FR-1139

REPORT NO. R-1139

DATE 27 March 1935

SUBJECT

Test of Weston Decibel Meters (Model 301)

BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

Report No. R-1139
Test of Weston Decibel Meters (Model 301)

27 March 1935

NRL Report No. R-1139
BuEng.Prob. M6-8

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test of Weston Decibel Meters (Model 301)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 4 Tables - 2 Plates - 3

Authorization: BuEng let. S67/22(1-24-W8) of 26 Jan. 1935.

Date of Tests: 31 January to 7 February 1935.

Prepared by:

S.A. Greenleaf, Asst.Rad.Engr.

Reviewed by:

T.McL. Davis, Radio Engr., Chief of Section.

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

Approved by:

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

Distribution:
BuEng.(5)

mbe

TABLE OF CONTENTS

Appendices

AUTHORIZATION FOR TEST

1. This test was authorized by Bureau of Engineering letter, ref. (a). Other correspondence pertinent to this problem is listed as refs. (b) and (c).

Reference: (a) BuEng let. S67/22(1-24-W8) of 26 Jan. 1935.
(b) NRL Report No. R-1083 of 10 October 1934.
(c) Specifications for Instruments, 17-1-12 dated 2 December 1929.

OBJECT OF TEST

2. The object of this test is to ascertain the suitability of decibel meters, Weston Model 301, of three different speeds, for use with different types of Navy radio equipment as volume indicators.

ABSTRACT OF TEST

3. The following tests were made: (a) determination of damping factor, responsiveness and period; (b) determination of the maximum and minimum deflection of the pointer, in terms of decibels, for square topped telegraphically keyed signals, at various speeds within the range of normal hand keying, and high speed transmission.

CONCLUSIONS

(a) The subject meter, serial number 1098912, designated as "high speed", is considered the most suitable for general use in Naval receiving equipment and superior to any output level indicator which has been tested by this Laboratory.

(b) The action of the high speed meter, serial number 1098912, is such that if the limit of needle swing is read for keying speeds up to 12.5 words per minute, it will indicate within .5 decibel of the value that would obtain for a continuous unkeyed signal; and for keying speeds above this it is more nearly accurate when read under the same conditions than any of the other instruments tested.

(c) The general purpose meter, serial number 1089006, gives a serious overswing of about 4 decibels for keying frequencies less than 2.3 cycles (about 6 words per minute) and at 5 cycles (12.5 words per minute) it will read about 4 decibels low. As keyed speeds below 12 words per minute are depended upon for direction finder bearings, this instrument with its low damping and bad overswing will be wholly unsuited for this type of work.

(d) The slow speed meter, serial number 1083296, is altogether too slow for code or direction finder work requiring about 2 seconds of applied voltage to reach a true reading and for all keyed speeds above 5 words per minute will read about 4 decibels below the closed key indication.

(e) The sensitivity of all of the instruments reported upon herein is based upon a center scale zero decibel calibration for a 6 milliwatt level. This generally accepted high level as used for telephone and land line transmission is considered to be too high for phone reception of telegraphically keyed radio signals as the energy of the latter is generally concentrated at a favorable pitch for maximum ear response while in the case of the former it is distributed throughout the sound spectrum.

RECOMMENDATIONS

It is recommended:

(a) That the so-called "high speed" type of meters as represented by the sample meter bearing serial number 1098912 be considered as decidedly preferable for service use to any others tested and reported upon herein or known to the Laboratory.

(b) That consideration be given to a change in meter calibration so that it will be based upon a 600 instead of a 500 ohm line.

(c) That consideration be given to a more sensitive instrument or to the use of a transformer with the subject meters, so that the calibration may be based upon a zero level of 60 instead of 6000 microwatts. Such a zero level would encourage operation of receivers at a more efficient level and provide a scale that would always be "+" thus eliminating the confusion and errors that might result in reporting signal strengths with "+" and "-" readings on the scale.

(d) That the more sensitive instrument as recommended under (c) above be given particular consideration for direction finder equipment.

(e) That the dials of such meters as may be calibrated in accordance with the recommendation given in (c) above, be marked to indicate the "0" level is 20 decibels below 6 milliwatts.

DESCRIPTION OF MATERIAL UNDER TEST

4. The subject instruments are rectifier type voltmeters, Model 301, serial Numbers 1098912 and 1089006, manufactured by the Weston Electrical Instrument Corporation, Newark, N.J. The scales are calibrated from -10 to +6 decibels, with a zero level of 6 milliwatts at 500 ohms, or 1.73 volts. The meters are flush mounting in a bakelite case, similar in appearance to the standard 3-1/2" decibel meter.

METHOD OF TEST

5. The damping factor was determined by repeated observations, when applying voltage sufficient to produce momentary full scale deflection, and recording maximum momentary deflection and steady deflection after the pointer had come to rest.

6. The responsiveness was determined by applying voltage sufficient to produce momentary full scale deflection and noting the time required for the pointer to come to rest. In the case of the slow speed meter, a stop watch was used and repeated observations made. In the case of the high speed meter, the time was determined from the frequency of an audio oscillator, the output of which was synchronized with the period of the meter under test. Synchronization was determined by noting the highest frequency at which a maximum deflection could be obtained.

7. Determination of the maximum and minimum deflection of the pointer at various speeds of keying was accomplished in the following manner: The output of an audio oscillator shunted with a 500 ohm load was keyed by a Creed relay, the meter under test being placed across the 500 ohm resistor and the output voltage being regulated to give a deflection to zero level on the meter with the key closed. The relay was operated with a second audio oscillator, the output of which was coupled to a one stage experimental amplifier with grid bias regulation to give one impulse in the plate circuit for each cycle. The primary of the relay was in series with the plate circuit of the amplifier tube. Evening up of the length of dots with the spaces was accomplished by placing an ohmmeter across the moving arm of the relay, and first the forward contact, then the back contact, and regulating the bias of the amplifier tube until equal deflections were obtained. This adjustment was made for every change of frequency.

8. The two audio oscillators used were General Radio type 513B, serial numbers 44 and 80, and the relay, Creed and Company, Ltd. serial number 2054.

DATA RECORDED DURING TEST

9. The data recorded are given in Tables 1 and 2 and Plates 1 to 3 inclusive.

PROBABLE ERROR IN RESULTS

10. The frequency accuracy is that obtainable with General Radio type 513B audio oscillators which are adjusted with reference to self contained reeds and when so adjusted are considered to be within 2%.

11. The accuracy of the decibel readings at zero level are considered to be within the 5% allowance that is usually accepted for copper oxide rectifier a.c. instruments. The accuracy of the decibel readings below zero level, when keying at various speeds, is largely dependent upon the maintenance of the square characteristic or equality of duration of the dots and spaces, and the method used to obtain this adjustment, that of equalizing the resistance between the center arm of the relay, and the front and back contacts, is estimated to give an accuracy within 10%.

RESULTS OF TESTS

12. The damping factor, responsiveness and period of subject meters Model 301, serial numbers 1098912, 1089006 and 1083296, are shown in Table 1, being expressed in terms as defined in ref. (c). The maximum and minimum deflection of the pointer, in terms of decibels, for square topped telegraphically keyed signals, at various speeds, is shown in Table 2, for subject meters.

13. Similar data are also given for the meter previously tested and reported on in ref. (b), Model 301, serial number 1083296, for comparative purposes.

14. The data contained in Table 2 is also shown graphically on Plates 1 to 3 inclusive.

15. Keying speeds are shown in cycles per second, the accepted ratio of words per minute to cycles per second being 2.5 to 1. Due to the high degree of responsiveness of subject meter 1098912, and the fact that it approached critical damping, zero level is nearly reached for each dot when keying at 5 cycles per second or 12.5 words per minute, and the pointer does not level off to a steady deflection until 35 cycles per second is reached. There is an overswing of 2.5 angular degrees, but this small amount of underdamping does not appear objectionable, and tends to improve the responsiveness.

16. Subject meter, 1089006, shows a much lesser degree of responsiveness and a very small damping factor, the pointer having an overswing of 38 angular degrees, with six distinct oscillations before coming to rest. When keying at 5 cycles per second, the pointer covers a range from -3 to -8 decibels and levels off to a steady deflection at 23 cycles per second. When keying at slow speeds and with dots, dashes, and spaces of unequal duration, deflections of the pointer are so variable and erratic that no estimate can be made of the true output level.

17. It will be noted that the meter used for comparison has smaller ranges of deflection at 5 cycles per second and that the pointer levels off to a steady deflection at correspondingly lower speeds, the Model 301 meter, serial number 1083296 having a range of from -4.75 to -5.5 decibels, leveling off at 14 cycles per second.

CONCLUSIONS

18. The subject meter, serial number 1098912, designated as "high speed", is considered the most suitable for general use in Naval receiving

equipment and superior to any output level indicator which has been tested by this Laboratory.

19. The action of the high speed meter is such that if the limit of needle swing is read for keying speeds up to 12.5 words per minute, it will indicate within .5 decibel of the value that would obtain for a continuous unkeyed signal; and for keying speeds above this it is more nearly accurate when read under the same conditions than any of the other instruments tested.

20. The general purpose meter, serial number 1089006, gives a serious overswing of about 4 decibels for keying frequencies less than 2.3 cycles (about 6 words per minute) and at 5 cycles (12.5 words per minute) it will read about 4 decibels low. As keyed speeds below 12 words per minute are depended upon for direction finder bearings, this instrument with its low damping and bad overswing will be wholly unsuited for this type of work.

21. The slow speed meter, serial number 1083296, is altogether too slow for code or direction finder work requiring about 2 seconds of applied voltage to reach a true reading and for all keyed speeds above 5 words per minute will read about 4 decibels below the closed key indication.

22. The sensitivity of all of the instruments reported upon herein is based upon a center scale zero decibel calibration for a 6 milliwatt level. This generally accepted high level as used for telephone and land line transmission is considered to be too high for phone reception of telegraphically keyed radio signals as the energy of the latter is generally concentrated at a favorable pitch for maximum ear response while in the case of the former it is distributed throughout the sound spectrum.

TABLE 1

Meter No.	Swings per.sec.	Time, sec. one swing	Period Sec.	Maximum Deflection	Responsive-ness	Damping Factor
1098912	8	0.125	0.25	100°	7.81	40
1089006	3.205	0.312	0.624	100°	1.63	.266
1083296	.835	1.2	2.4	100°	0.833	179

TABLE 2

Maximum and minumum deflection of pointer at various keying speeds, in decibels.

Speed cyc/sec	Meter Model 301 No.1098912 Max Deflection	Meter Model 301 No.1098912 Min Deflection	Meter Model 301 No.1089006 Max Deflection	Meter Model 301 No.1089006 Min Deflection	Meter Model 301 No.1083296 Max Deflection	Meter Model 301 No.1083296 Min Deflection
5	-0.2	-10	-3.0	-8.0	-5.5	-4.75
10	-3.5	-8.5	-5.0	-6.0	-5.2	-5
15	-4.2	-6.5	-5.25	-5.75	-5.1	*
20	-4.75	-5.75	-5.2	-5.3	-5.1	
25	-5	-5.5	-5.2	*	-5.1	
30	-5.25	-5.5	-5.3	*	-5.1	
35	-5.25	*	-5.1		-5.1	
40	-5.1	*	-5.2		-5.1	
45	-5.1	*	-5.2		-5.1	
50	-5.1	*	-5.3		-5.1	
55	-5.1		-5.2		-5.1	
60	-5.3		-5.3		-5.1	
65	-5.1		-5.3		-5.1	
70	-5.3		-5.5		-5.4	
75	-5.2		-5.2		-5.3	
80	-5.2		-5.2		-5.6	
85	-5.2	-5.5	-5.3		-5.6	
90	-5.2		-5.4		-5.7	
95	-5.3		-5.5		-5.8	
100	-5.6		-5.5		-5.9	
105	-5.5		-5.5		-6.0	
110	-5.5		-5.5		-6.0	
115	-5.5		-5.5		-6.1	
120	-5.5		-5.5		-6.1	

* slight oscillations.

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

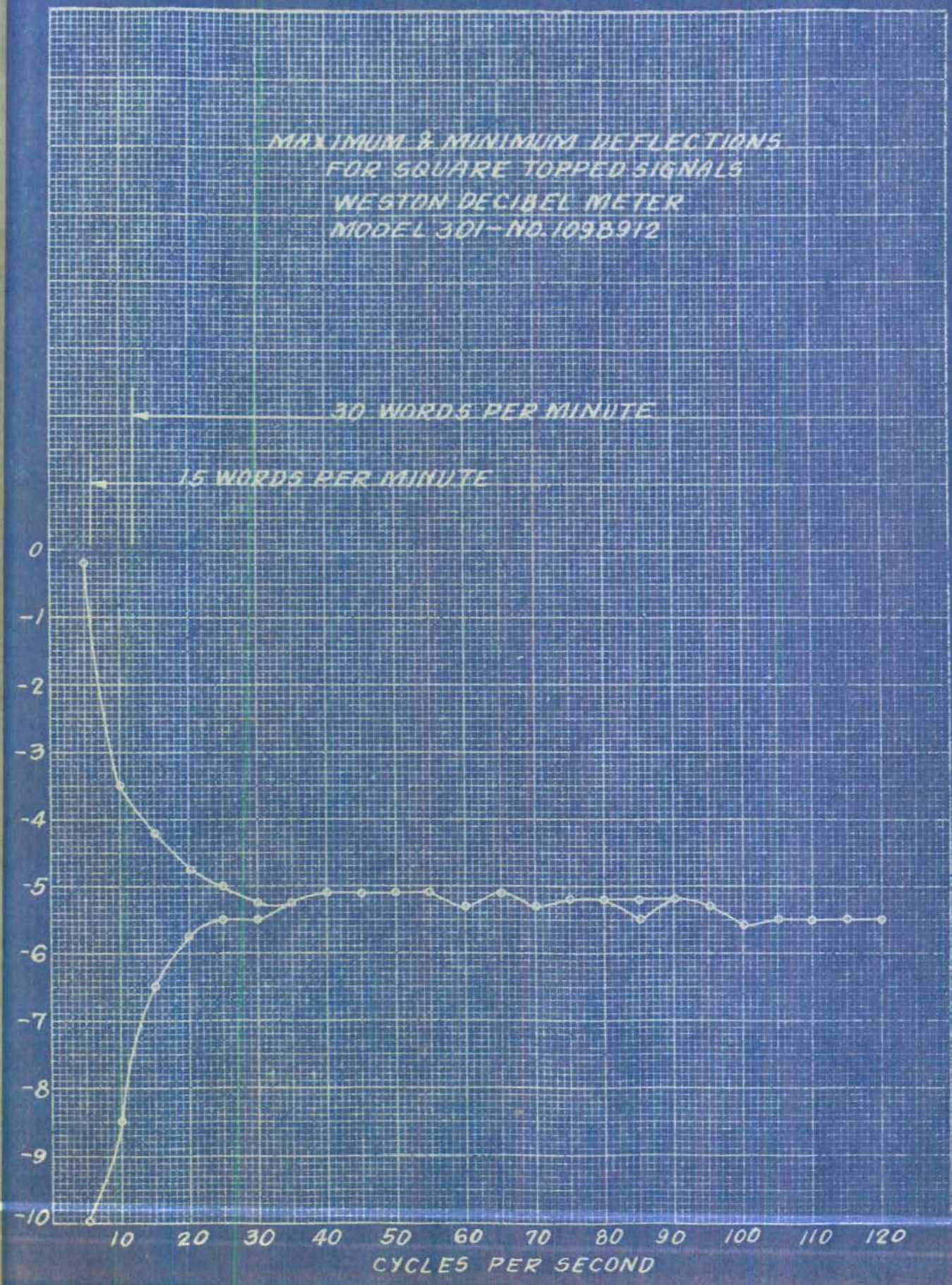

PLATE I

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

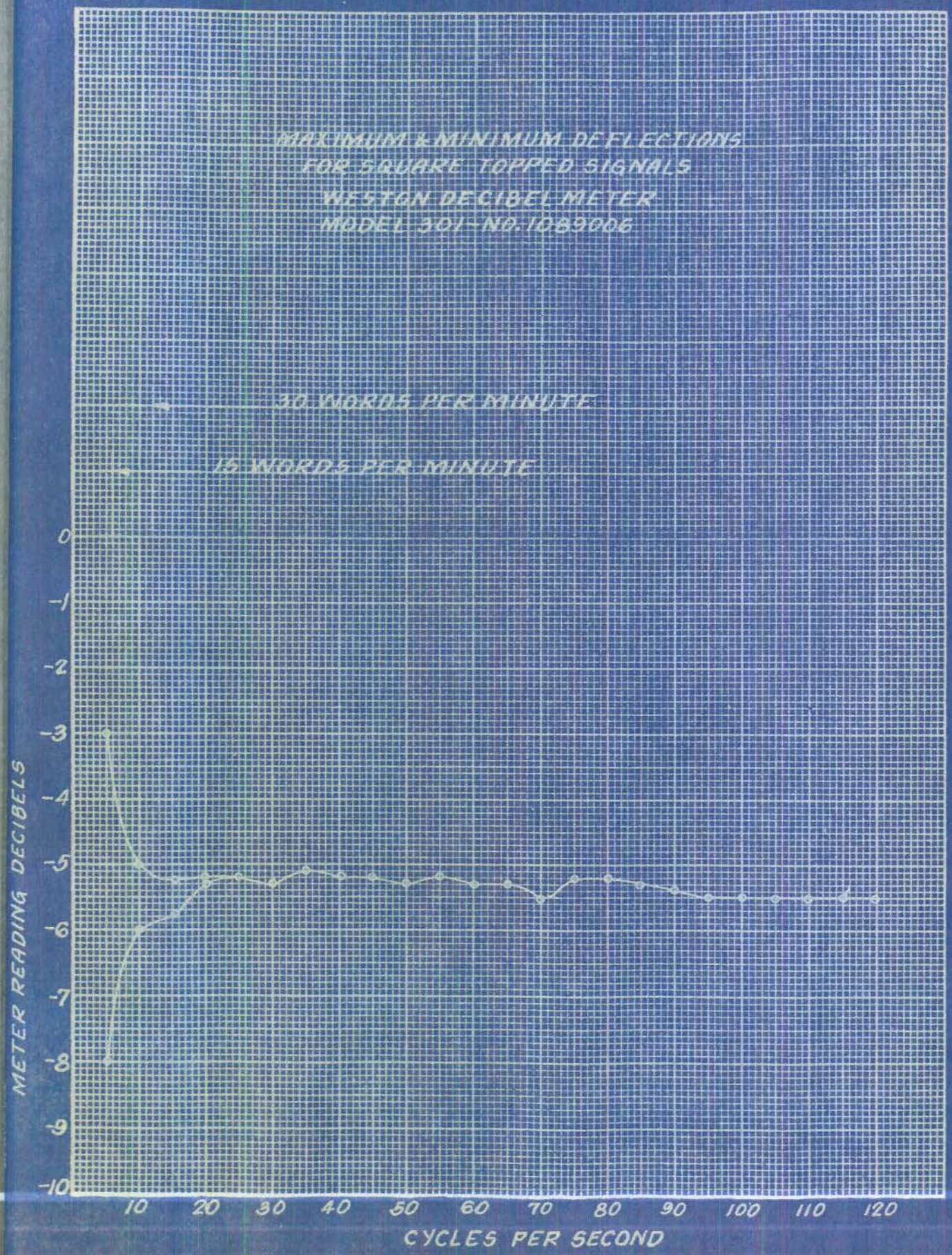

PLATE 2

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

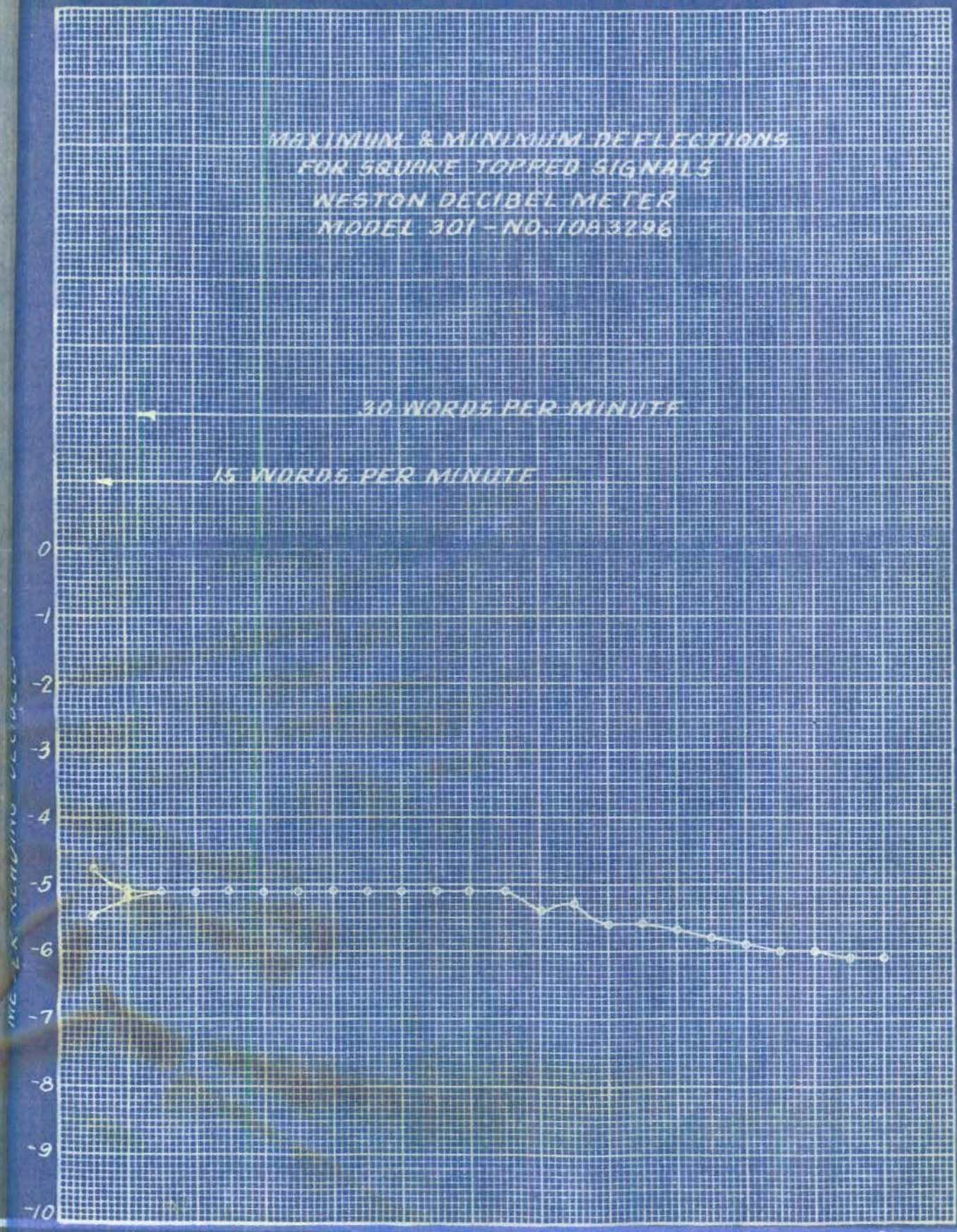

PLATE 3