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SUBJECT

Report of

Test of Ferris Model 32A

Interference Locator

and

Field Strength Meter

FR-1495

by

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NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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NAVY DEPARTMENT

BUREAU OF ENGINEERING

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NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Date of Test: 11 October to 10 November 1938.

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Appendices

AUTHORIZATION

1. This problem was authorized by Bureau of Engineering letter, reference (a). Another letter, pertinent to this problem, is listed as reference (b).

Reference: (a) BuEng let.S67/85(9-24-R8) of 30 Sept.1938.
(b) BuEng let.NOs-61598(10-5-R8) of 10 Oct.1938.

OBJECT OF TEST

2. The object of the test was to determine the merits of the Model 32A Ferris Radio Interference Locator as a cw field intensity meter.

ABSTRACT OF TEST

3. Tests were conducted to determine the sensitivity of the subject equipment as an interference locator, audio level in headphones and portability. Tests were also conducted to determine the precision of repeatability, accuracy of calibration, selectivity, constancy of the effective height of the one-half meter vertical signal collector and the effect on the calibration by deviation in "A" and "B" battery voltages when the equipment is used as a voltmeter. Wherever possible, comparative tests were made against the Model 44A Western Electric field intensity measuring equipment as well as on the Model OC test set.

Conclusions

(a) The sensitivity of this instrument appears to be materially lower than that of the Model CXO equipment which has been used previously. It has been noted that the controlled audio level of the headphones is very low, so low in fact, as to be inaudible, even with tightly fitted headphones, in the presence of external noises such as are common in a shop or on board ship where the device might be used. The equipment is much smaller and lighter than the Model CXO.

(b) The 41 inch constant length antenna is too wobbly for best efficiency. No test was made on a telescopic type of antenna.

(c) Calibration procedure is relatively simple and convenient. It is noted that the resistance variation controlled by the knob marked "Int. Adj." is in too coarse steps for entirely satisfactory operation. It is noted also that the resistance controlled by knob "Int.Calib." is insufficient on some ranges to set to calibration demand or fiducial line, even though test of "A" and "B" battery voltages indicates sufficient voltage.

(d) It is believed the repeatability is satisfactory, although some deviations exist.

(e) The error in the measurement of field intensity by this equipment may be from zero to 12 or 14 decibels (the larger error occurring at 18 megacycles), but it is believed this equipment will be quite useful as an easily portable means of determining field intensities approximately. Since the errors gradually increase as the frequency increases, it may be concluded the effective height of the antenna may not be constant.

Recommendations

It is recommended:

(a) That a more rigid but telescopic antenna replace the present whip-like antenna of test equipment.

(b) That means be provided for cutting out the automatic volume control and substituting a manual volume control so that an amplifying type of cathode ray oscilloscope could be plugged into the telephone jack or connected to a pair of binding posts in the same circuit. This would permit the hearing to supplement the use of the meter or cathode ray in running down interferences and make it unnecessary to watch the meter as the operator walks with the instrument.

(c) That the instrument be provided with sufficient potentiometer control for internal adjustment and calibration purposes.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material under test consisted of one Model 32A Ferris Radio Noise and Field Strength Meter with attachable 41 inch flexible antenna. All batteries are self contained.

METHOD OF TEST

5. Resonance curves were taken in the Laboratory using a Model LN Standard Signal Generator connected to the high side of the test equipment through a 10 micromicrofarad condenser as recommended by the designers. Calibration at levels of 200 and 1,000 microvolts using black scale readings of test equipment were made in the same way.

6. Field intensity measurements were made in the field either from a local Laboratory transmitter of fairly constant output or from broadcasting stations and at different output levels and at various distances, but where the distance from the transmitter to the test station was never less than two wave-lengths.

7. The effect of battery voltage variations on the calibration was observed in the Laboratory under the same conditions as noted in paragraph 5.

DATA RECORDED DURING TEST

8. The data recorded are given in Tables 1 to 4 and Plate 1.

RESULTS OF TEST

9. The following sub-paragraph numbers agree with the similarly numbered paragraphs in reference (a).

2(a). See Table 1. These data were taken as indicated in paragraph 5 of this report. Similar data taken in the field are shown in Table 2 under Column F as Per Cent Repeatability.

2(b). Data relating to self consistency on the two ranges for output levels of 200 - 1,000 microvolts were taken as indicated in paragraph 5 of this report and tabulated in Table 3 as Per Cent Relative Error in microvolts for scales "Black" and "Red." Similar data taken in the field are shown in Table 2 under Column E. These data are referred relatively to the Model OC test set as a standard: the units are expressed in decibels.

The relative accuracy at a given frequency for different intensity levels is shown in Table 2 under Column C and is expressed relatively to the Model OC test set as a standard: the units are in decibels.

2(c). The relative consistency of overlapping frequency bands is shown in Table 2 under Column H and is expressed in decibels.

2(d). Due to the time limit set by the manufacturers, this test was not made, but overall resonant response curves were taken at frequencies of fo' = 1 megacycle and fo" = 20 megacycles, which are shown on Plate 1.

2(e). This test was not made due to the time limit set by the manufacturer.

2(f). Constancy of the effective height of the 41-inch antenna assumed to be one-half meter may be estimated from Table 2, under Column C on the basis of the relative difference between Columns A and B. This difference is seen to be positive or greater in the high frequency region passing through zero into a negative difference, becoming a maximum negative around 4 megacycles and then less negative as the frequency is lowered. This may be interpreted to indicate the effective height of the vertical antenna is greater than one-half meter at 18 megacycles (except for the data shown in line four, Columns A and B, where the test set is 10.2 decibels below the Model OC standard). From 10 megacycles on through lower frequencies, the effective height is definitely smaller than one-half meter, reaching a minimum effective height at 4 megacycles, then returning gradually nearer to one-half meter, as the frequency is further diminished. This opinion is based solely upon the accuracy of the Model OC test set, for obviously both antennas are subjected to the same field strength or nearly so.

2(g). The effect on the indicated field intensity of battery voltage variation is shown in Table 4.

CONCLUSIONS

10. The sensitivity of this instrument appears to be materially lower than that of the Model CXO equipment which has been used previously. It has been noted that the controlled audio level of the headphones is very low, so low in fact, as to be inaudible, even with tightly fitted headphones, in the presence of external noises such as are common in a shop or on board ship where the device might be used. The equipment is much smaller and lighter than the Model CXO.

11. The 41 inch constant length antenna is too wobbly for best efficiency. No test was made on a telescopic type of antenna.

12. Calibration procedure is relatively simple and convenient. It is noted that the resistance variation controlled by the knob marked "Int. Adj." is in too coarse steps for entirely satisfactory operation. It is noted also that the resistance controlled by knob "Int. Calib." is insufficient on some ranges to set to calibration demand or fiducial line, even though test of "A" and "B" battery voltages indicates sufficient voltage.

13. It is believed the repeatability is satisfactory, although some deviations exist.

14. The error in the measurement of field intensity by this equipment may be from zero to 12 or 14 decibels (the larger error occurring at 18 megacycles), but it is believed this equipment will be quite useful as an easily portable means of determining field intensities approximately. Since the errors gradually increase as the frequency increases, it may be concluded the effective height of the antenna may not be constant.

Table 1

Calibration of Ferris Model 32A

Serial 2 Radio Noise and Field Strength Meter

(Black Scale)

	Test Set Response		Precision of Repeatability (%)	
	at 200 μv input	at 1000 μv input	at 200μv input	at 1000 μv input
Range A				
.55 mc	95	500	98.4	100
1.00	140	750	99.4	100
1.55	130	640	98.0	100
Range B				
1.55	90	650	98.5	100
4.00	150	750	99.5	100
Range C				
4.00	65	275	99.3	100
10.00	150	750	99.0	100
Range D				
10.00	170	800	96.3	97.7
20.00	350	4500	77.6	84.2

Range X

Internal calibration not possible due to lack of adjustment in "Calibrate" control.

Table 2

Column	A	B	C	D		E	F	G	H
Freq mc	Test Eqpt db above 1 μv/m	OC Std db above 1 μv/m	Rel.Diff. db	Freq. Range	Intensity Range	Self-Consistency Rel.Diff. db	Precision of Repeatability %	44A Std db above 1 μv/m	Diff. in overlapping freq bands db
18	81.6	71.8	9.8	D	R		100	-	
18	92.0	80.0	12.0	D	R		100	-	
18	112.0	102.2	9.8	D	R		100	-	
18	84.0	94.2	-10.2	D	R		100	-	
10	83.5	87.7	-4.2	D	R		100	-	
10	75.6	87.7	-12.1	C	R		100	-	± 7.9
10	69.6	71.3	-1.7	D	R		100	-	
10	66.0	71.3	-5.3	C	B	± 2.0	100	-	± 3.6
10	64.0	71.3	-7.3	C	R		100	-	
4	79.1	93.2	-14.1	C	R		100	97.6	
4	92.0	93.2	-1.2	B	R		100	97.6	±12.9
4	62.8	73.4	-10.6	C	B	± 2.8	100	76.8	
4	60.0	73.4	-13.4	C	R		100	76.8	±16.9
4	76.9	73.4	+ 3.5	B	R		100	76.8	
1.55	81.6	84.9	- 3.3	A	R		100	88.4	
1.55	75.6	77.8	- 2.2	A	R		100	89.0	
1.23	72.0	73.1	- 1.1	A	R		100	-	
1.23	71.0	74.6	- 3.6	A	R		-	78.5	
1.23	72.5*	74.6	- 2.1	A	R		-	78.5	
1.23	73.0*	74.6	- 1.6	A	R		99.3	78.5	
1.46	83.0	84.6	- 1.6	A	R		-	88.4	
1.46	83.5	84.6	- 1.1	A	R		99.6	88.4	
1.46	85.0*	84.6	+ 0.4	A	R		-	88.4	
1.06	58.5	59.1	- 0.6	A	B	± 1.5	100	61.3	
1.06	60.0	59.1	+ 0.9	A	R		100	61.3	
1.06	62.0*	59.1	+ 2.1	A	R		-	61.3	
0.950	84.5	89.3	- 4.8	A	R		-	92.1	
0.950	88.0*	89.3	- 1.3	A	R			92.1	

Table 2 (continued)

Column	A	B	C	D		E	F	G	H
Freq mc	Test Eqpt db above 1 μv/m	OC Std db above 1 μv/m	Rel.Diff. db	Freq. Range	Intensity Range	Self-Consistency Rel.Diff. db	Precision of Repeatability %	44A std. db above 1 μv/m	Diff. in overlapping freq. bands db
0.760	39.5	43.0	-3.5	A	B			45.0	
0.760	43.0*	43.0	0.0	A	B			45.0	
0.630	78.0	85.0	-7.0	A	R			85.7	
0.630	80.0*	85.0	-5.0	A	R			85.7	
0.600	52.0	58.8	-6.8	A	B			60.8	
0.600	55.0*	58.8	-3.8	A	B			60.8	
0.600	57.0	58.8	-1.8	A	B	Hand on case		60.8	

* Test instrument was suspended by shoulder strap from observer.

Table 3

Self Consistency of Black and Red Ranges
at 1.0 megacycles

Input µv	Black Scale µv	Red Scale µv	Black Scale Relative Error %	Red Scale Relative Error %
1	1		± 0	
5	6		20	
10	14		40	
20	24		20	
50	42		-16	
100	75		-25	
200	140	210	-30	+5
300	200	325	-33 1/3	8
400	275	425	-31	6
500	375	580	-25	16
600	450	690	-25	15
700	525	840	-25	20
800	625	1000	-22	25
900	690	1150	-22	28
1000	750	1300	-25	30
1500	1000	1800	-33	20
2000		2100		5
3000		3000		0
4000		3750		-6.2
5000		4250		-15
6000		4500		-25
7000		5500		-21
8000		6100		-23
9000		6800		-24
10000		7200		-28

Table 4

Effect of Battery Voltage Variation

on Microvolt Reading

Freq mc	LN Output µv	A Battery volts	B Battery volts	Test Set Reading µv Black Scale	Red Scale
1	500	3.00	135.0	370	540
1	500	3.00	124.7	400	585
1	500	3.00	115.0	415	550
1	500	2.80	134.5	370	540
1	500	2.80	124.8	395	560
1	500	2.80	115.0	420	560
1	500	2.54	134.1	375	550
1	500	2.54	124.8	380	550
1	500	2.54	115.0	415	560

Condition of test:

With a constant input voltage of 500 µv at a frequency of one megacycle applied from the Model LN signal generator in series with 10 µµf condenser to the high side of test set and a filament battery of 3 volts the "A Battery Test" indicated a relative reading well above the fiducial "low" line. This low limit line is approximately at 2.54 A battery volts. With 135 volts of B battery the "B Battery Test" indicated a relative reading well above the fiducial "low" line limit of 115 B battery volts.

U. S. NAVAL RESEARCH LABORATORY
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DATE

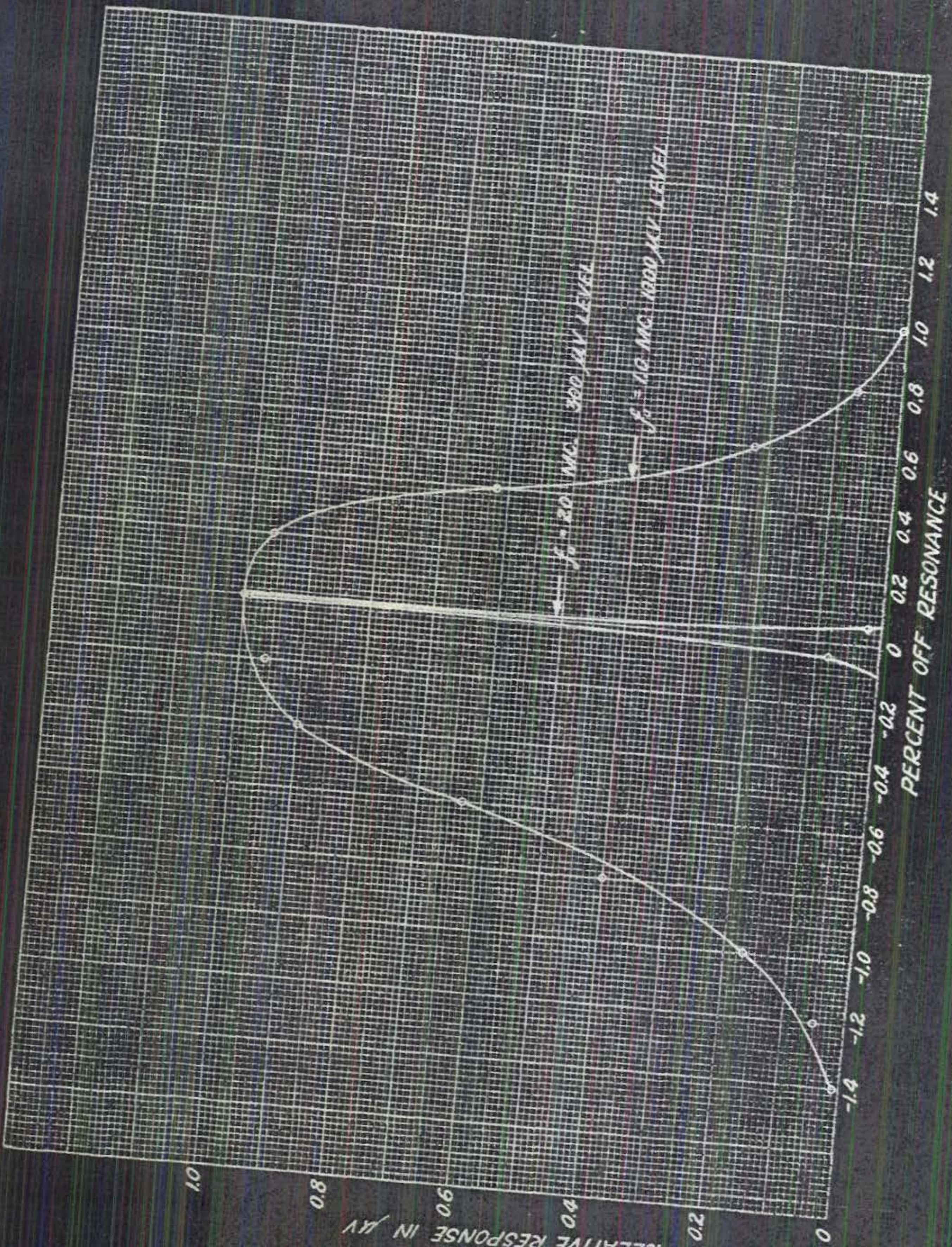

PLATE I