NATIONAL BROADCASTING COMPANY, INC.

PROOF OF PERFORMANCE REPORT

WEAF

PORT WASHINGTON NORTH LONG ISLAND

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WEAF

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Prepared by _____
Radio Facilities Engineer

Approved by _____
Vice President & Chief Engr

National Broadcasting Co Inc
Engineering Dept
Radio Facilities Section

AFFIDAVIT

State of New York

County of New York

I, Raymond F Guy, being duly sworn, depose and say as follows:

I am Radio Facilities Engineer of the National Broadcasting Company and as such supervise all engineering of Radio Facilities. The proof of performance measurements of WEAF were carried out under my supervision.

The measurements reported herein were made by William S Duttera, Radio Engineer, National Broadcasting Company, New York and William A Fitch, Radio Engineer, National Broadcasting Company, New York.

Mr William S Duttera graduated with the degree of B.S. from Gettysburg College and has had many years of experience in the engineering of broadcast transmitting facilities in the General Electric Company and National Broadcasting Company.

Mr William A Fitch graduated with the degree of M.S. from Union College, and has had many years of experience in the engineering of broadcast transmitting facilities in the General Electric Company and National Broadcasting Company.

It is my belief thatthe measurements reported herein were correctly made and are accurate.

(Signature)_____

(Date)_____

Subscribed and sworn to before me this_____day of October, 1940

_____
Notary Public

LOCATION OF MEASURING POINTS

Proof of performance measurements of the new WEAF plant had to be made during the hours when the old plant was not in operation. This limited the measuring time to a maximum of five hours per day. All measuring points within a radius of 2 miles were located during daylight hours, and the distances were accurately measured by means of a Transit and chain prior to starting measurements. Approximately 100 points were thus selected, measured and marked with stakes. Approximately 50,000 linear feet were chained off in the process of locating the points. In addition most of the measuring points on the 25 millivolt radials were selected by scouting in advance during daylight hours.

Areas in the vicinity of the station were so characterized by hills and woods that it was necessary to separate some of the measuring points by more than .1 mile. In general the measurements were not made near wires nor in thickly wooded areas although some of the points had to be located in areas which ordinarily would be undesirable.

TIME REQUIRED FOR MEASUREMENTS

Selection of measuring points started on September 10 and was completed on September 29. Measurements started on September 29 and were completed on October 12. 20 man weeks were devoted to proof of performance, exclusive of other measurements connected with adjustment of the antennas.

METHOD USED TO TAKE FIELD INTENSITY MEASUREMENTS

The standard antenna method of measuring radio field intensity was used for the proof of performance measurements. A calibrated loop antenna is used to collect the radio energy. The loop antenna is oriented and tuned for maximum output. The receiver gain is adjusted to give a convenient deflection on the output meter. Then with the loop antenna turned to a right angle position so that the measured output is low, the calibrating oscillator is turned on at a fixed input and tuned to approximately zero beat with the residual measured field. The output meter is adjusted to a fixed scale position by adjusting the gain of the receiver. Then the calibrating oscillator is turned off, the loop reoriented to the maximum position and the receiver attenuator adjusted to give a convenient deflection on the output meter leaving the receiver gain the same as when calibrating. From a reading of the output meter, the attenuator setting and the loop constant, the field intensity may be calculated.

Meter readings and attenuator settings were converted to actual field intensity values as follows:

$$\frac{\text{Output meter reading} \times \text{attenuator}}{K} = E$$

E = field intensity in microvolts per meter
K = 2.53 = loop constant

A RCA type 75B field intensity meter serial number 512 was used for the proof of performance measurements. This field intensity set was last calibrated on October 11, 1940. The accuracy of this equipment is ± 5%.

Measurements are listed serially in the attached tabulation. Each point is identified by a radial letter (A to K) and a designating number. In addition, there is listed the bearing of each radial, the distance from each point to the center of the antenna system, the readings of the field intensity meter and the field intensity values computed therefrom. From the attached plots of E versus D for each radial, the corresponding unattenuated fields at one mile have been determined by comparing with the best fitting theoretical propagation curve. In each case the value is that obtained at the intersection of the corresponding inverse distance curve with the one mile ordinate. In addition, the ratio of directive to non directive fields were measured at a distance of approximately one mile from the station as a check on the values of the field in these directions. Very good agreement was found between the results from the various methods described.

The attached polar diagram is a plot of the measured unattenuated field in the direction of the radials described above. A polar diagram is also attached giving the ratio between directive and non directive field intensity.

TABULATION OF FIELD INTENSITY MEASUREMENTS

PROOF OF PERFORMANCE

WEAF PORT WASHINGTON N Y

50 KW 660 KC

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
A	32°	1	.6	63	50000	1250
		2	.7	270	10250	1095
		3	.768	255	10250	1035
		4	.848	226	10250	915
		5	.928	163	10250	660
		6	1.028	198	10250	805
		7	1.084	163	10250	660
		8	15.4	74.5	2245	66.3
		9	16.6	62.5	2245	55.3
		10	18.3	55	2245	48.8
		11	19.3	158	574	35.8
		12	20	123	574	27.8
		13	22.3	104	574	23.8
		14	23.5	83	574	18.8
		15	24.7	73	574	16.6
		16	25.8	67.5	574	15.3

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
B	77°44'	1	.7	58.5	50000	1155
		2	.8	210	10250	850
		3	.9	187	10250	757
		4	1.1	160	10250	650
		5	1.3	121	10250	490
		6	2.8	58.3	10250	236
		7	3.15	53	10250	214
		8	3.37	228	2245	202
		9	4.05	156	2245	138.5
		10	4.8	111	2245	98.5
		11	5.35	97	2245	86
		12	6.15	66	2245	58.6
		13	7.45	168	574	38
		14	10.5	110	574	25
		15	13.0	67	574	15.2
		16	13.9	154	117.5	7.15

Radial	Bearing	Point No	Ditance Miles	Meter Reading	Attenuator	Field Intensity MV/M
C	108°50'1	1	.83	266	10250	1080
		2	.9	224	10250	908
		3	1.0	216	10250	879
		4	1.1	175	10250	710
		5	1.2	223	10250	903
		6	1.3	145	10250	589
		7	1.37	129	10250	525
		8	1.42	110	10250	445
		9	1.68	104	10250	421
		10	3.15	60	10250	244
		11	3.5	228	2245	202
		12	4.1	99	2245	87.8
		13	4.8	103	2245	91.5
		14	5.7	79.5	2245	70.5
		15	7.8	103	574	23
		16	10.7	58.5	574	13.2
		17	12.5	55.5	574	12.6
		18	14.1	53.5	574	12.1

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
D	153°54'	1	.75	77.5	50000	1520
		2	.975	248	10250	1003
		3	1.33	187	10250	757
		4	1.49	150	10250	619
		5	1.61	110	10250	445
		6	1.96	123	10250	500
		7	2.10	104	10250	423
		8	2.46	102	10250	414
		9	2.64	76	10250	308
		10	3.45	255	2245	226
		11	3.9	177	2245	157
		12	5.2	134	2245	119
		13	6.1	88	2245	78
		14	7.4	68.5	2245	60.9
		15	9.2	247	574	56.1
		16	10.65	171	574	38.7
		17	12.4	121	574	27.5
		18	15.9	78	574	17.7
		19	17.8	73	574	16.5
		20	19.75	76	574	17.2

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
E	189°49'	1	.539	144	50000	2844
		2	.738	108	50000	2140
		3	1.085	70	50000	1388
		4	1.33	253	10250	1025
		5	1.38	241	10250	975
		6	1.805	179	10250	724
		7	2.61	123	10250	500
		8	2.71	114	10250	461
		9	3.17	99	10250	401
		10	3.75	66	10250	267
		11	4.23	80.5	10250	326
		12	4.7	295	2245	261
		13	5.05	275	2245	244
		14	6.3	196	2245	174
		15	7.5	132	2245	117
		16	8.4	158	2245	140
		17	10.4	112	2245	99.5
		18	12.4	67.5	2245	60
		19	13.6	247	573	56
		20	16.1	203	573	46.1
		21	17.45	198	573	45

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
F	216°36'	1	.66	107	50000	2123
		2	.70	128	50000	2530
		3	.82	107	50000	2107
		4	.9	93	50000	1842
		5	2.38	189	10250	766
		6	2.8	132	10250	535
		7	3.55	93.5	10250	383
		8	3.95	86	10250	348
		9	6.2	67	10250	272
		10	7.5	202	2245	179
		11	7.6	224	2245	198
		12	8.05	202	2245	178
		13	10.1	147	2245	130
		14	11.5	131	2245	116
		15	13	78	2245	69
		16	13.4	73.5	2245	65
		17	15.25	71	2245	63
		18	15.5	70	2245	62
		19	15.6	247	573	56.3
		20	15.8	250	573	56.9
		21	16.2	215	573	48.7
		22	16.7	214	573	48.5
		23	16.9	232	573	52.5
		24	18	240	573	54.5
		25	19	189	573	42.9
		26	20.3	187	573	42.4
		27	22.2	178	573	40.4
		28	2.3	167	573	37.9

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
G	236°44¹	1	.643	128	50000	2530
		2	.81	99.5	50000	1965
		3	.953	94	50000	1859
		4	1.01	87	50000	1720
		5	1.12	91.5	50000	1809
		6	1.34	67	50000	1322
		7	1.71	265	10250	1071
		8	2.6	185	10250	748
		9	2.7	172	10250	696
		10	3	121	10250	490
		11	6.5	60.5	10250	245
		12	7.5	60.5	10250	245
		13	7.75	226	2245	200.2
		14	8.6	198	2245	176
		15	10.4	181	2245	160.6
		16	11.75	181	2245	160.6
		17	13.1	134	2245	119
		18	13.3	138	2245	122.1
		19	16.1	124	2245	110.1
		20	17.2	120	2245	106.7
		21	17.4	108	2245	95.7
		22	17.8	71.5	2245	63.3
		23	25.4	181	574	41.0
		24	25.5	174	574	39.4
		25	27.3	168	574	38.2
		26	27.4	158	574	35.9
		27	29.8	150	574	34.1
		28	31.5	134	574	30.4
		29	32.8	142	574	32.1
		30	34.8	132	574	29.9
		31	38.8	113	574	25.6
		32	39.3	108	574	24.6
		33	40.7	101	574	22.9

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
H	252°14'	1	.784	126	50000	2486
		2	.904	90.5	50000	1790
		3	1.026	78.5	50000	1550
		4	1.136	68.5	50000	1353
		5	1.20	61	50000	1204
		6	1.45	232	10250	940
		7	1.60	247	10250	1000
		8	5.7	72.5	10250	293
		9	7.65	254	2245	225
		10	8.4	205	2245	182
		11	9.75	212	2245	188
		12	10.35	170	2245	151
		13	11.35	158	2245	140
		14	13.1	133	2245	118
		15	13.9	138	2245	122
		16	14.5	133	2245	118
		17	16.1	99	2245	88
		18	16.3	75	2245	66.5
		19	16.6	105	2245	93.0
		20	18.5	229	574	52
		21	19.7	59.5	2245	53
		22	21.7	215	574	48.8
		23	251.1	186	574	42.2
		24	25.8	146	574	33.2
		25	28.4	132	574	29.9
		26	30.1	117	574	26.6
		27	30.5	110	574	24.9
		28	31.4	93	574	21.0
		29	32.4	88	574	19.9
		30	19.9	88	574	19.9

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
I	270°54'	1	.701	124	50000	2453
		2	.759	100	50000	1980
		3	.95	82.5	50000	1633
		4	1.42	60.5	50000	1193
		5	1.485	248	10250	1005
		6	1.63	232	10250	939
		7	6.2	69.5	10250	28.2
		8	6.3	58.1	10250	236
		9	6.5	254	2245	225
		10	7.55	209	2245	186
		11	7.7	212	2245	188
		12	8.0	191	2245	169.4
		13	8.7	185	2245	164
		14	9.25	165	2245	146-3
		15	10.75	160	2245	142
		16	12.15	122	2245	108
		17	13.	122	2245	108
		18	13.7	83.5	2245	74.2
		19	14.8	67	2245	59.5
		20	16.8	59.5	2245	53.0
		21	19.3	195	574	44.25
		22	20.0	163	574	37.
		23	20.8	147	574	33.4
		24	23.4	134	574	30.4
		25	26.0	122	574	27.7
		26	27.6	102	574	23.1

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
J	308°54'	1	.581	119	50000	2350
		2	.673	75	50000	1480
		3	.93	65	50000	1290
		4	1.00	295	10250	1195
		5	1.115	231	10250	936
		6	1.292	181	10250	734
		7	1.36	189	10250	766
		8	1.51	156	10250	633
		9	1.575	140	10250	568
		10	1.68	143	10250	580
		11	1.78	155	10250	629
		12	1.84	176	10250	714
		13	5.0	70	10250	284
		14	5.4	68	10250	276
		15	7.6	191	2245	169
		16	7.7	183	2245	162
		17	8.8	170	2245	151
		18	9.6	160	2245	142
		19	10.7	75	2245	66.6
		20	12.2	65.5	2245	58
		21	14.5	55	2245	48.7
		22	15.9	164	574	37.2
		23	17.4	143	574	32.4
		24	21.5	130	574	29.5
		25	23.8	121	574	27.4
		26	24.5	94	574	21.4

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
K	347°24'	1	.6	96	50000	1900
		2	.7	64.5	50000	1275
		3	.8	268	10250	1085
		4	.900	225	10250	914
		5	1.02	235	10250	951
		6	1.06	193	10250	781
		7	1.1	169	10250	685
		8	1.135	173	10250	702
		9	1.17	166	10250	674
		10	1.205	158	10250	640
		11	1.29	142	10250	575
		12	7.6	144	2245	128.5
		13	10.5	80	2245	70.8
		14	11.7	68.5	2245	60.8
		15	13.7	55	2245	48.7
		16	16.0	160	574	36.3
		17	17.1	142.5	574	32.3
		18	18.8	127	574	28.8
		19	19.2	123	574	27.7
		20	20.6	83	574	18.8
		21	21.6	80	574	18.15
		22	23.5	68.5	574	15.5
		23	23.9	57	574	12.9
		24	24.8	54.5	574	12.3

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
P	Brooklyn	1	19.5	242	574	55
		2	20.6	171	574	38.8
		3	21.3	165	574	37.4
		4	21.3	116	574	26.4
		5	22	137	574	31.2
		6	22.3	122	574	27.6
		7	23.3	139	574	31.5
		8	22.7	268	574	61
		9	23.2	281	574	63.8
		10	23.7	233	574	52.8
		11	24.4	159	574	36.2
		12	24.3	143	574	32.5
		13	24	154	574	35
		14	23.9	155	574	35.2
		15	23.8	154	574	35
		16	23.9	119	574	27
		17	23.8	187	574	42.5

Radial	Bearing	Point No	Distance Miles	Meter Reading	Attenuator	Field Intensity MV/M
W	New York	1	11.8	88	2245	78.1
		2	11.5	93.4	2245	83
		3	11.3	99	2245	88
		4	11.3	88	2245	78.1
		5	11.8	116	2245	103
		6	12.1	99	2245	88
		7	12.3	111	2245	98
		8	13	122	2245	108
		9	13.4	180	2245	159.5
		10	13.7	135	2245	120
		11	14.1	83	2245	73.5
		12	14.7	111	2245	98
		13	15.2	105	2245	93
		14	15.8	138	2245	122
		15	17.5	111	2245	98
		16	17.8	122	2245	108
		17	18	116	2245	103

TABULATION OF COMPARATIVE

DIRECT AND NON DIRECTIVE MEASUREMENTS

Point Number	Bearing	E Directive	E Non-Directive	ED End
A - 3	32°	1035	1380	.75
B - 6	77°44'	236	288	.82
C - 6	108°50'	589	785	.75
E - 5	189°49'	975	806	1.21
F - 2	216°36'	2530	1940	1.3
G - 6	236°44'	1325	990	1.34
H - 3	252°14'	1550	1150	1.35
J - 3	308°50'	1290	1010	1.28
K - 2	347°24'	1280	1280	1.0

TABULATION OF COMPARATIVE

DIRECT AND NON DIRECTIVE MEASUREMENTS

Point Number	Bearing	E Directive	E Non-Directive	ED End
A - 3	32°	1035	1380	.75
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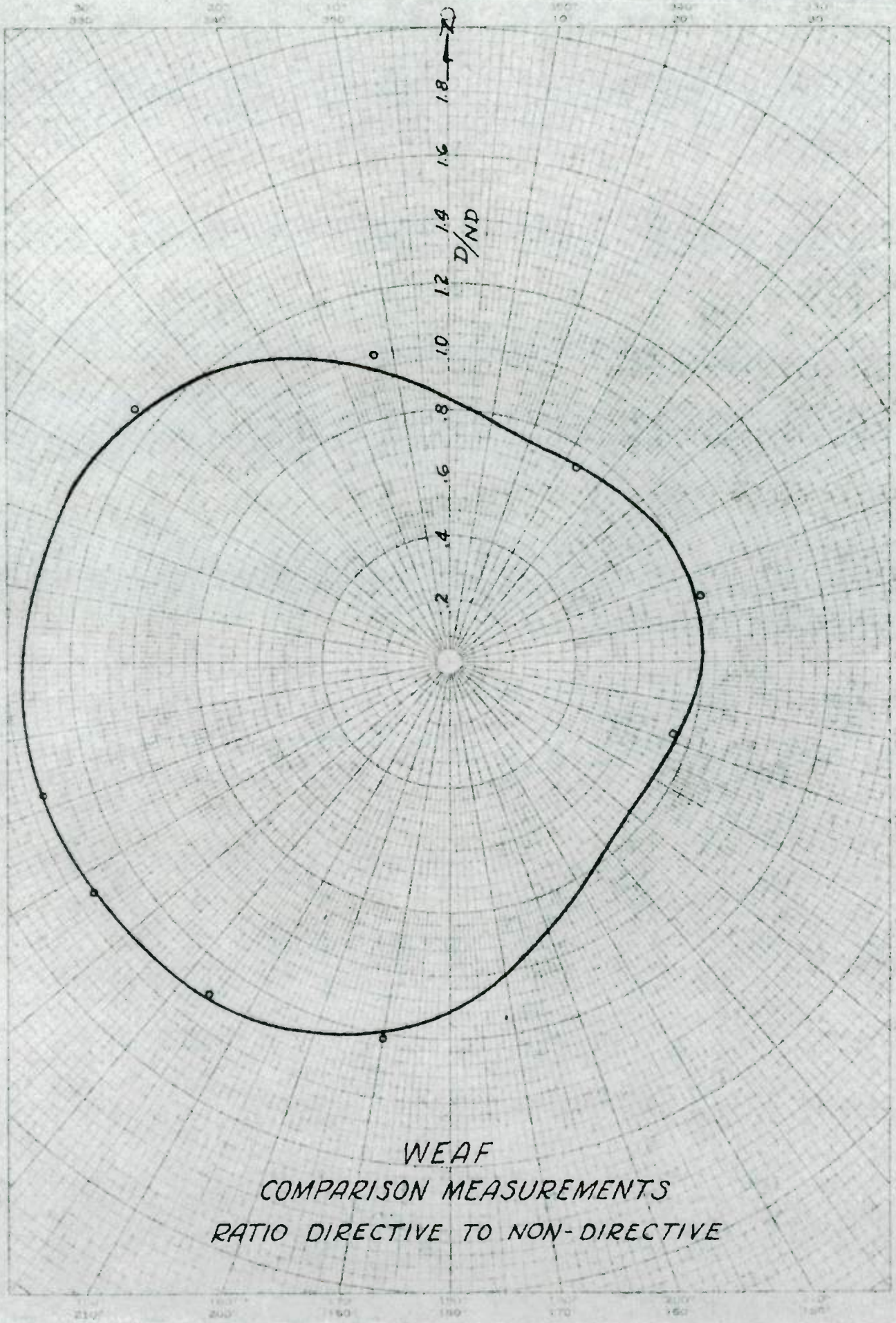
F - 2	216°36'	2530	1940	1.3
G - 6	236°44'	1325	990	1.34
H - 3	252°14'	1550	1150	1.35
J - 3	308°50'	1290	1010	1.28
K - 2	347°24'	1280	1280	1.0

200-R



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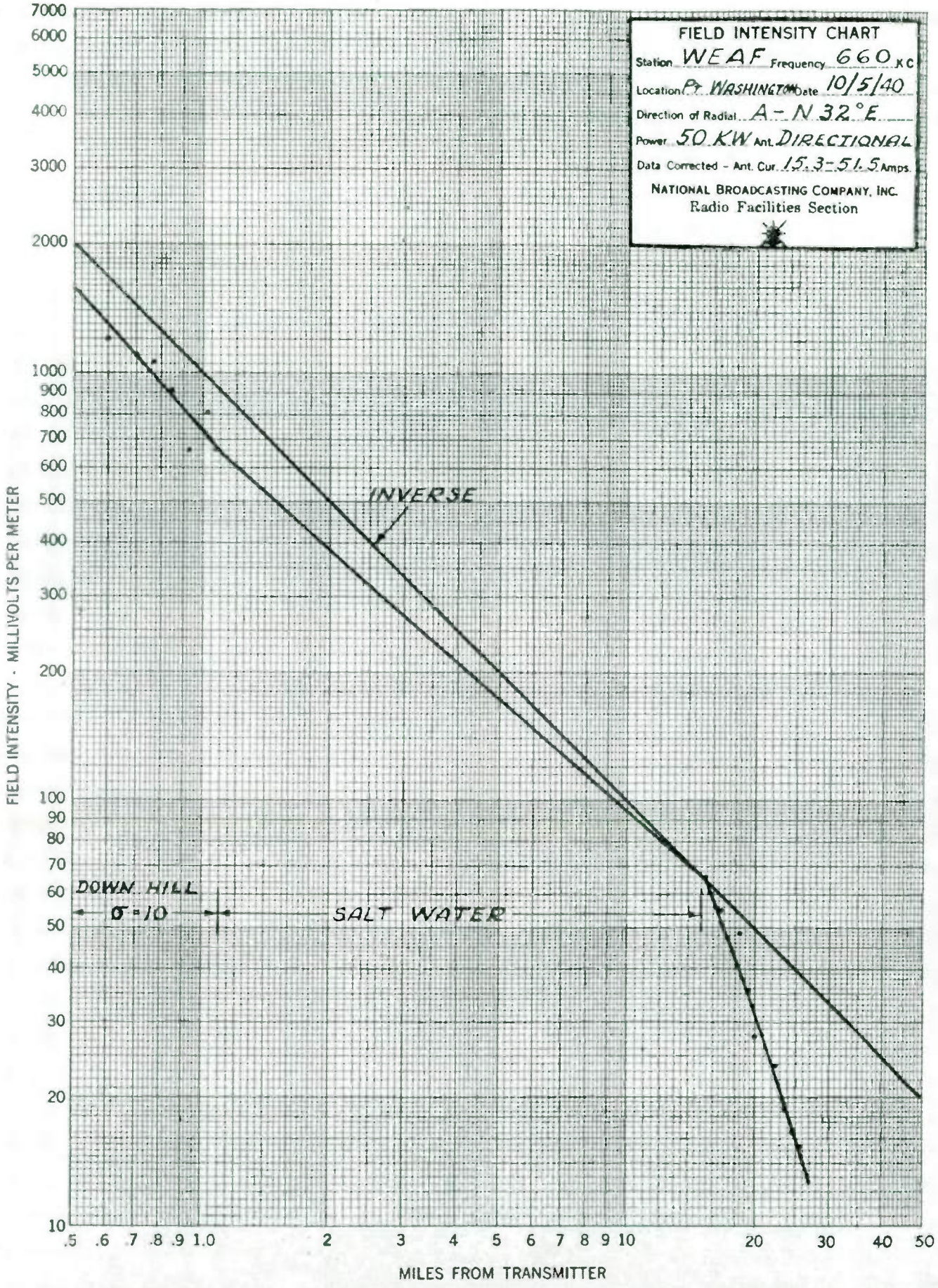
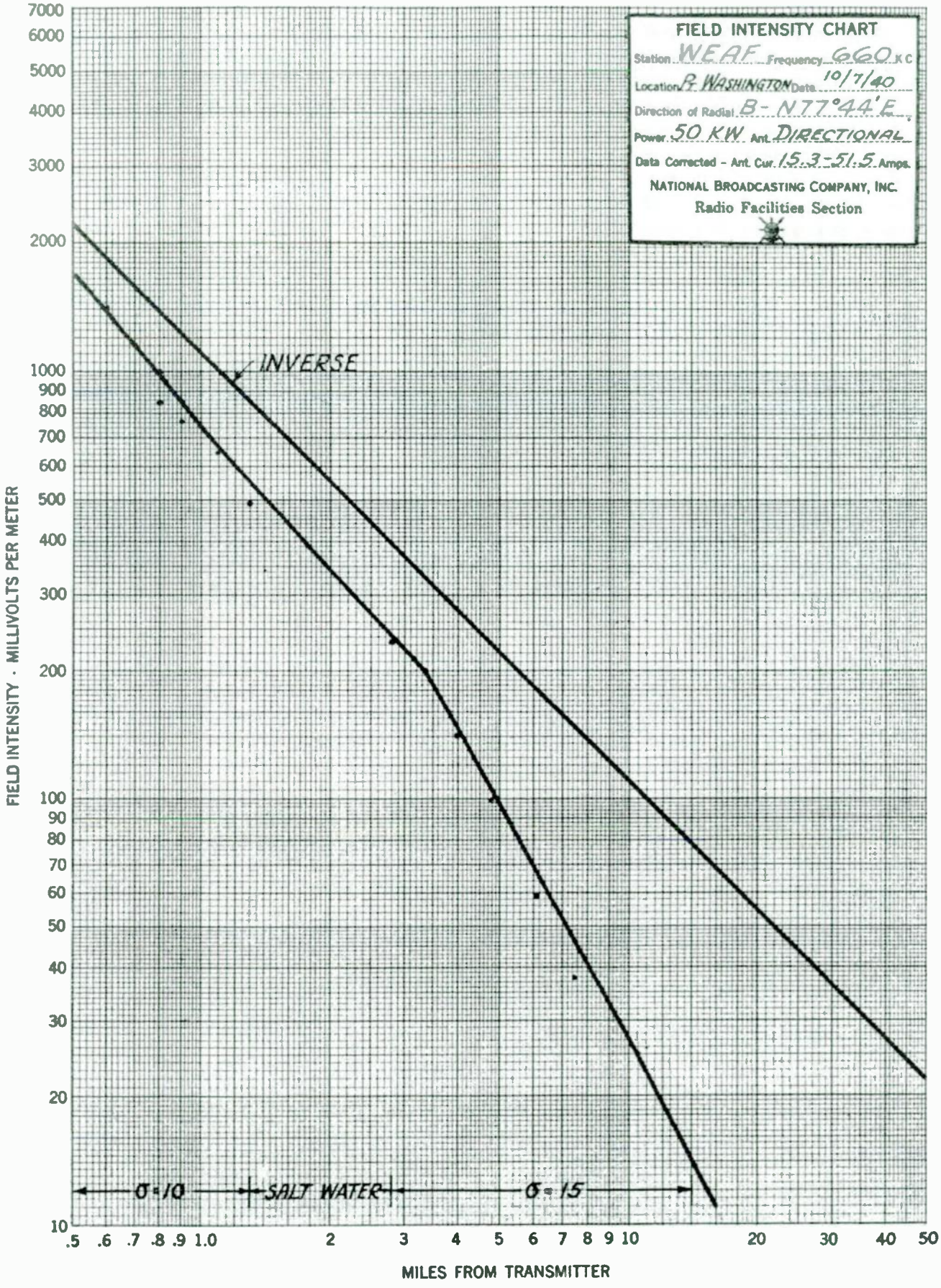
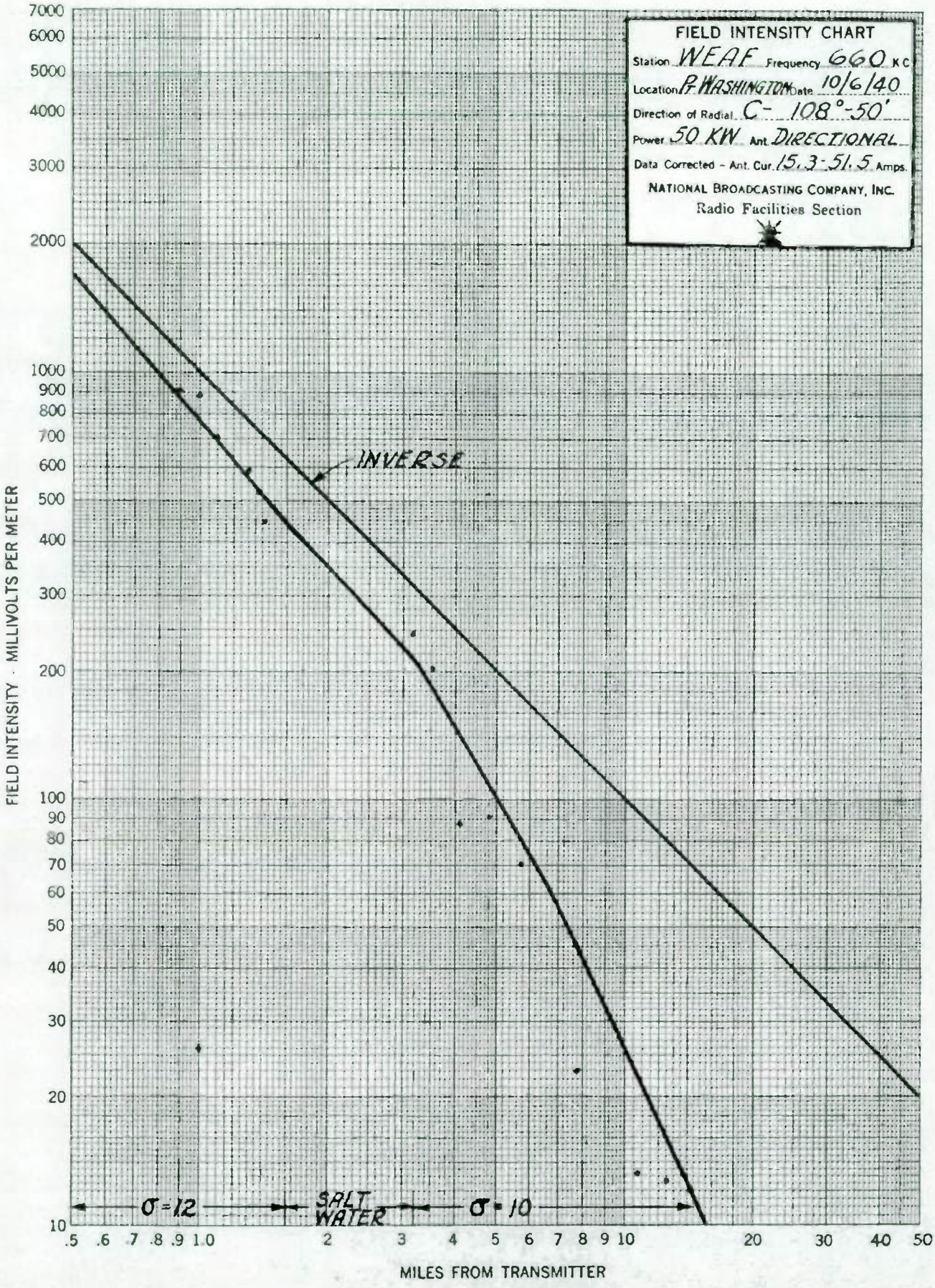
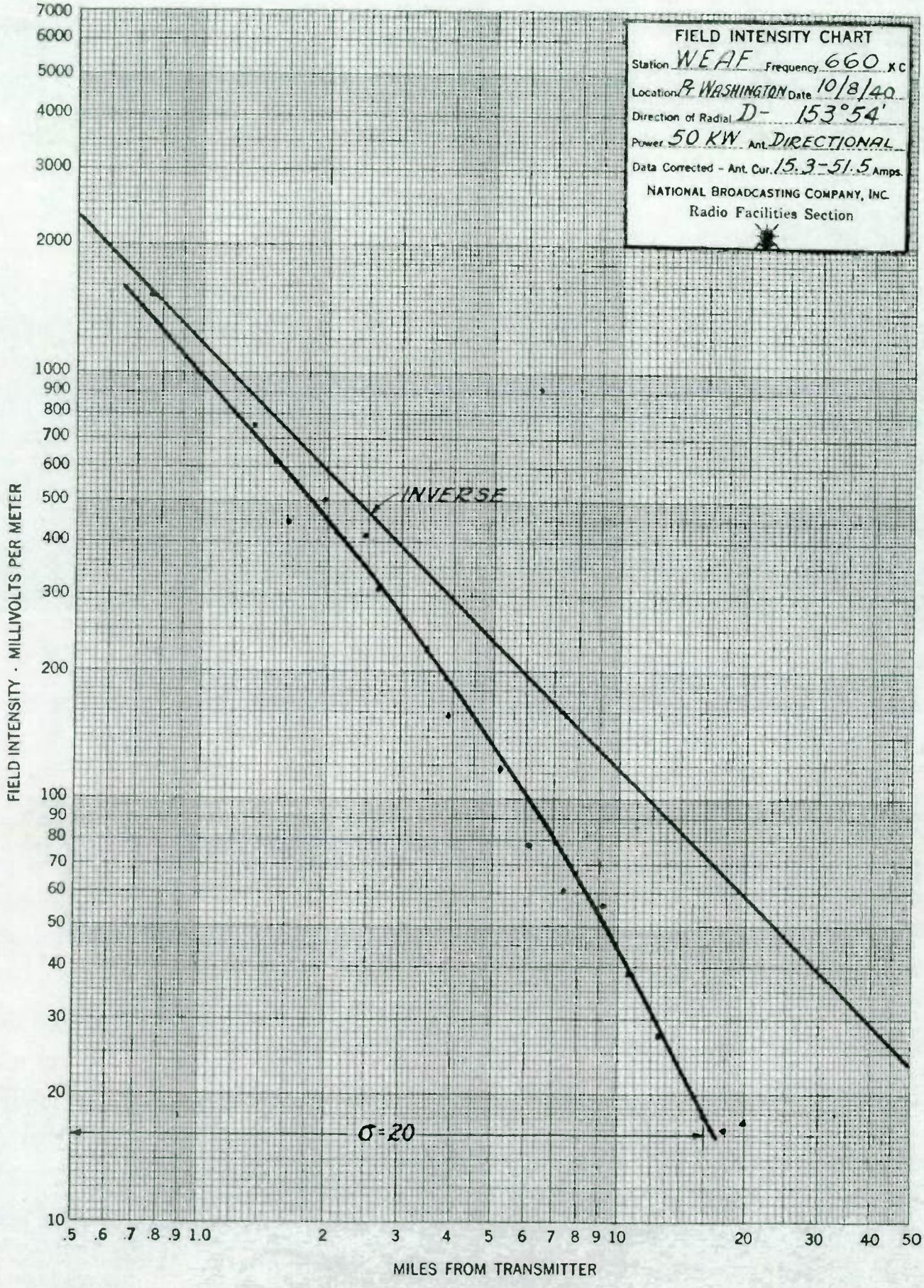
COMPARISON MEASUREMENTS

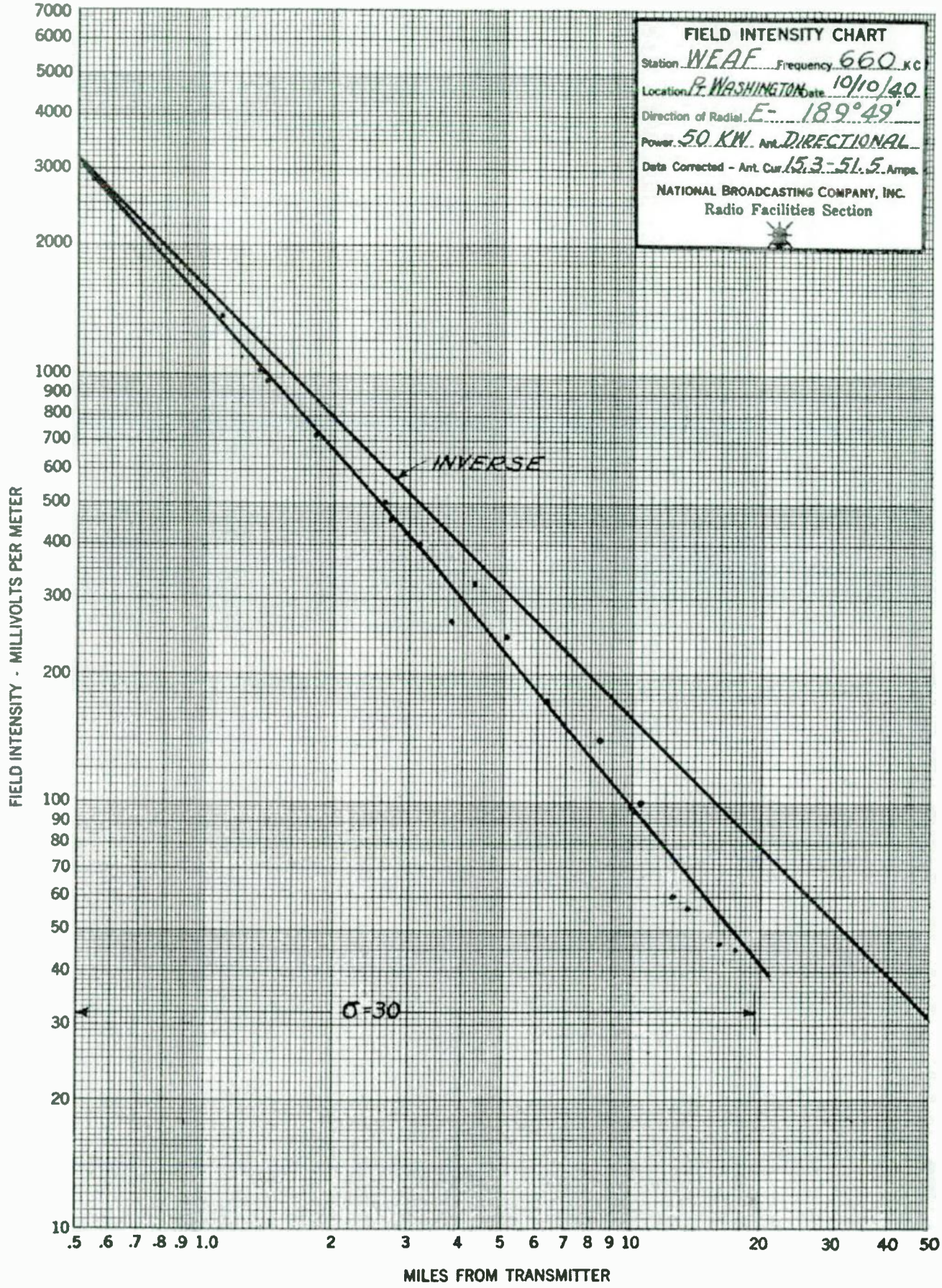
RATIO DIRECTIVE TO NON-DIRECTIVE

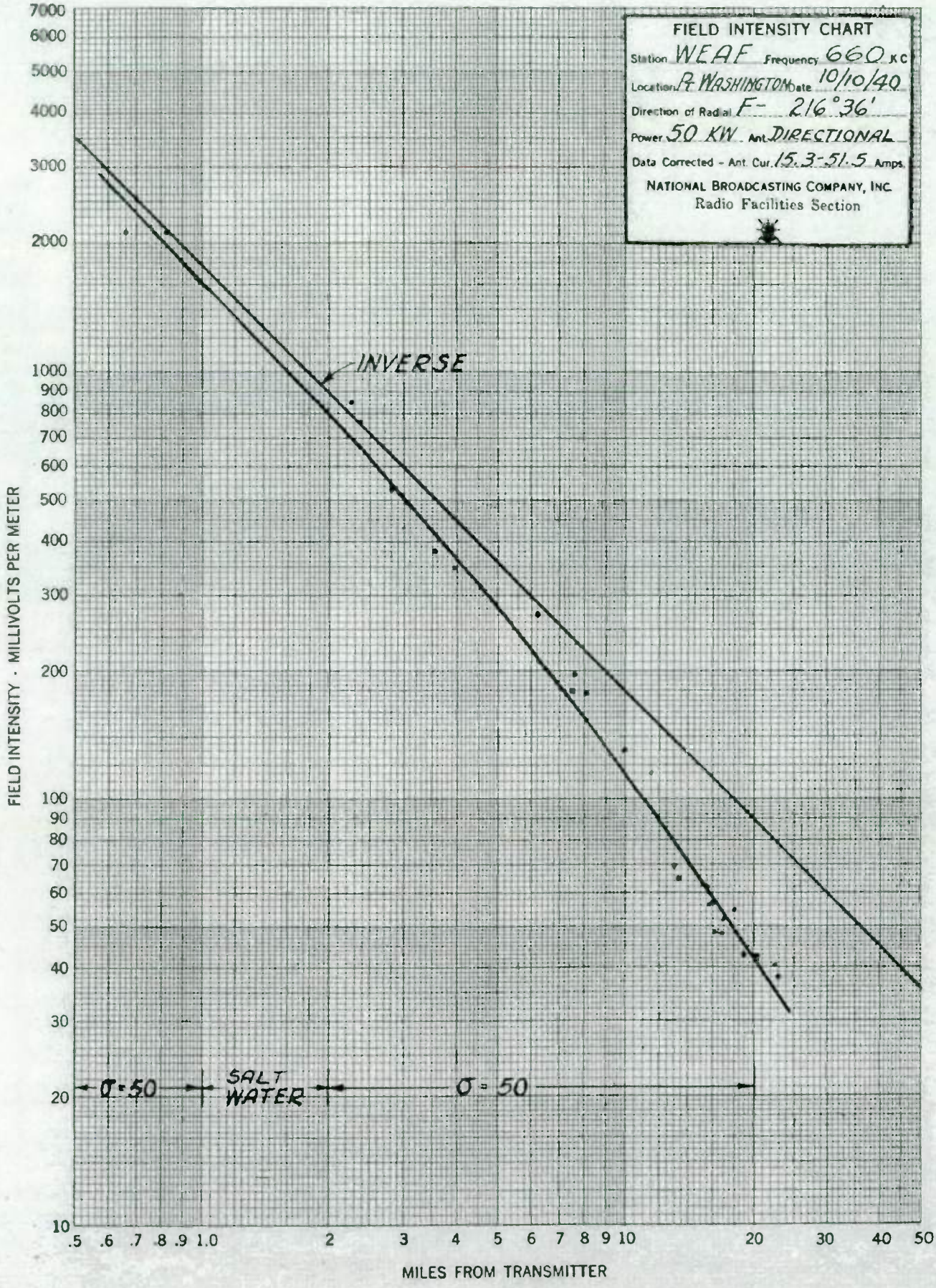


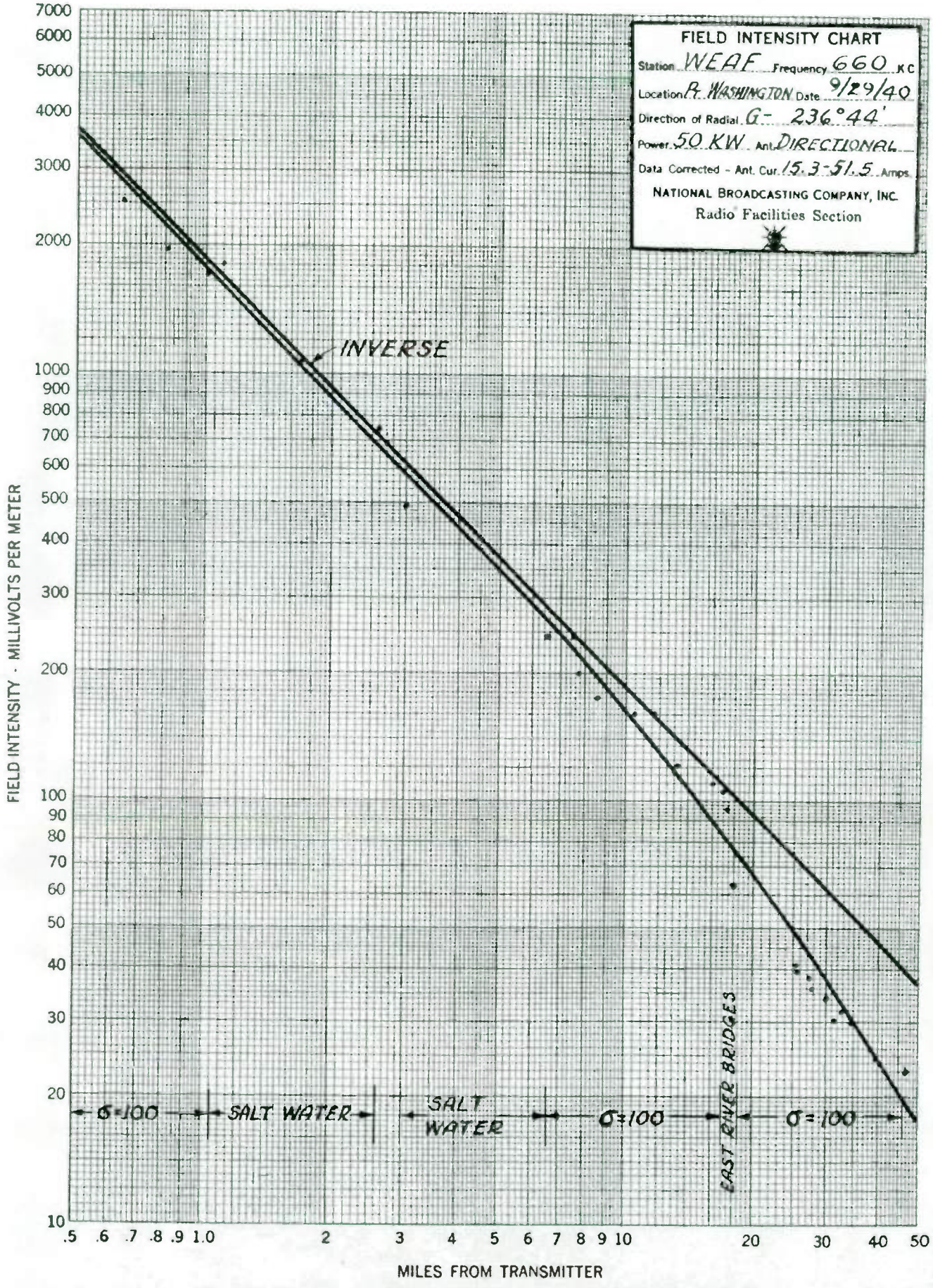


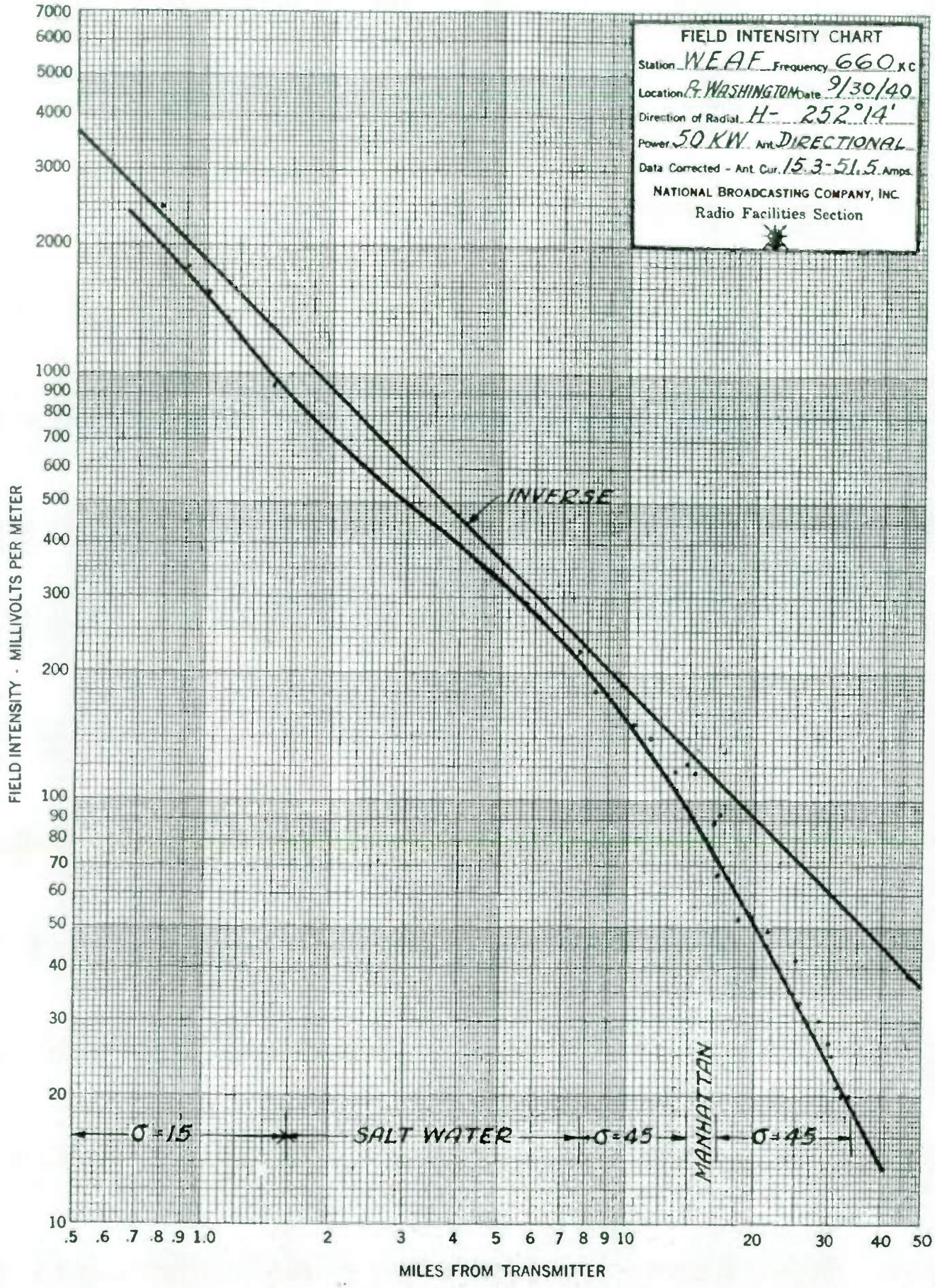


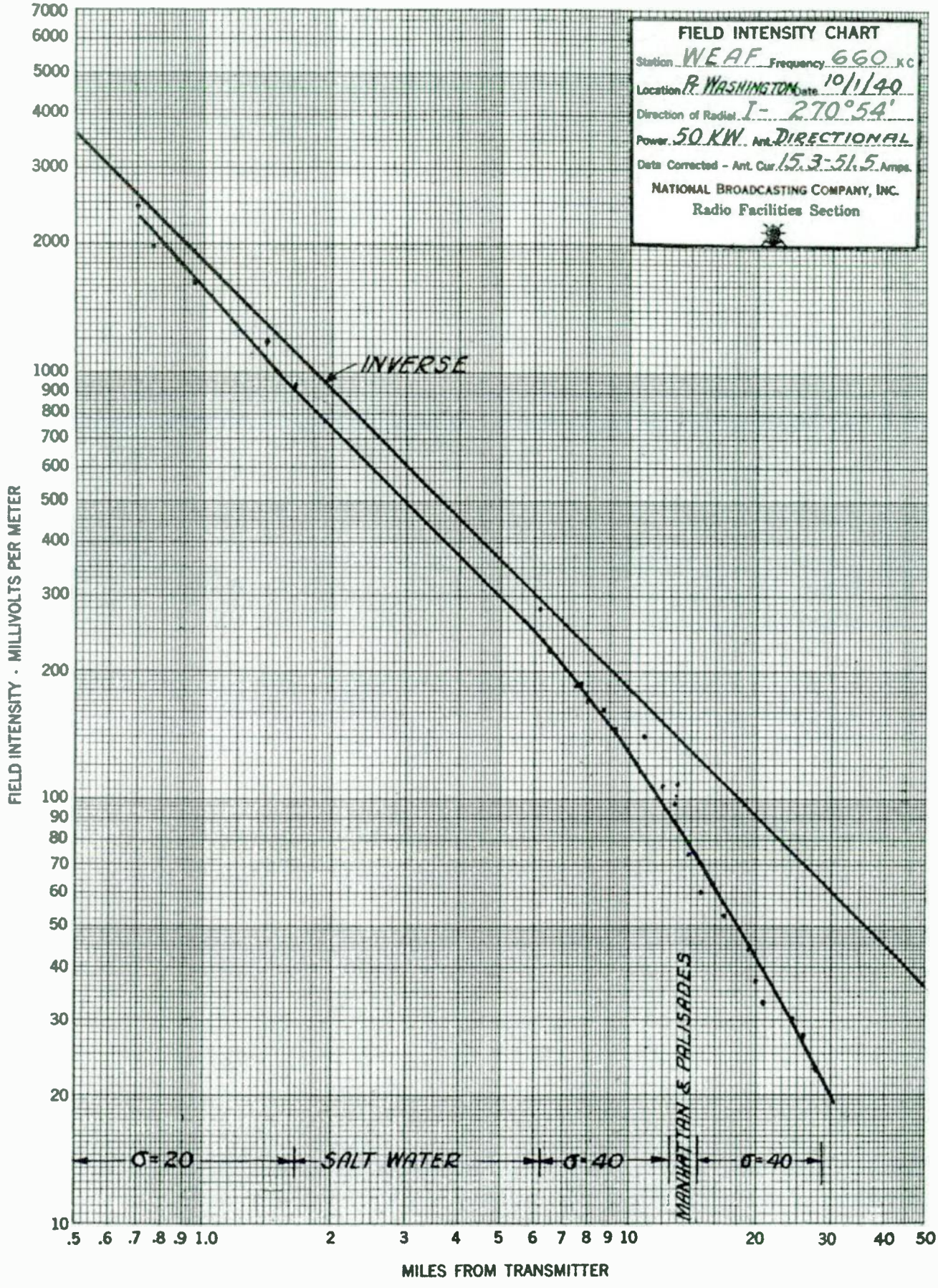


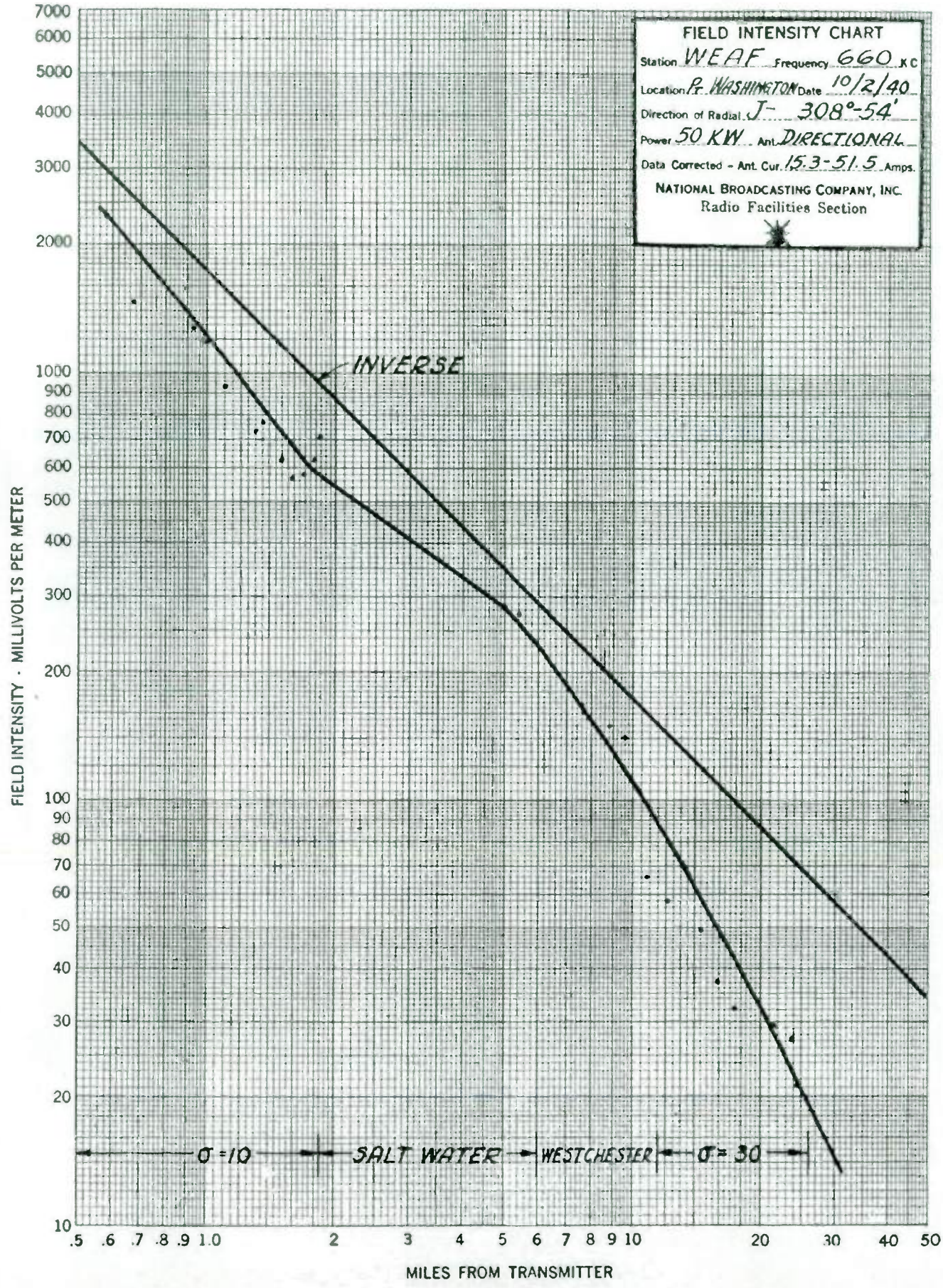


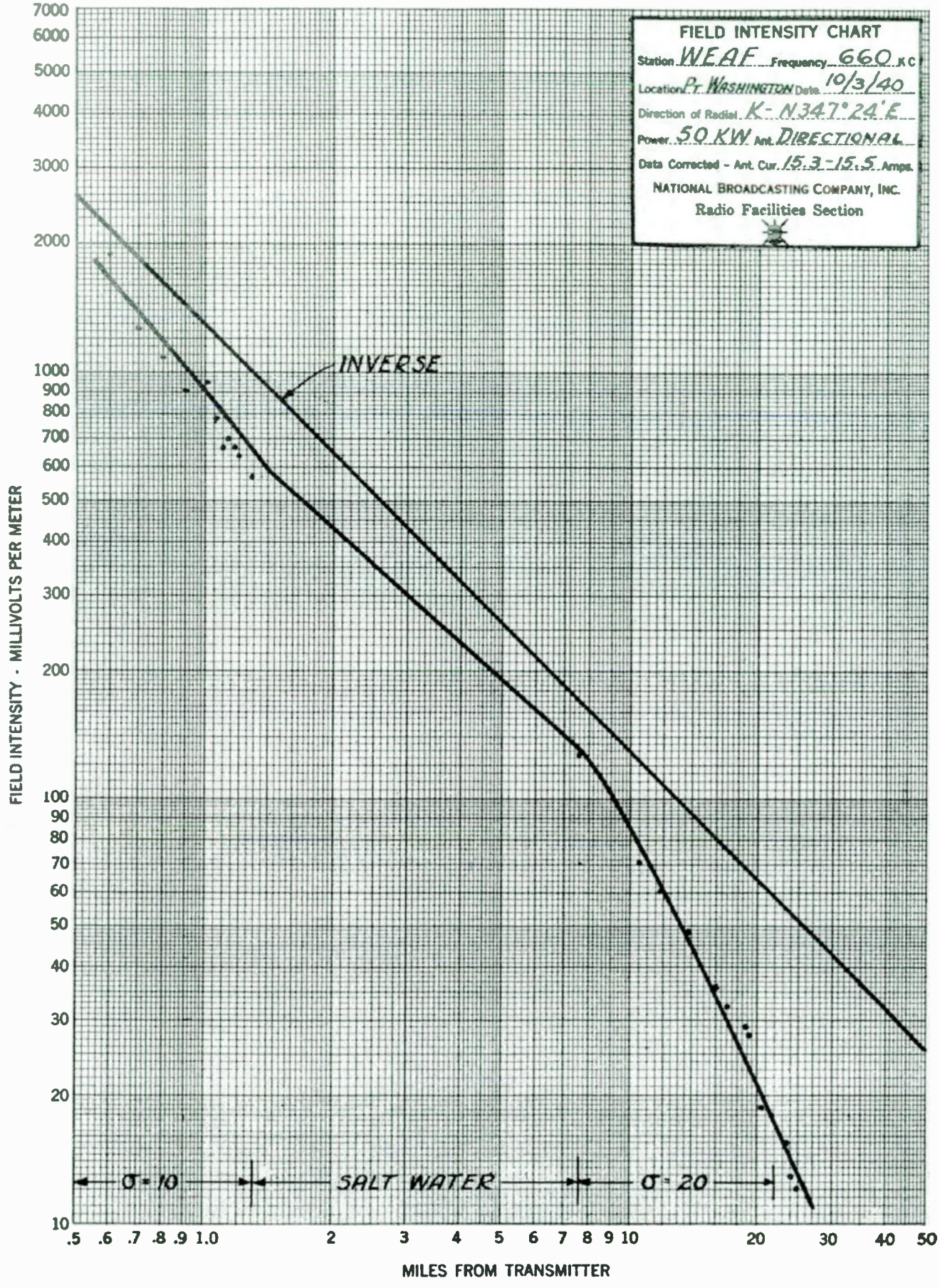


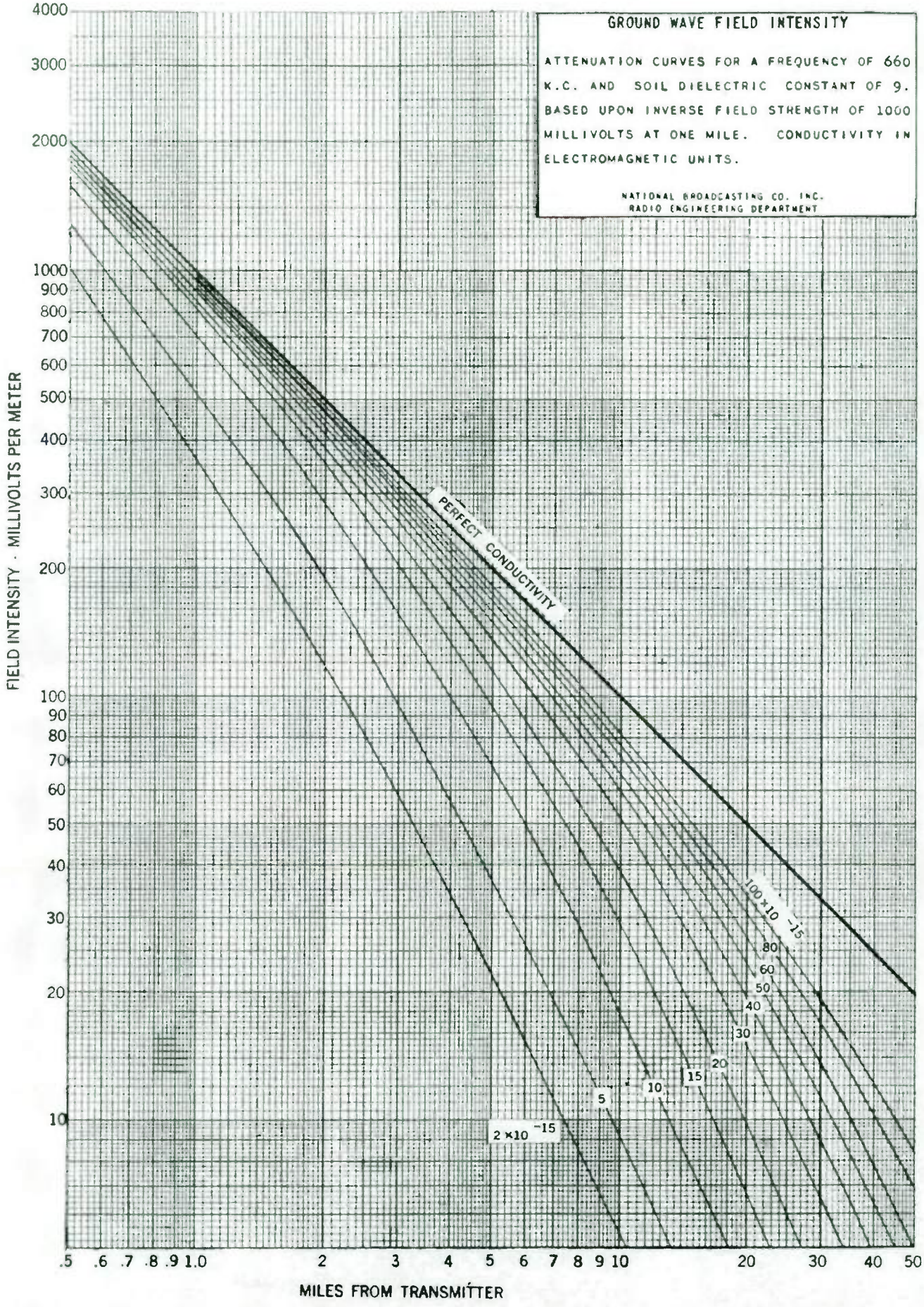




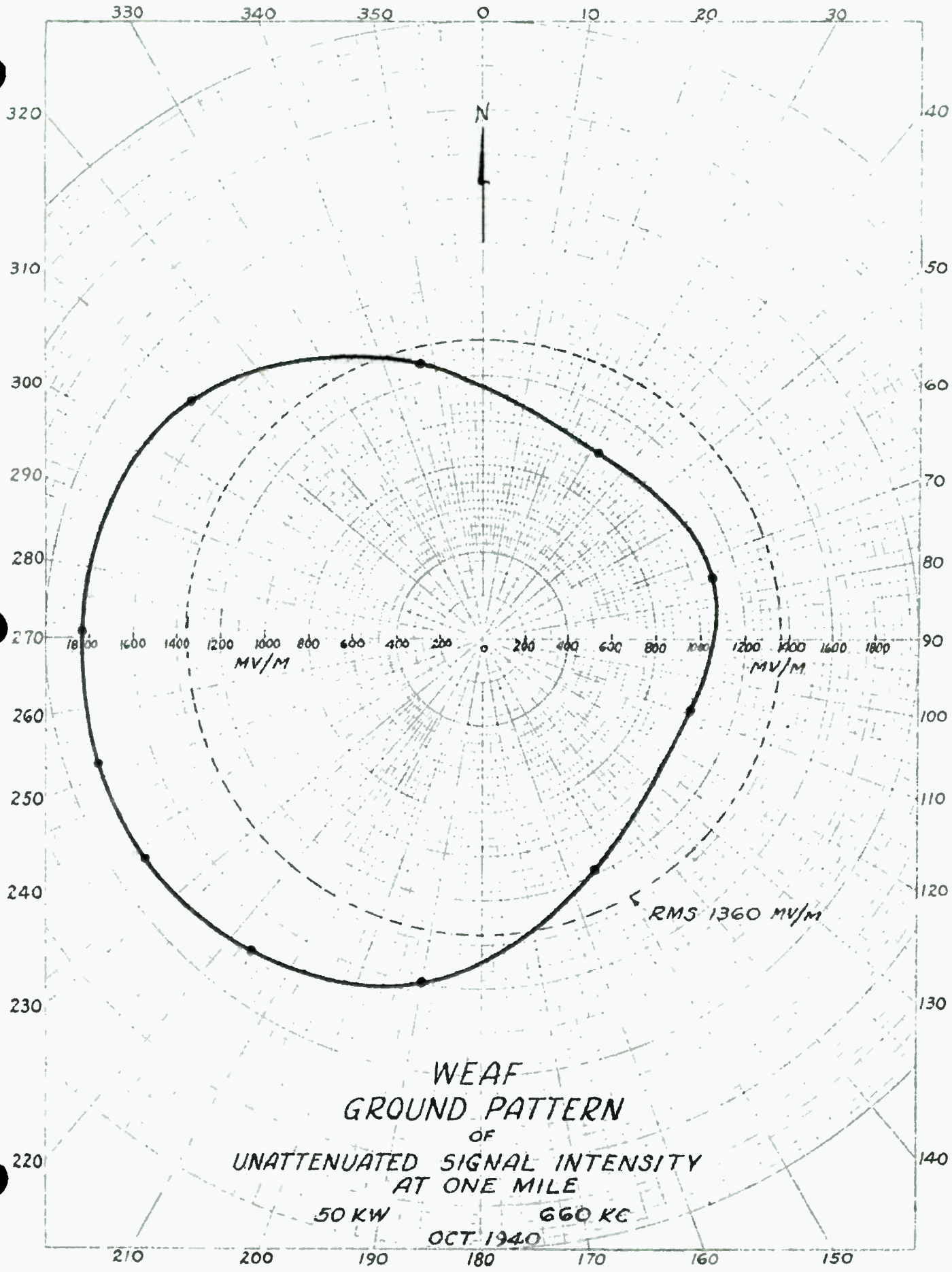








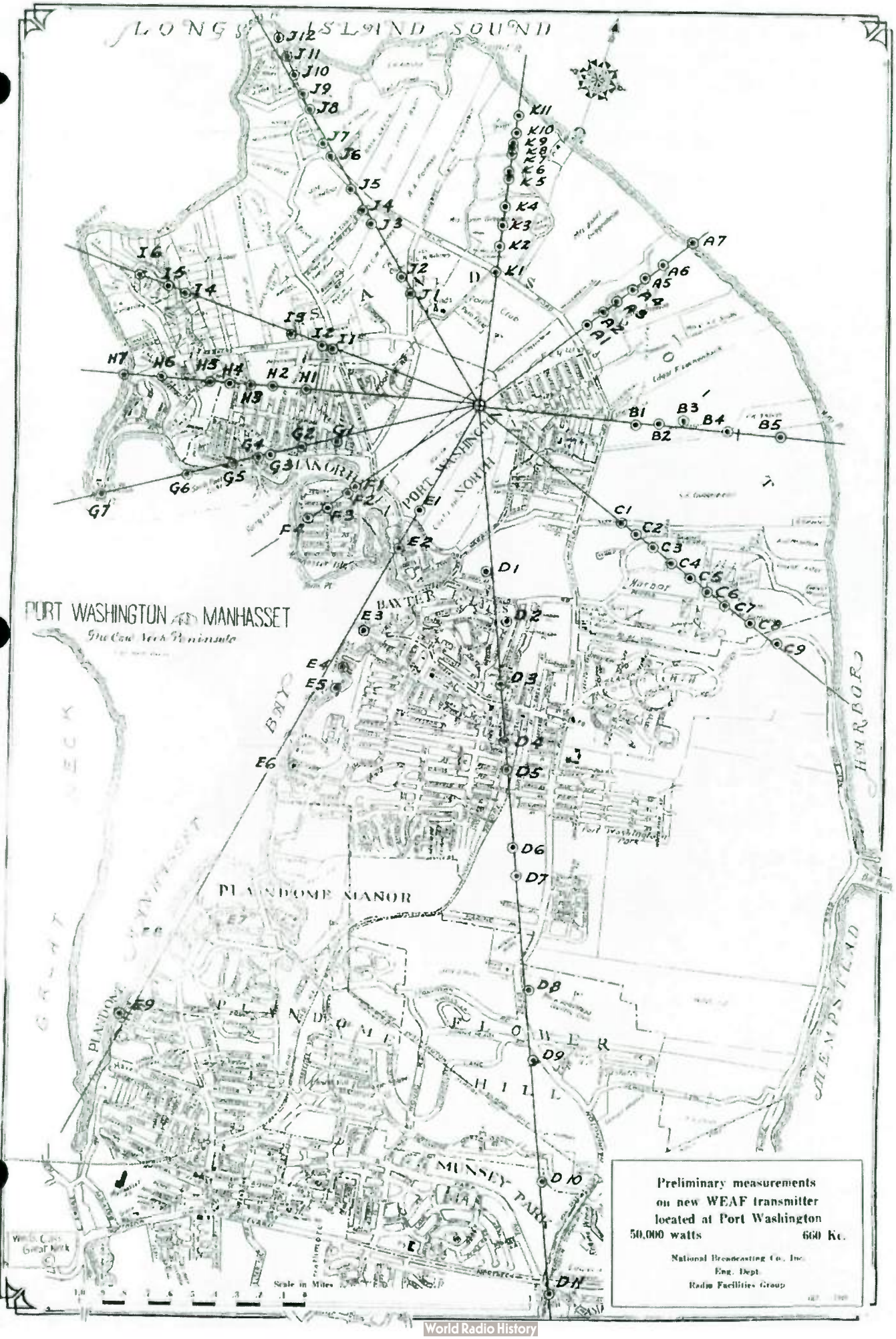
199-R



WEAF
GROUND PATTERN
OF
UNATTENUATED SIGNAL INTENSITY
AT ONE MILE

50 KW 660 KC

OCT 1940



WEAF DIRECTIONAL ANTENNA

COMPLETE DESCRIPTION OF ANTENNA ARRAY

(a) Two elements
(b) Element No. 1 is an insulated, square, tappered and self-supporting, made by Lehigh Structure Steel. Element No. 2 is the same.
(c) Neither tower is top loaded.
(d) Element No. 1 is 315 feet above the base insulator. Element No. 2 is the same.
(e) Element No. 1 is 322 feet above the ground. Element No. 2 is the same.
(f) Element No. 1 is 399 feet above mean sea level. Element No. 2 is the same.
(g) All spacings phasings and bearings are with respect to element No. 1 and are as follows:

Element	Spacing	Phasing	True Bearing
#1	0'-0°	0°	0
#2	400' or 97°	115° leading	N 75° E

(h) The two elements have a radial ground system averaging 600 feet and each composed of 120 radials. The ground system is shown in drawing E4.
(i) The current in element No. 1 is 15.3 amperes and the current in element No. 2 is 51.5 amperes. The specified resistance at the point of common input is 76 ohms and the current is 25.65 amperes.
(j) The schematic wiring diagram is shown on drawing 196R.
(k) -
(l) The painting is in accordance with drawing 195R. The lighting is in accordance with drawing 187R.
(m) A phase monitor is employed. The phase meter indicates line 2 leads line 1 by 233 degrees.

INPUT POWER MEASUREMENTS OF DIRECTIONAL ANTENNA SYSTEM FOR STATION WEAF

In accordance with Section 3.54, the following measurements of resistance and reactance have been made. These measurements were made at the input to the directional antenna system indicated as point A on drawing 196R.

1. Complete Data Taken

Freq KC	C_1	C_2	R	X_a	R_a
685	1029	1130	42.1	+ j20.4	42.1
680	1028	1098	46.9	+ j14.8	46.9
675	1027	1068.5	53.75	+ j8.8	53.75
670	1027	1047	61.4	+ j4.5	61.4
665	1026.5	1035	69.7	+ j2.	69.7
660	1027	1029	80.0	+ j0.6	80.
655	1026	1037	92.5	+ j2.5	92.5
650*	511	1000	26.54	+ j6.4	109.
645*	511	1008	29.8	+ j11	121.
640*	511	1020	32.8	+ j22	130.
635*	510	1040	34.6	+ j43	131.

*For these measurements a capacity of 502 uuf was placed in series with the unknown and the unknown was placed in parallel with C_1 to obtain C_2. The values of resistance and reactance were calculated as follows:

$$R = \frac{R X_1^2}{(X_1 - X_2)^2 + R^2}$$

$$X_a = \frac{X_1\left[X_2(X_1 - X_2) - R^2\right]}{(X_1 - X_2)^2 + R^2}$$

2. Graph drawn

The above data has been plotted and shown on drawing 198R.

3. Method of making measurements

The schematic of the antenna circuit is shown on drawing 196R. The above measurements made at point A at which the input power is determined.

These measurements were made in the manner described in the General Radio instruction book for this bridge and briefly as follows: The initial

reading of the bridge (C-1) was obtained with a fixed mica condenser in series with the unknown and with the unknown shorted. In this case the bridge was balanced by means of a variable condenser and the power factor adjustment. The reading of C-1 is the reading of the variable condenser for balanced condition. The short is then taken off the unknown and the bridge is again balanced by means of variable condenser and the decade box within the bridge. The reading of the variable condenser is designated as C-2 and the reading of the decade resistance is designated as "R". Except as noted on the tabulated data, these readings of "R" are the resistance of the unknown. In the case of the four lower frequency measurements it was necessary to use the indirect method of measurement. In this case a capacity of 502 uuf was placed in series with the unknown. C_1 is then the capacity reading of the bridge with the unknown open. The resistance and reactance for these four cases was calculated from the equations appearing in section 1 with the data.

4. Equipment

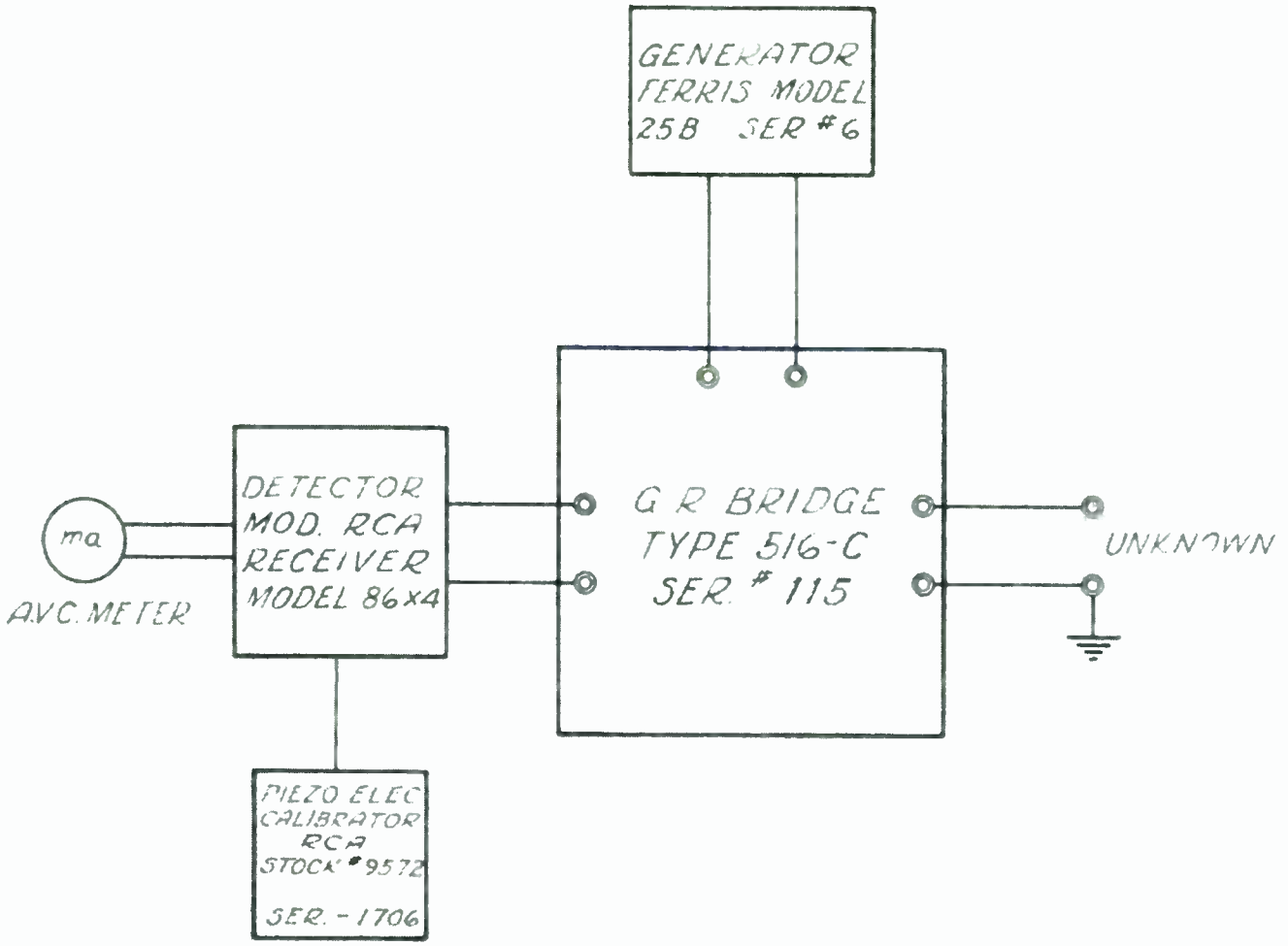
In making these measurements the following equipment was used and is diagramatically shown on drawing 197R.

(a) A General Radio bridge, type 516C, serial 115.
(b) A Ferris signal generator, model 25B, serial #6.
(c) Modified RCA receiver, model 86X4 with an AVC milliameter.
(d) RCA Piezo electric calibrator, stock 9572, serial 1706.

5. Calibration

The General Radio bridge was checked with standard variable condenser and decade box just before making these measurements. The accuracy is within 0.5 percent. The frequency of the signal generator was checked from a crystal of the transmitter and from the Piezo electric calibrator during these measurements. The accuracy is within 100 cycles.

DRAWN PGH DATE 9-24-40 ENGINEER APPROVED	NATIONAL BROADCASTING CO., INC. ENGINEERING DEPARTMENT	DRAWING NO. 197-R



BLOCK DIAGRAM

ANTENNA IMPEDANCE MEASURING EQUIPT.

198-R