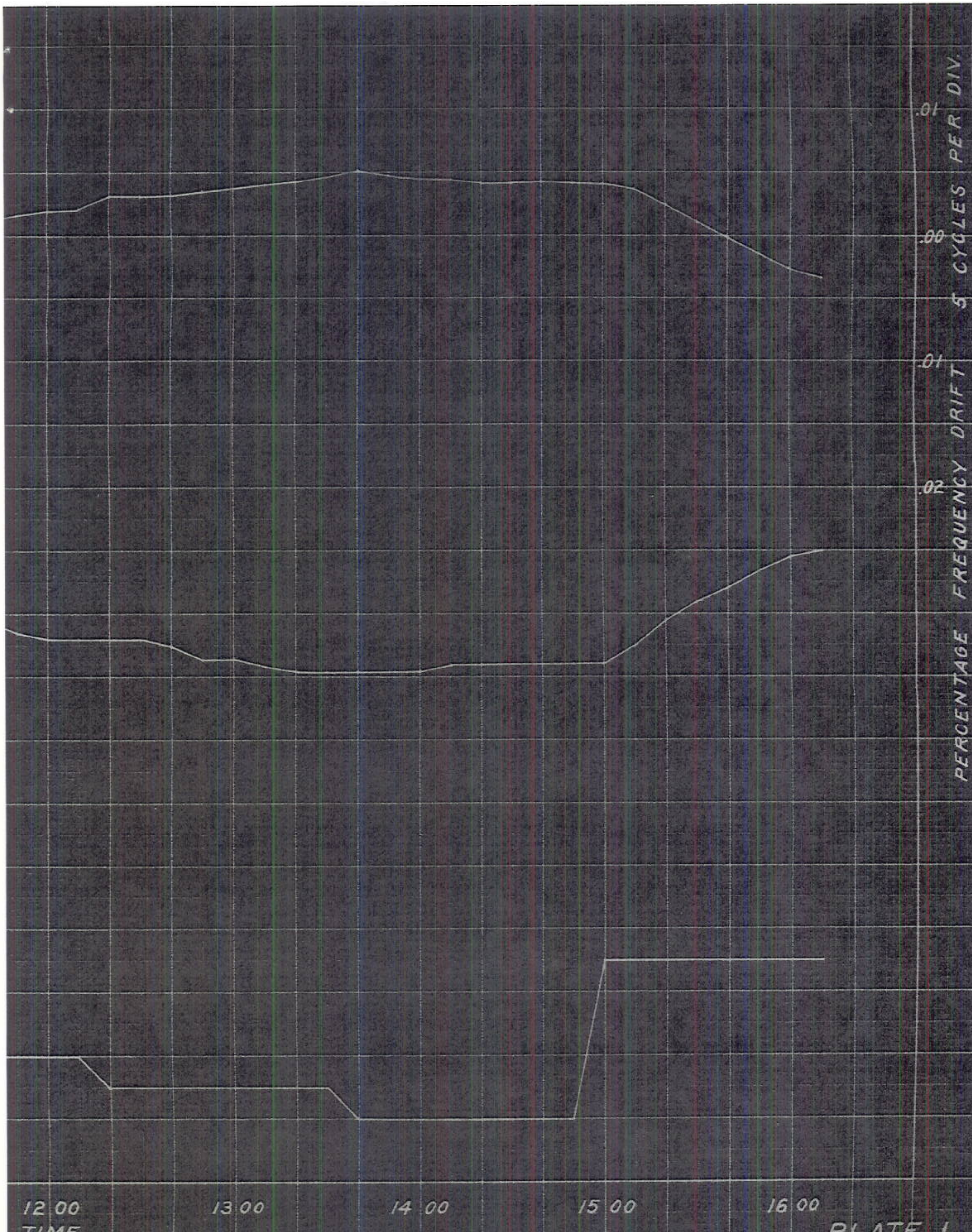
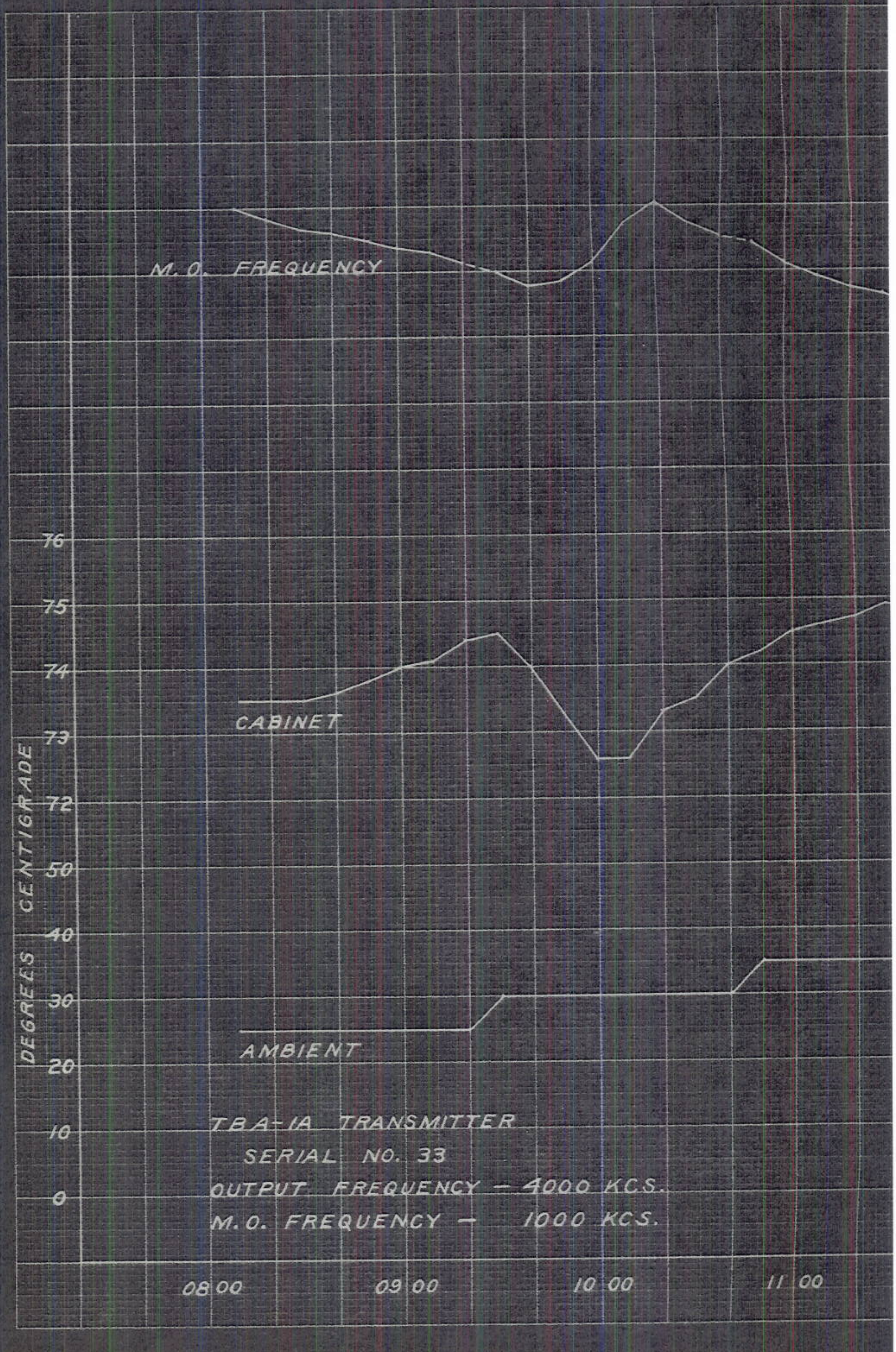
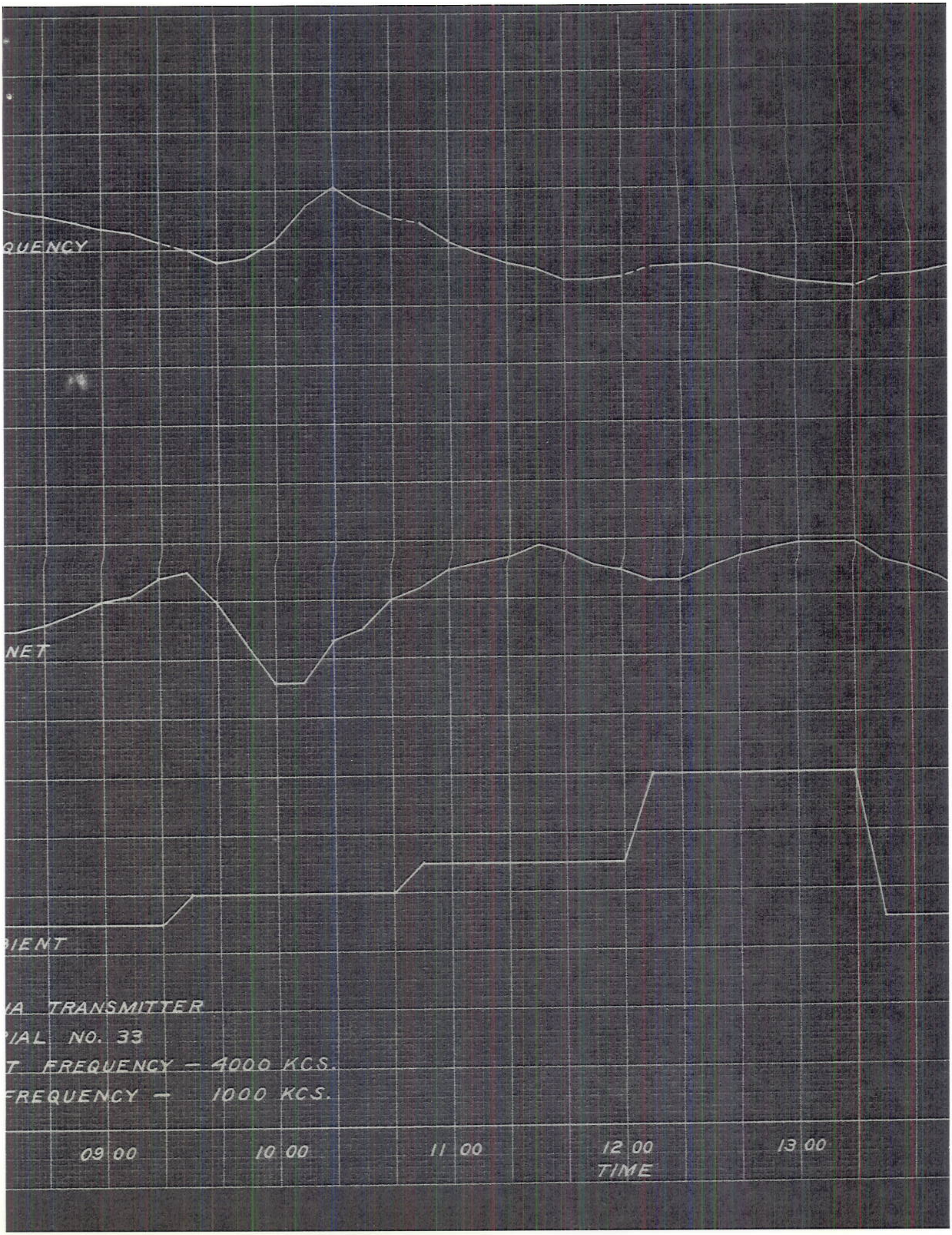


PLATE I

KEUFFEL & ESSER CO. N.Y.


M.O. FREQUENCY
CABINET
AMBIENT
DEGREES CENTIGRADE
76
75
74
73
72
50
40
30
20
10
0
TBA-1A TRANSMITTER
SERIAL NO. 33
OUTPUT FREQUENCY — 4000 KCS.
M.O. FREQUENCY — 1000 KCS.
08 00
09 00
10 00
11 00


QUENCY
NET
BIENT
VA TRANSMITTER
RIAL NO. 33
T FREQUENCY — 4000 KCS.
FREQUENCY — 1000 KCS.
09 00
10 00
11 00
12 00
13 00
TIME

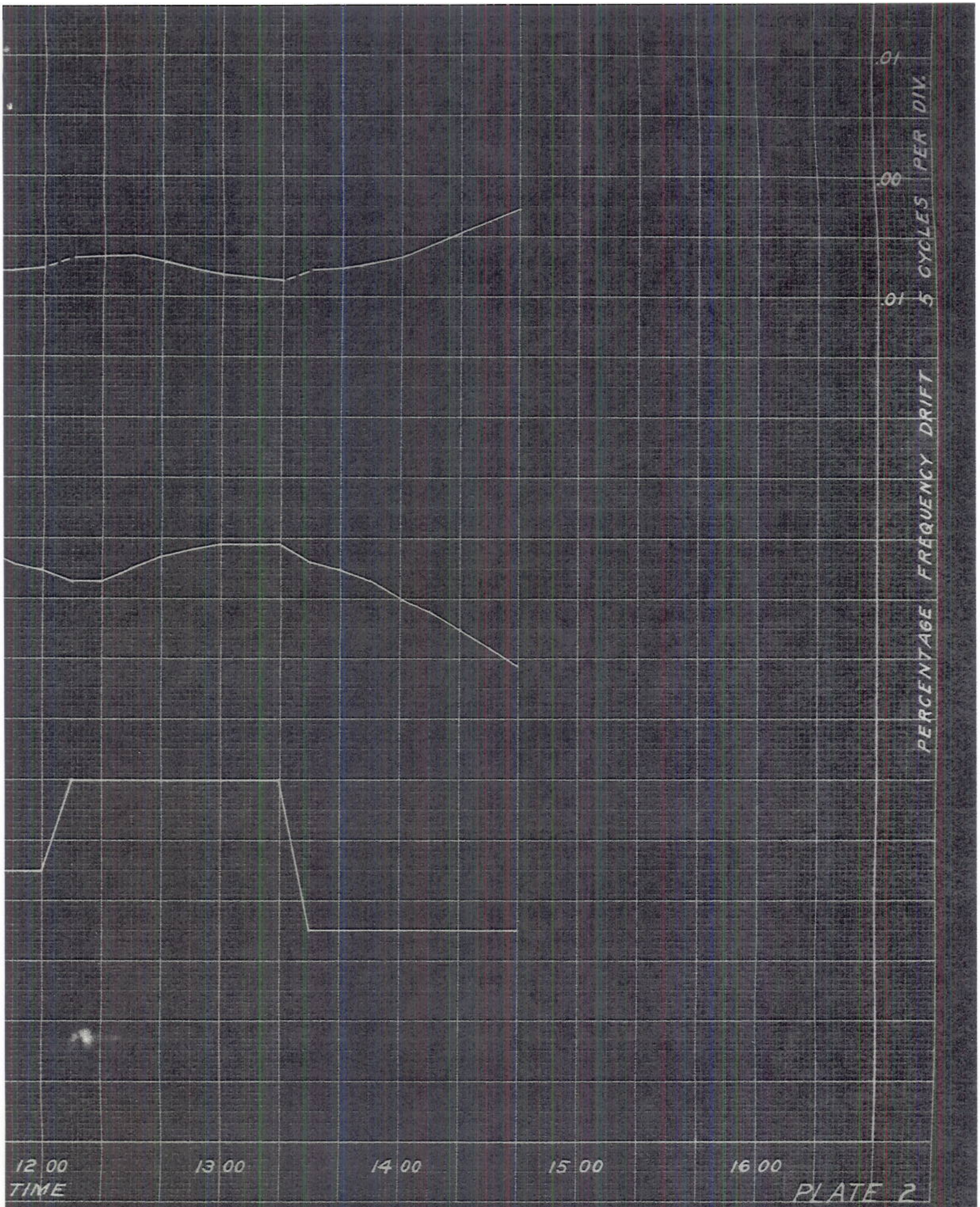
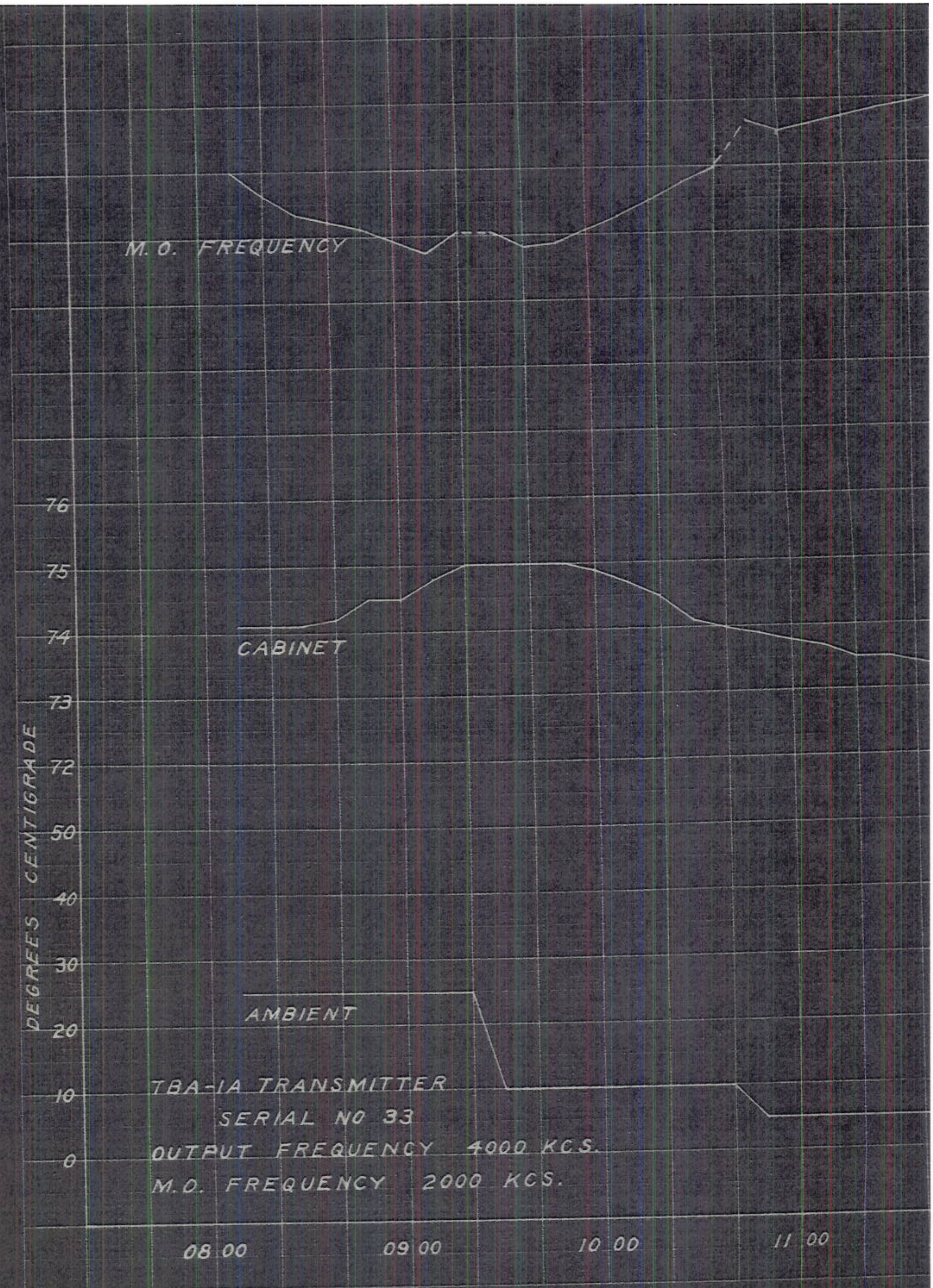
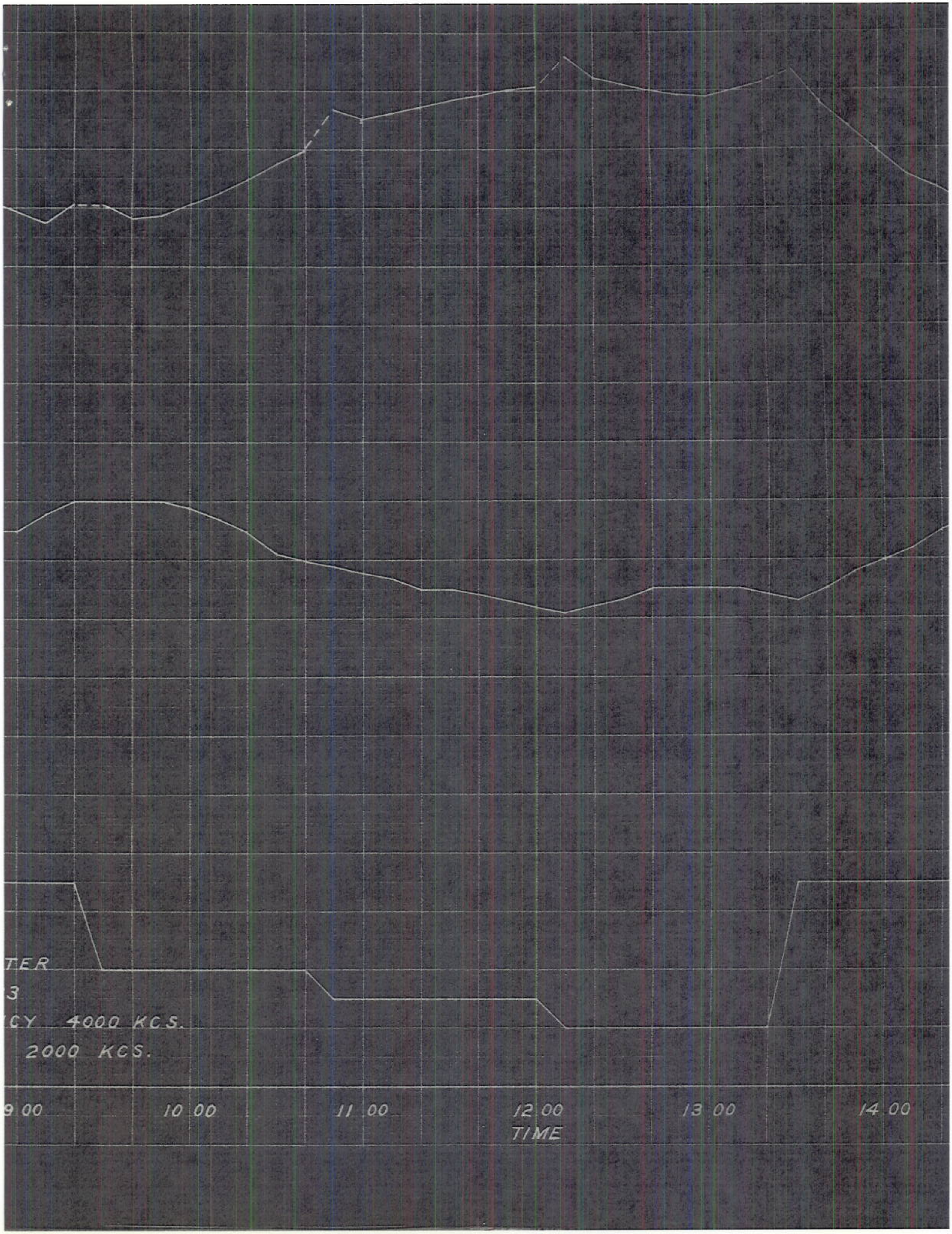


PLATE 2

KEUFFEL & ESSER CO. N.Y.


M. O. FREQUENCY
76
75
74
CABINET
73
72
50
40
30
20
10
0
DEGREES CENTIGRADE
AMBIENT
TBA-1A TRANSMITTER
SERIAL NO 33
OUTPUT FREQUENCY 4000 KCS.
M.O. FREQUENCY 2000 KCS.
08 00
09 00
10 00
11 00



TER
3
CY 4000 KCS.
2000 KCS.
9 00
10 00
11 00
12 00
13 00
14 00
TIME

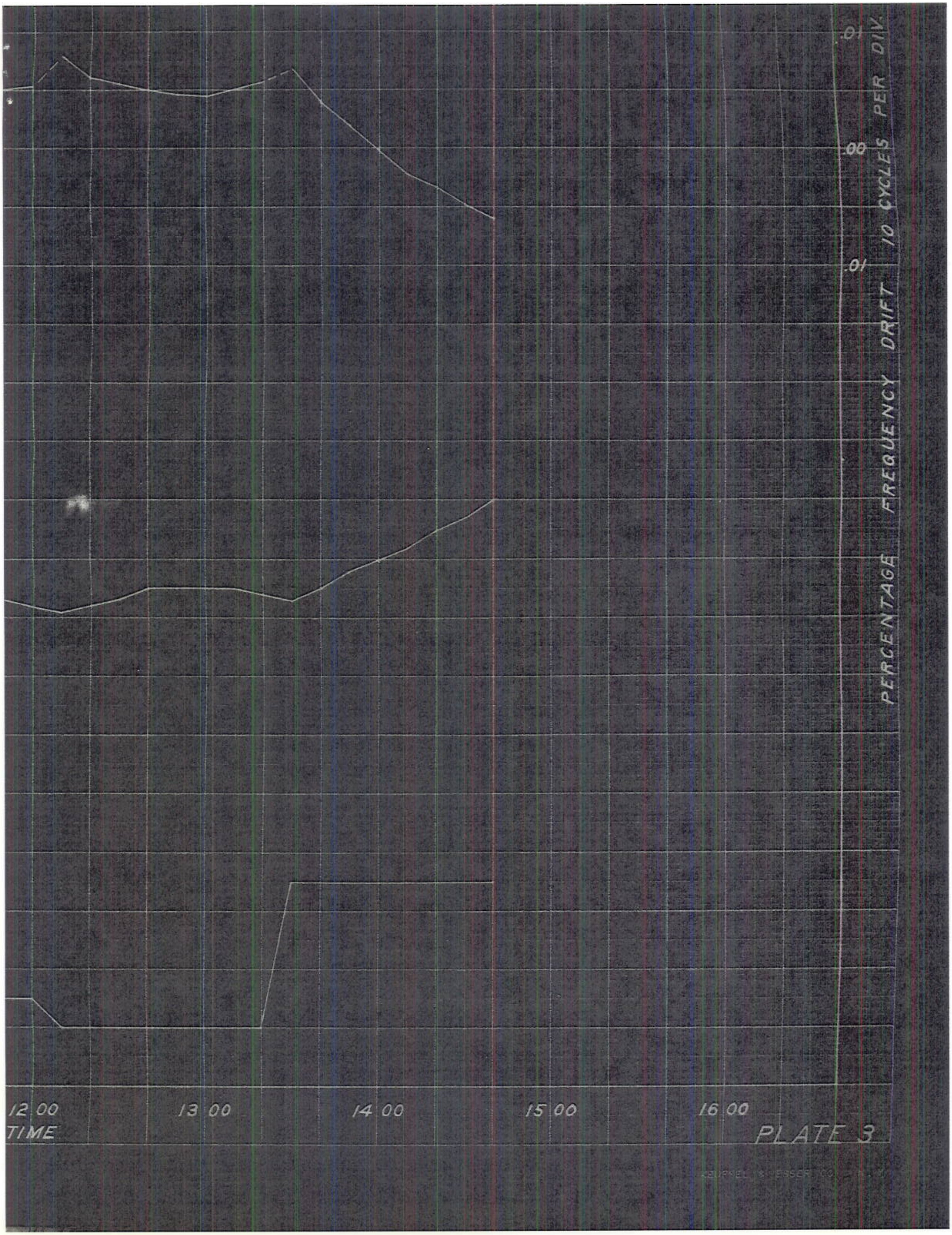
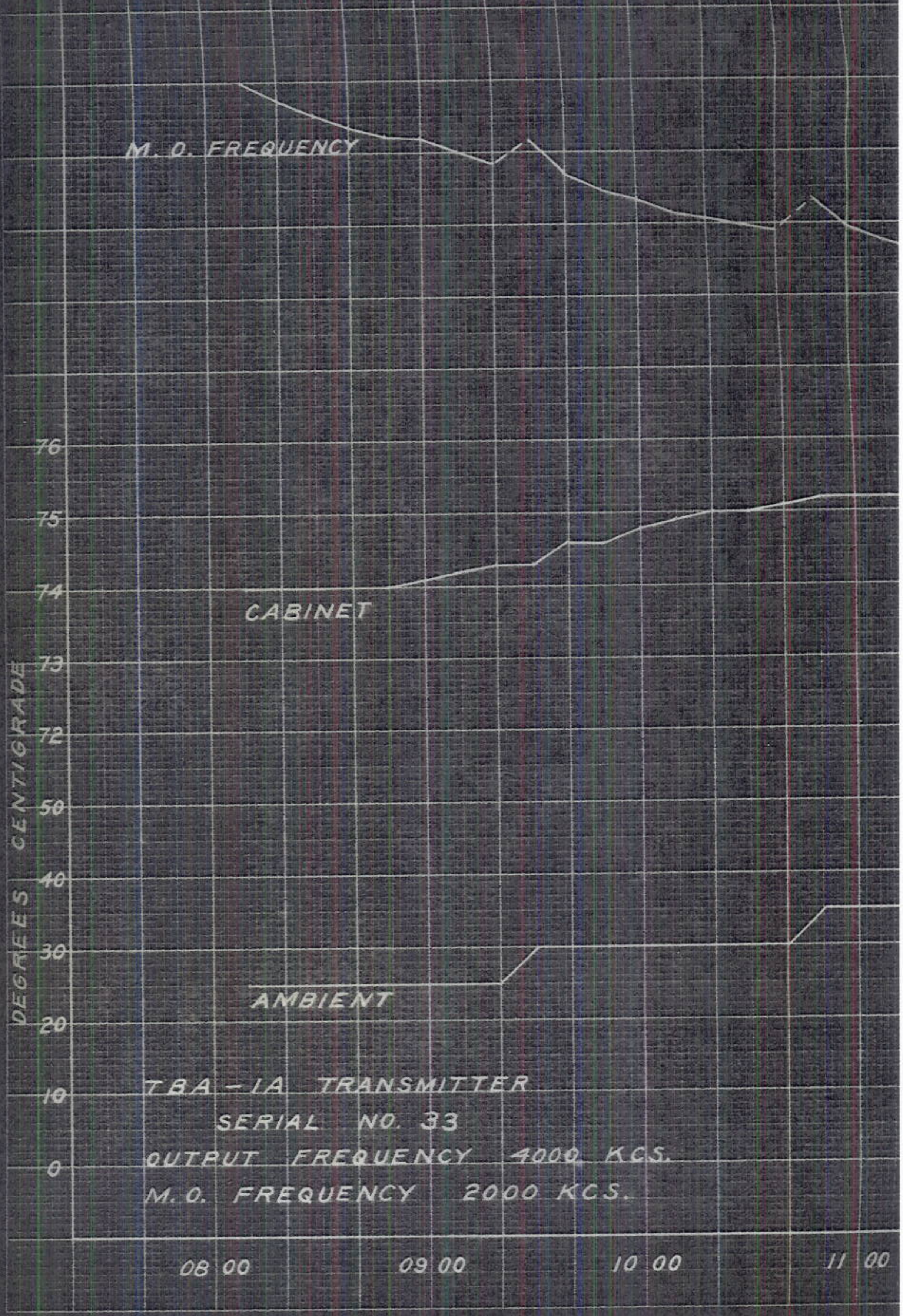
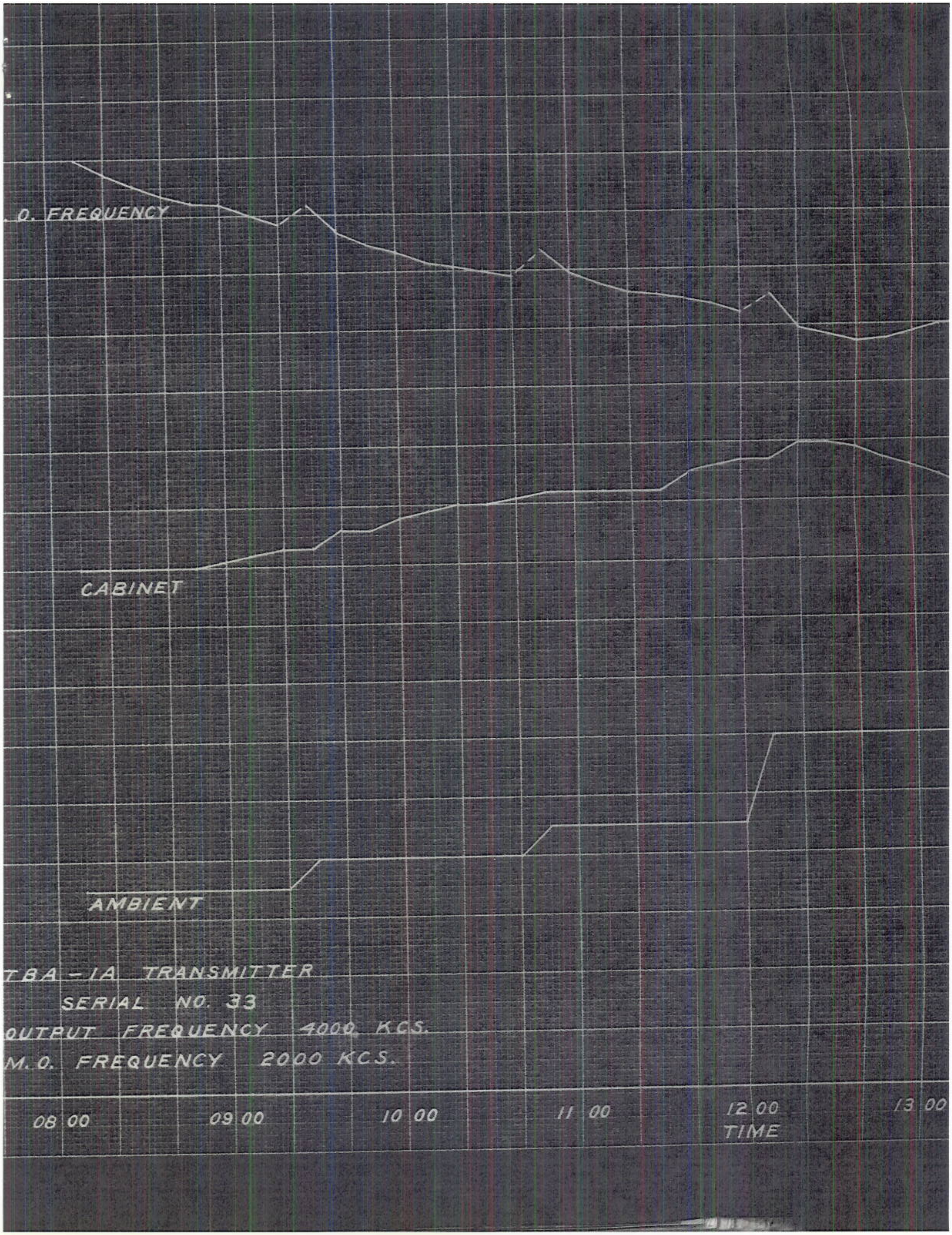

.01
.00
.01
PERCENTAGE FREQUENCY DRIFT 10 CYCLES PER DIV.
12 00
13 00
14 00
15 00
16 00
TIME

PLATE 3


M. O. FREQUENCY
CABINET
AMBIENT
DEGREES CENTIGRADE
76
75
74
73
72
50
40
30
20
10
0
TBA-1A TRANSMITTER
SERIAL NO. 33
OUTPUT FREQUENCY 4000 KCS.
M. O. FREQUENCY 2000 KCS.
08 00
09 00
10 00
11 00



. O. FREQUENCY
CABINET
AMBIENT
TBA-1A TRANSMITTER
SERIAL NO. 33
OUTPUT FREQUENCY 4000 KCS.
M.O. FREQUENCY 2000 KCS.
08 00
09 00
10 00
11 00
12 00
13 00
TIME

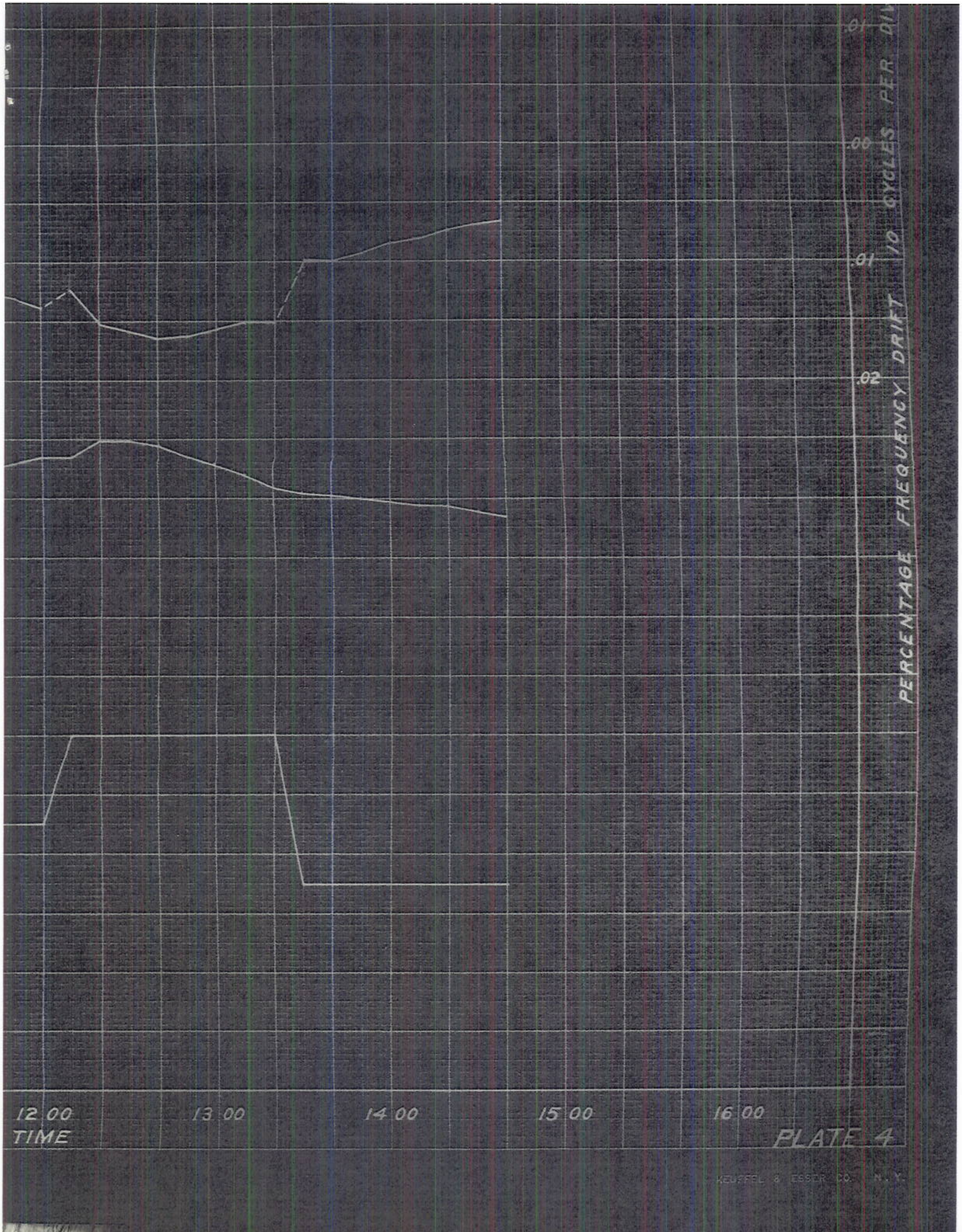
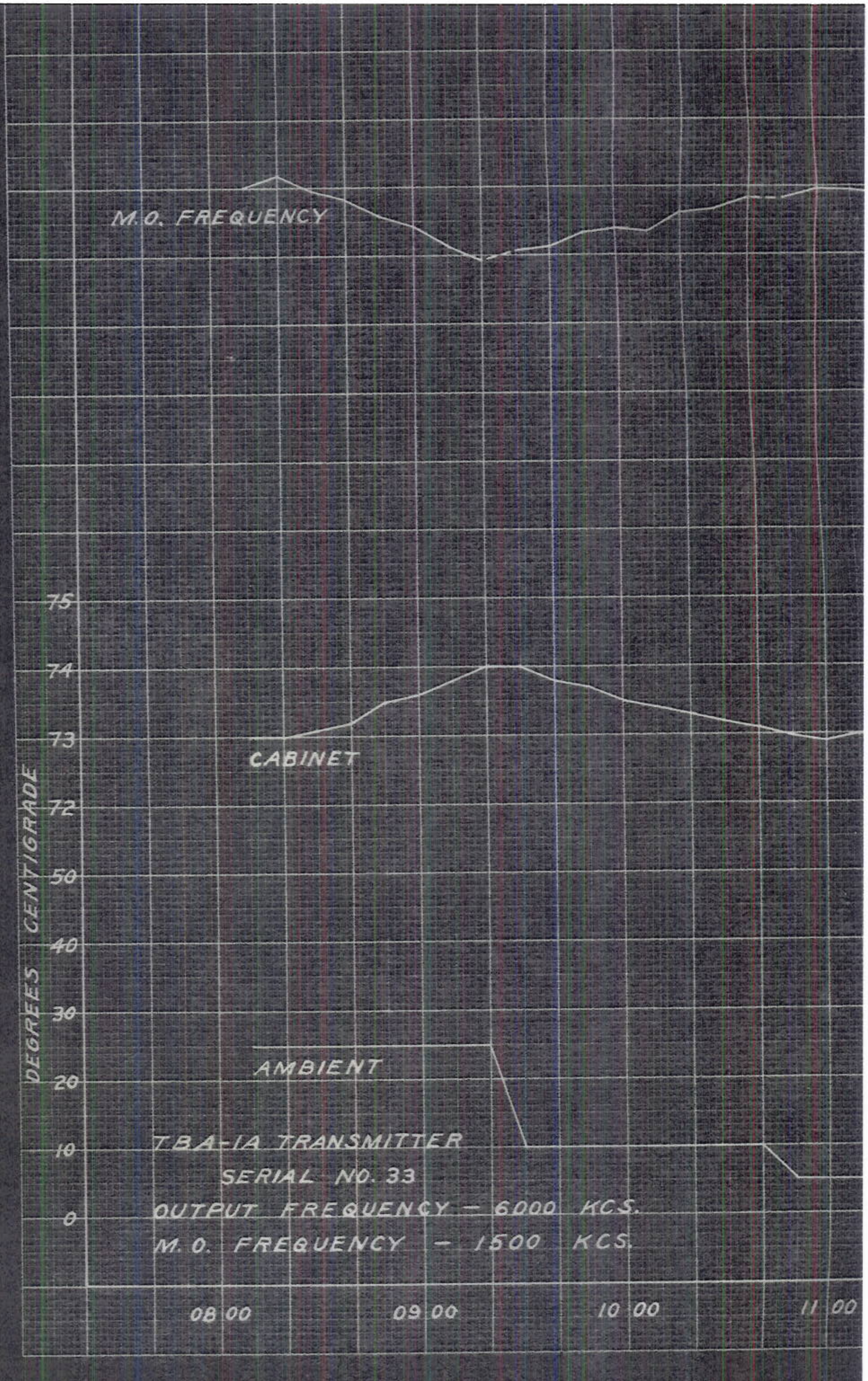
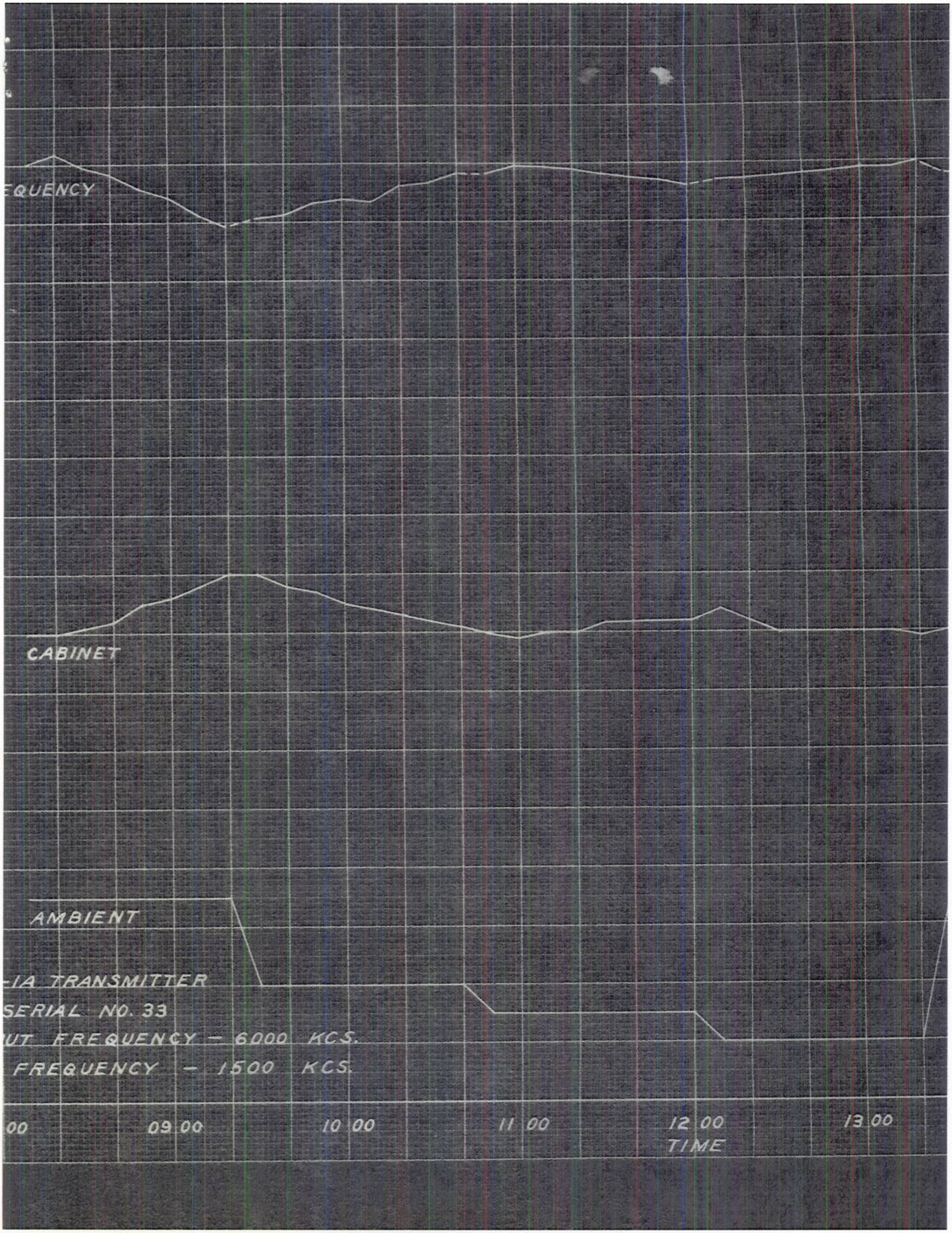

.01
.00
.01
.02
PERCENTAGE FREQUENCY DRIFT 10 CYCLES PER DIV
12 00
13 00
14 00
15 00
16 00
TIME
KEUFFEL & ESSER CO. N.Y.

PLATE 4


M.O. FREQUENCY
75
74
73
CABINET
72
50
40
30
20
10
0
DEGREES CENTIGRADE
AMBIENT
TBA-1A TRANSMITTER
SERIAL NO. 33
OUTPUT FREQUENCY - 6000 KCS.
M.O. FREQUENCY - 1500 KCS.
08 00
09 00
10 00
11 00



EQUENCY
CABINET
AMBIENT
-IA TRANSMITTER
SERIAL NO. 33
UT FREQUENCY - 6000 KCS.
FREQUENCY - 1500 KCS.
00
09 00
10 00
11 00
12 00
TIME
13 00

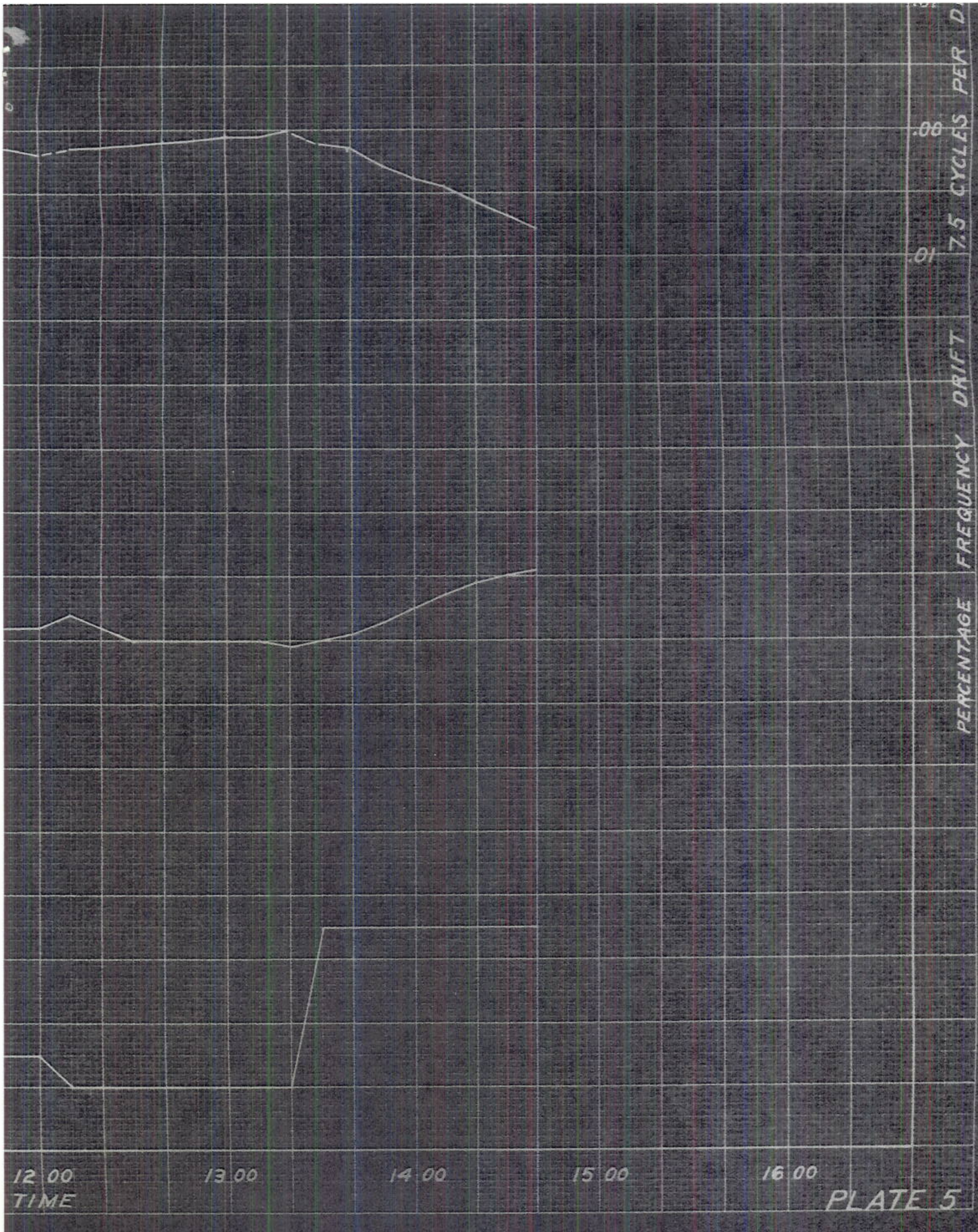
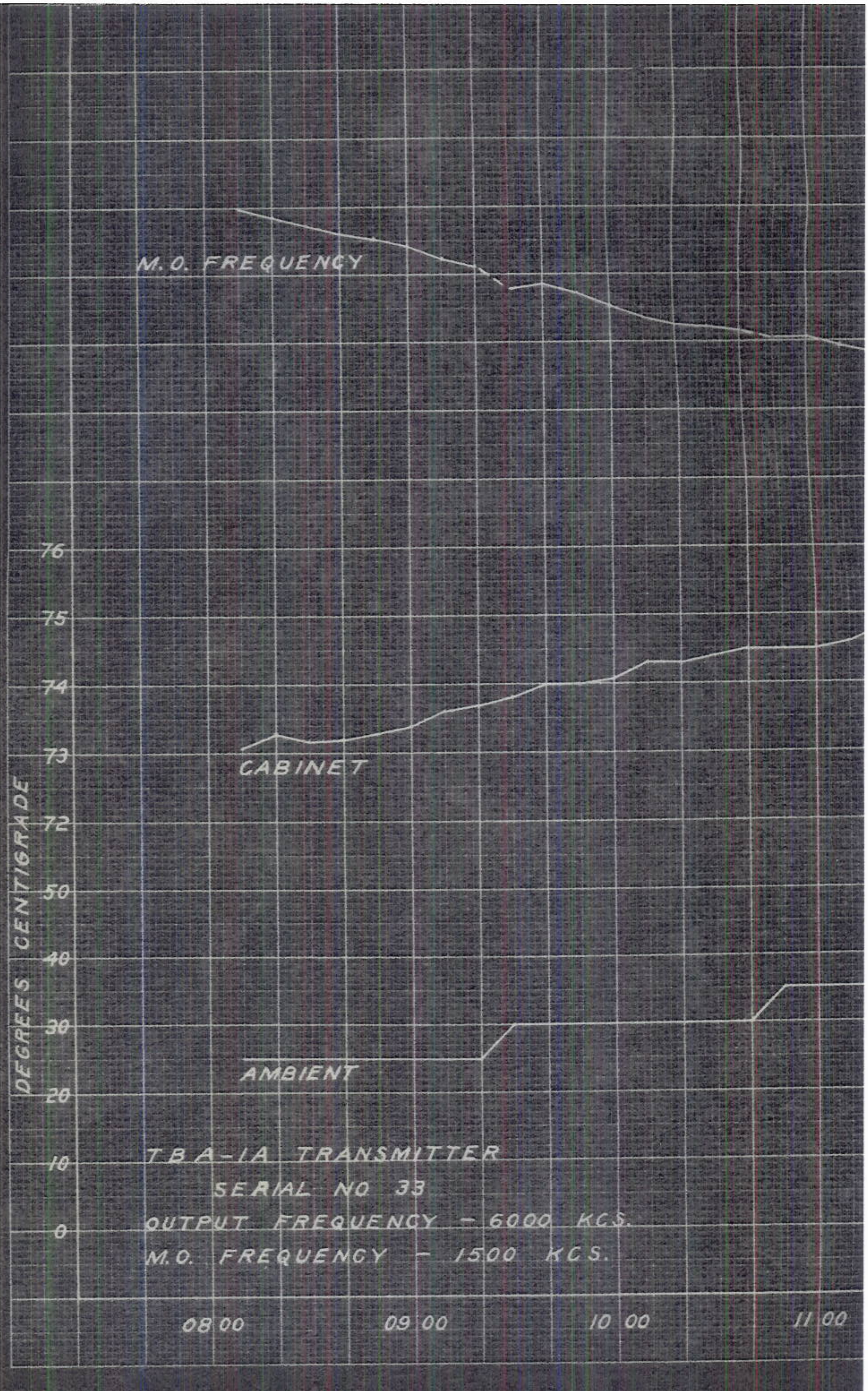
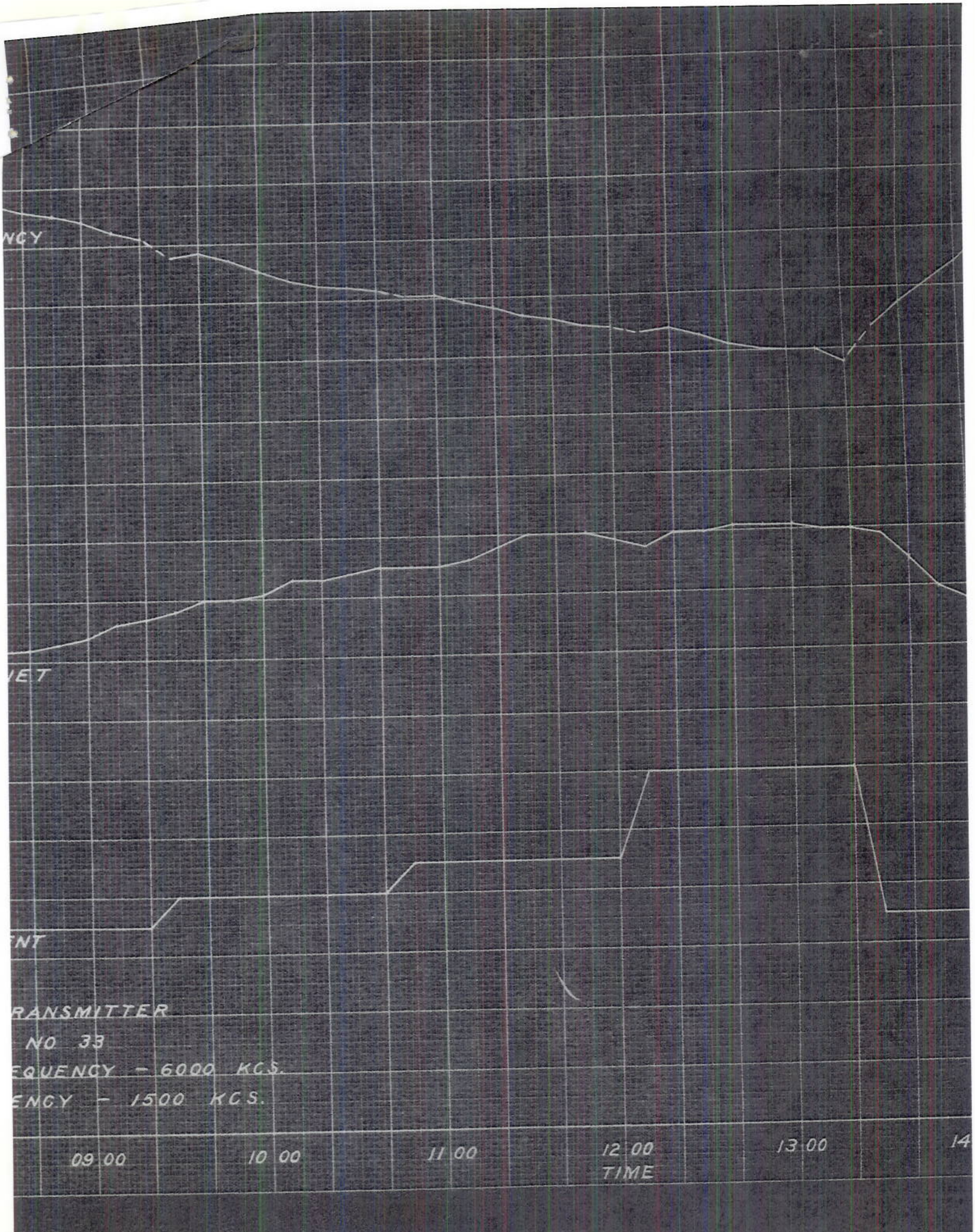
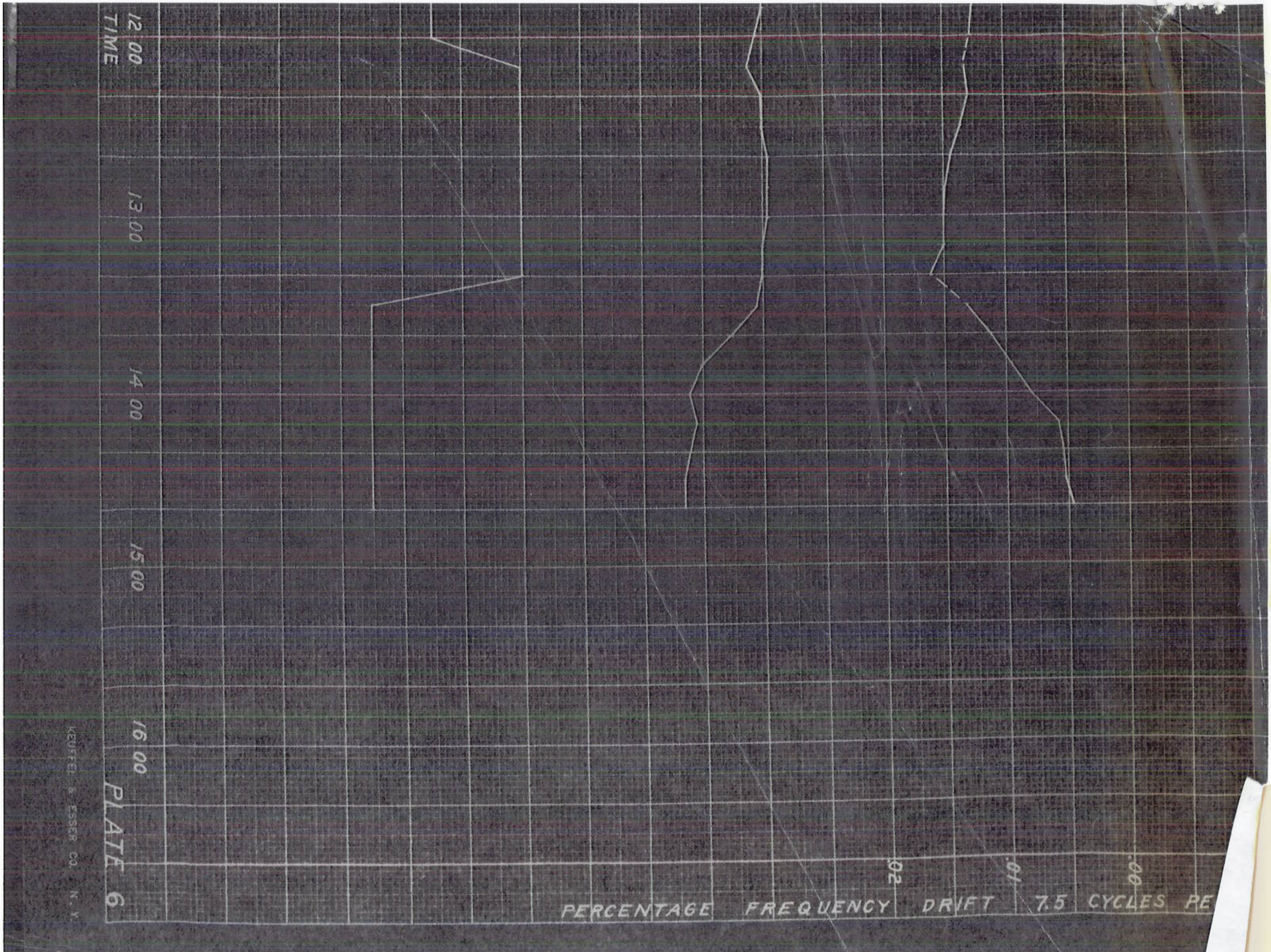


PLATE 5

KEUFFEL & ESSER CO. N. Y.


M.O. FREQUENCY
76
75
74
73
CABINET
72
50
40
30
AMBIENT
20
10
0
DEGREES CENTIGRADE
TBA-1A TRANSMITTER
SERIAL NO 33
OUTPUT FREQUENCY - 6000 KCS.
M.O. FREQUENCY - 1500 KCS.
08 00
09 00
10 00
11 00


NCY
NET
NT
RANSMITTER
NO 33
EQUENCY - 6000 KCS.
ENCY - 1500 KCS.
09 00
10 00
11 00
12 00
TIME
13 00
14



12 00
TIME
13 00
14 00
15 00
16 00
PLATE 6
KEUFFEL & ESSER CO. N. Y.
.02
.01
.00
PERCENTAGE FREQUENCY DRIFT 7.5 CYCLES PE