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FIELD STRENGTH RECORDINGS HIGH ISLAND ANTENNA

WNBC 660 kc New York, N. Y.

June 3, 1963

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A D RING
HOWARD T HEAD
MARVIN BLUMBERG

City of Washington)
)ss
District of Columbia)

Howard T. Head, being first duly sworn, upon oath deposes and says that he is a consulting radio engineer, a partner in the firm of A. D. Ring & Associates, with offices at 1710 H Street, N. W., Washington, D. C. He is a registered professional engineer (Reg. No. 2521) in the District of Columbia. His qualifications as an engineer are a matter of record with the Federal Communications Commission.

He states that the calculations and exhibits in the accompanying report were made by him personally or under his direction and that all facts contained herein are true of his own knowledge except where stated to be on information or belief, and as to those facts, he believes them to be true.

Howard T. Head
Howard T. Head, Affiant

Subscribed and sworn to before me this 3rd day of June, 1963 .

Elsie Loucks
Notary Public

My Commission expires: March 31, 1968

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TABLE OF CONTENTS

FIELD STRENGTH RECORDINGS FROM HIGH ISLAND ANTENNA

WNBC - 660 kc - New York, New York

June 3, 1963

Table of Contents (Cont'd.)

TELEPHONE
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FIELD STRENGTH RECORDINGS FROM
HIGH ISLAND ANTENNA

WNBC - 660 kc - New York, New York

June 3, 1963

The National Broadcasting Company, Inc., and the Columbia Broadcasting System, Inc., are licensed for the operation of Standard Broadcast Stations WNBC on 660 kc and WCBS on 880 kc in New York City. Both stations are Class I-A clear channel stations licensed to operate with a power of 50 kw, unlimited time. Since early May of this year, these two stations have been in regular operation employing a common radiating system located at High Island, located in Long Island Sound, Borough of the Bronx, New York City. The tower is insulated at the base and has an overall height of 520 feet, 11 inches above the base insulator and 528 feet, 4 1/2 inches above ground level. The structure is sectionalized approximately 432 feet above the base insulator. Top loading is provided by the use of 120-foot sections of the top guy wires which are electrically connected to the tower. Pertinent mechanical and electrical details are shown in Figure 1.

During April of 1963, the services of this firm were retained by NBC and CBS, jointly, to conduct special propagation tests from this radiator at 660 kc. The antenna was loaded with sufficient inductance at the sectionalized insulator to produce minimum radiation in the horizontal plane and a large vertical lobe of energy at an angle on the order of 50° above the horizontal. Skywave field strength recordings were made at distances of approximately 350 and 550 miles from the antenna.

In addition to this mode of operation, the tower was also operated as a conventional radiator with the loading inductor open. This provided an electrical height (employing the lower section only) of approximately 112° above the base insulator. Current distribution measurements were made for both modes of operation, and groundwave field strength measurements were made out to a distance of approximately 15 miles from the antenna in the direction of the field strength recording stations, in accordance with Section 3.186 of the Commission's Rules. This report describes the techniques employed and summarizes the results obtained.

The initial adjustment of the radiating system for operation in the "loaded" mode (i.e., with the loading inductor connected across the sectionalizing insulator) was effected by estimating the amount of inductance required to place the current minimum on the tower at a point expected to produce minimum field in the horizontal plane. An observer with a field strength meter was stationed at a suitable location approximately one mile from the antenna, and the value of the inductance was varied.

It was found that the initial estimate of the inductance required was too high; the inductance was then decreased in successive steps until the field strength measurements indicated that the inductance had been varied through the optimum value. A graph of measured field strength versus inductance was then prepared, and from this graph a refined estimate of the required inductance was made. Also, the initial adjustment had made it apparent that a continuously variable inductor would be needed, and the inductor employed for the original work was replaced by a variable rotary inductor. By means of an RF bridge, this inductor was adjusted to provide the inductance value indicated by the initial tests, and the new inductance system was substituted for the original one. Minor adjustments of the rotary inductor were then made until minimum field strength was obtained at the observer's location.

For the operation of the radiating system in the conventional, or "unloaded," mode, the tuning across the sectionalizing insulator was removed. Switching contactors were installed at both the tower base and the sectionalizing insulator to select the appropriate network to permit automatic switching between the two modes of operation. The 880 kc decoupling networks were left in the circuit. A large indicator light was installed at the sectionalizing insulator to provide positive indication of the position of the contactor at the sectionalizing point.

With power supplied to the radiating system for both modes of operation, field strength measurements were made out to a distance of approximately 15 miles from the antenna. The direction chosen was 271.5° True, which is the direction toward the recording stations. Table I lists these field strength measurements for both modes of operation. Figures 2 and 3 are graphs of field strength versus distance, in which the measurements are analyzed in accordance with the Commission's Rules. Figure 4 is a map showing the locations at which the field strength measurements were made.

Current distribution measurements were then made along the entire length of the tower using a current sampling device supplied by CBS. This instrument was calibrated at 660 kc, by supplying known RF currents to a section of tubing simulating a tower leg. This calibration of the device permitted determination of the actual tower currents for both modes of operation.

Table II lists the current distribution measurements obtained as indicated. The first column in Table II, entitled "Station No.," indicates, by number, a series of current measuring stations established along the tower for the purpose of making current distribution measurements. Measuring Station No. 1 was located 10 feet above the base insulator, and Station No. 2, 8 feet above Station No. 1. Successive stations were spaced by alternating intervals until the tower top was reached. The spacing was chosen to minimize interference from tower connecting flanges and other appurtenances to the tower. Table II lists the height of each measuring station above the base insulator.

The last two columns of Table II list the measured currents at each measuring station for both the loaded and unloaded modes. The values given have been reduced to the equivalent of 1 kw RF input to the base networks, and it has been assumed that the total current flowing past each measuring station is three times the current in a single leg.

Figures 5A and 5B are graphs showing the measured current distributions for both the loaded and the unloaded modes of operation. On Figures 5A and 5B, the smooth curves are the calculated current distribution curves, assuming sinusoidal current distribution and ratio of wave length along the tower to wave length in free space of 0.95. In the case of the loaded mode, the configuration of the top guy wires which contribute top loading must be taken into account. Figure 5B shows both the actual current distribution which would be expected and the "effective" current distribution after subtracting the guy wire component. It will be noted that in both instances the measured current distribution is in quite good agreement with that calculated.

The determination of the current distribution along the tower permits the calculation of the distribution of energy in the vertical plane and the power flow through the hemisphere. If "I" is expressed in amperes and "E" in millivolts per meter, the vertical radiation pattern may be established by integration of the current distribution using the following relationship:

$$E = 0.651 \int_0^G I(z) \cos \theta \cos (z \sin \theta) \, dz \; . \; . \; . \; . \; (1)$$

where

- G = tower height
- z = coordinate along the tower
- $I(z)$ = total current in tower at point z
- θ = angle above the horizon.

The power flow into the hemisphere may be determined using the following relationship: (P = power in kw)

$$P = 4.32 \times 10^{-5} \int_{0}^{\pi/2} E^2 \cos \theta \, d\,\theta \quad . . . . (2)$$

It is convenient to perform these integrations graphically using a polar planimeter. In performing Integration No. 1, it will be noted that for the loaded mode, the integral must be essentially zero for $\theta = 0$. This, in turn, requires that the area under the two branches of the current distribution curve be equal. However, if the lower branch of Figure 5B is considered to extend only from the base insulator to the indicated current node, the lower branch will not include sufficient area to result in radiation cancelling that from the top branch. Since the base insulator is several feet above ground, and since the effective ground plane is probably a short distance below ground level, it is necessary to extend the lower branch of the curve a short distance below the base insulator. This has been done in integrating Figure 5B to produce the required condition for minimum radiation in the loaded mode.

Figures 6A and 6B are polar graphs showing the vertical distribution of radiation for each of the two modes. Figure 6C is a graph in Cartesian coordinates showing a comparison of the radiation distribution in the vertical plane for the two modes of operation. For the loaded mode, two vertical radiation distributions are shown. The solid line shows the calculated distribution (based on the current measurements) assuming an abrupt 180° phase shift at the current node. Since the ground wave field strength measurements (Figure 2) show a small but finite amount of radiation in the horizontal plane, this indicates the presence of small quadrature current component in the tower. For a field in the horizontal plane of 12 mv/m inverse field, at one mile, this would require a quadrature current on the order of 150 ma. This is considerably below the sensitivity of the current measuring instrument. The dashed line in Figure 6C has been arrived at employing the measured value of 12 mv/m inverse field at one mile, assumed to be a quadrature with the vertical radiation produced by the sinusoidal current shown in Figure 5B.

Figure 7 shows the integration of the power flow through the hemisphere for both modes of operation using Equation 2 above. The graph paper shown is special "integrating" graph paper constructed for the purpose of providing power integrations. This integration shows a power flow for the unloaded mode of essentially 1 kw. For the loaded mode, however, the integration shows a power flow into the hemisphere of only 335 watts. This indicates substantial loss between the feed point where the input power was determined and the radiated signal. These sources of loss would include losses in the tuning networks, losses in the loading inductor, and ground losses. Referring to Figure 5B, it will be noted that the base radiation resistance is on the order of 2 ohms. If the customary assumption of 2 ohms ground loss is applied, it will be noted that ground losses alone would be expected to dissipate on the order of one-half of the RF power supplied to the radiating system.

After the tower had been properly adjusted for both modes of operation, skywave field strength recording stations were established at Beaver Falls, Pennsylvania, and Wapakoneta, Ohio. These locations were chosen to provide stations at distances of approximately 350 miles and 550 miles west of High Island along a great circle route providing an essentially constant midpoint latitude (41° north). The Beaver Falls station was established at Conley's Motel, 4 miles north of Beaver Falls, and the Wapakoneta station at the Sundial Motel, approximately 1.6 miles east of Wapakoneta Courthouse. Figure 8 is a portion of a world aeronautical chart showing the relative locations of High Island, Beaver Falls and Wapakoneta. Figures 9 and 10 are sections of topographic maps showing the exact locations of the recording stations. The geographical coordinates of the recording stations were Beaver Falls, North Latitude 40° 48' 42", West Longitude 80° 19' 36"; Wapakoneta, North Latitude 40° 33' 31", West Longitude 84° 10' 03". The calculated distances from High Island are 343 miles to Beaver Falls and 546 miles to Wapakoneta.

After some experimentation, RCA Type WX-2 field strength meters were selected for use at both recording stations. At Beaver Falls, the output of the field strength meter was supplied directly to a one milliampere DC amplifier which was employed to drive an Esterline-Angus recorder. This field strength meter was operated in the logarithmic position. At

Wapakoneta, the IF output of the WX-2 meter was supplied to the input of a meter built by Crosley Radio Corporation, Cincinnati, Ohio. The output of the Crosley meter drove the Esterline-Angus recorder directly. These additional tuned stages of the Crosley instrument supplied the additional adjacent-channel rejection found necessary to exclude WSM, Nashville, Tennessee, on 650 kc and WMAQ, Chicago, Illinois, on 670 kc. The Crosley amplifier incorporated AGC, and supplied 5 ma DC output, which was employed to drive an Esterline-Angus recorder. Since the Crosley amplifier incorporated ample AGC action, the RCA meter was operated in the linear position.

The High Island transmitter was operated with an output power of 3 to 4 kw, alternating between the two modes of operation on a prearranged schedule. Table III lists the schedule which was followed. Transmissions were conducted on nights when the High Island facilities were available.

Field strength recordings were attempted on the following mornings: April 19, 20, 21 and 23, and May 4, 5 and 6, 1963. Because of equipment difficulties at High Island or the recording stations, not all of the recording data were considered valid. All of the data believed to be valid were analyzed for median values for each 13-minute recording interval (see Transmission Schedule, Table III).

Median values were also determined for each two-minute "off" period between transmission in Mode No. 1 and transmission in Mode No. 2. This analysis gives some indication of the atmospheric noise level prevailing for a particular night.

Tables IV-A and IV-B are lists of the median values as determined for each period at each recording station. Table IV-A gives the values of median field strength for the particular power being employed for a given mode on the morning indicated. Table IV-B presents the same data, except that in each instance the received field strengths have been converted to the equivalent of 1 kw radiated from the antenna.

Analysis of Results

The results of the field strength recordings have been analyzed by computing the ratios of median field in the loaded mode to median field strength in the conventional mode for each 13-minute recording interval at each recording station. These computations were made from the listings in Table IV-B. The ratios for each night, as well as the ratios for the entire period, were then ordered and distributions plotted for each recording station. These distributions are shown in Figures 11-A and 11-B for Beaver Falls and Figures 12-A and 12-B for Wapakoneta.

Figure 11-A is a plot of the distribution at Beaver Falls for all of the recording periods. Figure 11-B shows the distributions for the individual nights. It will be noted that these individual distributions fall quite close together. Referring to Figure 11-A, the median ratio of the field strength for the loaded mode to the field strength for the conventional mode is 0.49 and the 10% ratio is 0.85.

Figures 12-A and 12-B show the same data for the Wapakoneta recording station. It will be seen that the ratios are considerably higher for the mornings of April 21 and April 23. Reference to Table IV-A, as well as a study of the original recording tapes, indicates a relatively high level of atmospheric noise on these two mornings. For this reason, two composite curves have been plotted on Figure 12-A, one including data for all five mornings, and the other including data only for the morningsof May 4, May 5, and May 6. Again referring to Table IV-A and the original recording tapes, it will be seen that these mornings, especially the morning of May 6, were characterized by very low atmospheric noise levels. The dashed curve of Figure 12 indicates a median ratio of 0.3 and a 10% ratio of 0.44.

The observed ratios as shown in Figures 11-A and 11-B and 12-A and 12-B have been compared with the ratios which would be calculated employing the propagation curves and procedures contained in the Commission's Standard Broadcast Technical Standards. Figure 6a of Section 3.190 of the Commission's Technical Standards indicates pertinent vertical angles to be employed in calculating median and 10% skywave fields. For a distance of 343 miles (Beaver Falls), a vertical angle of 17.7° is to be employed in calculating median fields, and a range of vertical angles from 13° to 22° is to be employed in calculating 10% fields. For a distance of 546 miles (Wapakoneta), the respective angles are 10°, 7.4° and 12.8°.

These departure angles were laid out on Figure 6C of this report and a determination made of the ratios which should obtain at the recording stations for the departure angles indicated. In making this determination, the dashed curve of Figure 6C was employed. This curve represents the vertical energy distribution believed actually to obtain based on the groundwave field strength measurements for the loaded antenna mode shown in Figure 2. This is discussed more fully in the preceding paragraphs in connection with Figure 6C.

By applying the process just described, the following expected ratios at the two recording stations are calculated:

	Ratios	
Station	Median	10%
Beaver Falls	0.345	0.475
Wapakoneta	0.155	0.205

These values of expected ratio have been plotted on Figures 11-A and 12-A and are joined by a dashed line marked "FCC Prediction." The dot-dash line is drawn parallel to the dash line as the best straight line fit to the actual measured distribution. It will be seen that for all periods of recordings, the measured ratios are significantly higher than the ratios calculated using the Commission's propagation curves and procedures.

This program of recordings permits drawing very definite conclusions with respect to the results that obtained during the short time the work was carried on. It may be a mistake to draw quantitative conclusions applicable to long-time conditions, although the results indicate definitely that large amounts of radiation at high vertical angles produce significantly higher received skywave fields and would cause more interference than would be calculated using the propagation curves and methods contained in the Commission's Rules.

A. D. RING & ASSOCIATES

Howard T. Head

Howard T. Head
Registered Professional Engineer
District of Columbia
Registration No. 2521

June 3, 1963

TABLE I

FIELD STRENGTH MEASUREMENTS

HIGH ISLAND PROPAGATION TESTS

WNBC 660 kc New York, N. Y.

Point	Distance	Field Strength Loaded	Field Strength Unloaded
1A	.23 mi.	47.2 mv/m	.521 v/m
1	.48	43.1	344 mv/m
2	.6	22.6	284.5
3	.69	18.5	269
4	.78	15.1	210
5	.89	11.7	182
2A	.9	7.14	163
6	1.08	8.3	149
7	1.29	6.85	113
8	1.45	6.85	138
9	1.64	5.6	132.5
10	1.9	4.7	107.5
11	2.3	3.46	80
12	2.7	3.58	67.5
3A	2.88	3.24	84
13	3.05	5.6	105
4A	3.31	3.95	104
14	3.65	5.37	99.5
5A	3.94	2.81	70
15	4.22	3.54	---
16	4.6	3.05	60.8
17	5.4	1.63	---
18	6.0	2.1	78
19	6.25	1.9	---
20	6.58	---	32.2
21	7.51	1.42	---
22	7.8	.99	16.5
23	8.95	.81	---
24	9.9	.81	---
25	13.21	.71	---
26	14.49	.57	7.3

TABLE II

CURRENT DISTRIBUTION MEASUREMENTS

HIGH ISLAND PROPAGATION TESTS

WNBC 660 kc New York, N. Y.

Station Number	Height Above Base Insulator: Feet	Height Above Base Insulator: Electrical Degrees for v = 0.95c	Measured Current: Loaded	Measured Current: Unloaded
1	10	2.5	11.1 amps	3.15 amps
2	18	4.6	9.85	3.16
3	28	7.1	9.05	3.09
4	46	11.7	8.65	3.43
5	58	14.7	8.5	3.5
6	76	19.3	8.1	3.7
7	88	22.4	7.8	3.5
8	106	26.9	6.9	3.7
9	118	30.0	6.25	3.75
10	136	34.0	5.8	3.7
11	148	37.6	3.75	3.7
12	166	42.2	3.1	3.7
13	178	45.2	2.2	3.7
14	196	49.8	1.5	3.65
15	208	52.9	---	3.5
16	226	57.4	---	3.4
17	238	60.5	1.15	3.35
18	256	65.1	2.1	3.1
19	268	68.1	3.05	3.0
20	286	72.7	3.9	3.35
21	298	75.8	4.9	2.6
22	316	80.3	---	2.5

TABLE II

(Continued)

Station Number	Height Above Base Insulator: Feet	Height Above Base Insulator: Electrical Degrees for v = 0.95c	Measured Current: Loaded	Measured Current: Unloaded
23	328	83.4	5.95	2.47
24	346	88.0	6.9	2.15
25	358	91.0	7.75	2.0
26	376	95.6	8.3	1.75
27	388	98.6	10.1	1.6
28	406	103.2	10.8	1.35
29	418	106.3	12.25	1.35
30	433	110.1	9.1	1.1
31	443	112.6	12.0	1.1
32	461	117.2	12.0	1.0
33	473	120.2	11.7	1.0
34	491	124.8	10.8	1.0
35	503	127.9	11.7	0.9
36	517	131.4	14.4	1.15

All values reduced to the equivalent of 1 kw into the antenna networks.

TABLE III

OPERATING SCHEDULE

HIGH ISLAND PROPAGATION TESTS

WNBC 660 kc New York, N. Y.

Time (Eastern Time)	Loading Inductor	Carrier	Announcement
12:15 AM - 12:28 AM	Out	Modulated 1500 cps	"Test 1"
12:28 - 12:30		Off	
12:30 - 12:43	In	Modulated 400 cps	"Test 2"
12:43 - 12:45		Off	
12:45 - 12:58	Out	Modulated 1500 cps	"Test 1"
12:58 - 1:00		Off	
1:00 - 1:13	In	Modulated 400 cps	"Test 2"
1:13 - 1:15		Off	
1:15 - 1:28	Out	Modulated 1500 cps	"Test 1"
1:28 - 1:30		Off	
1:30 - 1:43	In	Modulated 400 cps	"Test 2"
1:43 - 1:45		Off	
1:45 - 1:58	Out	Modulated 1500 cps	"Test 1"
1:58 - 2:00		Off	
2:00 - 2:13	In	Modulated 400 cps	"Test 2"
2:13 - 2:15		Off	
2:15 - 2:28	Out	Modulated 1500 cps	"Test 1"
2:28 - 2:30		Off	
2:30 - 2:43	In	Modulated 400 cps	"Test 2"
2:43 - 2:45		Off	
2:45 - 2:58	Out	Modulated 1500 cps	"Test 1"
2:58 - 3:00		Off	
3:00 - 3:13	In	Modulated 400 cps	"Test 2"
3:13 - 3:15		Off	
3:15 - 3:28	Out	Modulated 1500 cps	"Test 1"
3:28 - 3:30		Off	
3:30 - 3:43	In	Modulated 400 cps	"Test 2"
3:43 - 3:45		Off	

TABLE III
(Continued)

Time (Eastern Time)			Loading Inductor	Carrier	Announcement
3:45 AM	-	3:58 AM	Out	Modulated 1500 cps	"Test 1"
3:58	-	4:00		Off	
4:00	-	4:13	In	Modulated 400 cps	"Test 2"
4:13	-	4:15		Off	
4:15	-	4:28	Out	Modulated 1500 cps	"Test 1"
4:28	-	4:30		Off	
4:30	-	4:43	In	Modulated 400 cps	"Test 2"

Modulation level, 20%.

TABLE IV-A

SUMMARY OF FIELD STRENGTH MEASUREMENTS
HIGH ISLAND PROPAGATION TESTS

WNBC 660 kc New York, N. Y.

(ACTUAL MEASURED VALUES)

		April 21, 1963 Median Field (uv/m)		April 23, 1963 Median Field (uv/m)		May 4, 1963 Median Field (uv/m)		May 5, 1963 Median Field (uv/m)		May 6, 1963 Median Field (uv/m)	
Time	Mode	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta
0015-0028	1							155	240	375	110
	OFF								23		12
0030-0043	2							87	28	80	17
	OFF								18		
0045-0058	1			260	235			300	155	355	138
	OFF				105				23		11
0100-0113	2			60	140	100	28	100	26	64	17
	OFF				135				18		10.5
0115-0128	1			190	310	550	110	240	110	285	170
	OFF				105				19		11
0130-0143	2			115	112	94	31	125	28	95	20
	OFF				82		23		19		9.5*
0145-0158	1			260	250	355	200	500	110	302	200
	OFF				120		19.5		20		9.5*
0200-0213	2			135	115	94	23	95	28	47	21
	OFF				80		14.5				9*

TABLE IV-A

Time	Mode	April 21, 1963 Median Field (uv/m)		April 23, 1963 Median Field (uv/m)		May 4, 1963 Median Field (uv/m)		May 5, 1963 Median Field (uv/m)		May 6, 1963 Median Field (uv/m)	
		Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta
0215-0228	1	285		420	230	480	83	700	150	148	150
	OFF				66		14.5		18		12
0230-0243	2	34				135	21	84	28	50	21
	OFF						15.5		17		8.5*
0245-0258	1	390				520	145	238	190	270	119
	OFF						18		17		8.5*
0300-0313	2	102				125	33	91	32	68	18
	OFF						13				
0315-0328	1	520	204			360	250	250	170	195	132
	OFF		46				24		18		8.5*
0330-0343	2	120	59			145	40	95	30	50	13.8
	OFF		43				19.5		14		8*
0345-0358	1	550	215			300	230	590	180	208	57
	OFF		52				24		12		
0400-0413	2	100	59			91	51	88	30	55	11
	OFF		20				18		10		8*
0415-0428	1	400	250			180	200	460	170	195	57
	OFF		29				18		12		8*
0430-0443	2	127	54				23	88	25	80	11.5

TABLE IV-A

Time	Mode	April 21, 1963 Median Field (uv/m)		April 23, 1963 Median Field (uv/m)		May 4, 1963 Median Field (uv/m)		May 5, 1963 Median Field (uv/m)		May 6, 1963 Median Field (uv/m)	
		Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta
50 kw											
1145-1200		2100	750	1150	350	460		610		370	

* Approximate

Mode 1 = conventional

Mode 2 = loaded

TABLE IV-B

SUMMARY OF FIELD STRENGTH MEASUREMENTS
HIGH ISLAND PROPAGATION TESTS

WNBC 660 kc New York, N. Y.

(VALUES REDUCED TO 1 kw RADIATED)

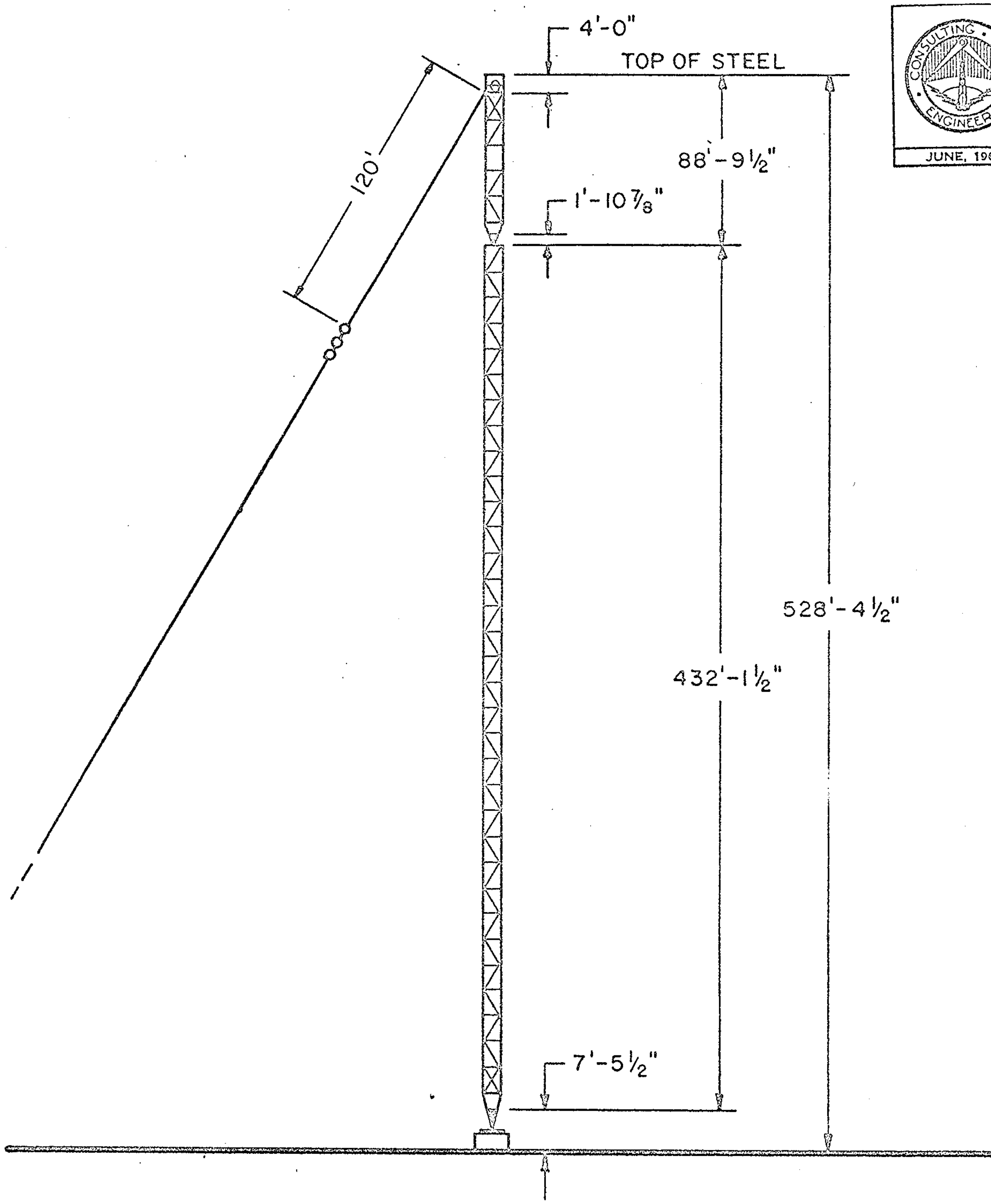
		April 21, 1963 Median Field (uv/m)		April 23, 1963 Median Field (uv/m)		May 4, 1963 Median Field (uv/m)		May 5, 1963 Median Field (uv/m)		May 6, 1963 Median Field (uv/m)	
Time	Mode	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta
0015-0028	1							84.5	131	205	60
0030-0043	2							82	26.4	75.4	16
0045-0058	1			138	125			163.5	85.4	193	75.2
0100-0113	2			49.3	115	90	25.1	94.3	24.5	60.3	16
0115-0128	1			101	165	324	65	131	60	155	92.7
0130-0143	2			96.5	94	86.6	28.6	118	26.4	89.5	18.8
0145-0158	1			140	134.7	194	109	272	60	165	109
0200-0213	2			118.5	101	88.5	21.7	89.5	26.4	44.2	19.8
0215-0228	1			229	125	262	45.2	381	81.6	80.7	81.6
0230-0243	2					127	19.8	79	26.4	47	19.8
0245-0258	1					276	77	130	104	147	65
0300-0313	2					112	29.6	85.8	30.2	64	17
0315-0328	1	290	114			191	133	136	92.7	106	72
0330-0343	2	147	72.5			130	35.9	89.5	29.3	47	13
0345-0358	1	307	120			160	122	322	98	113.5	31

TABLE IV-B
(Continued)

Time	Mode	April 21, 1963 Median Field (uv/m)		April 23, 1963 Median Field (uv/m)		May 4, 1963 Median Field (uv/m)		May 5, 1963 Median Field (uv/m)		May 6, 1963 Median Field (uv/m)	
		Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta	Beaver Falls	Wapa-koneta
0400-0413	2	123	72.5			81.6	45.8	83	29.3	51.8	10.4
0415-0428	1	223	140					251	92.7	106	31
0430-0443	2	156	66.5					83	23.6	75.3	10.8

Mode 1 = conventional

Mode 2 = loaded



CONSULTING RADIO ENGINEERS
JUNE, 1963

NOT DRAWN TO SCALE

Figure 1

SKETCH OF ANTENNA

High Island Propagation Tests

WNBC   660 kc   New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

fa

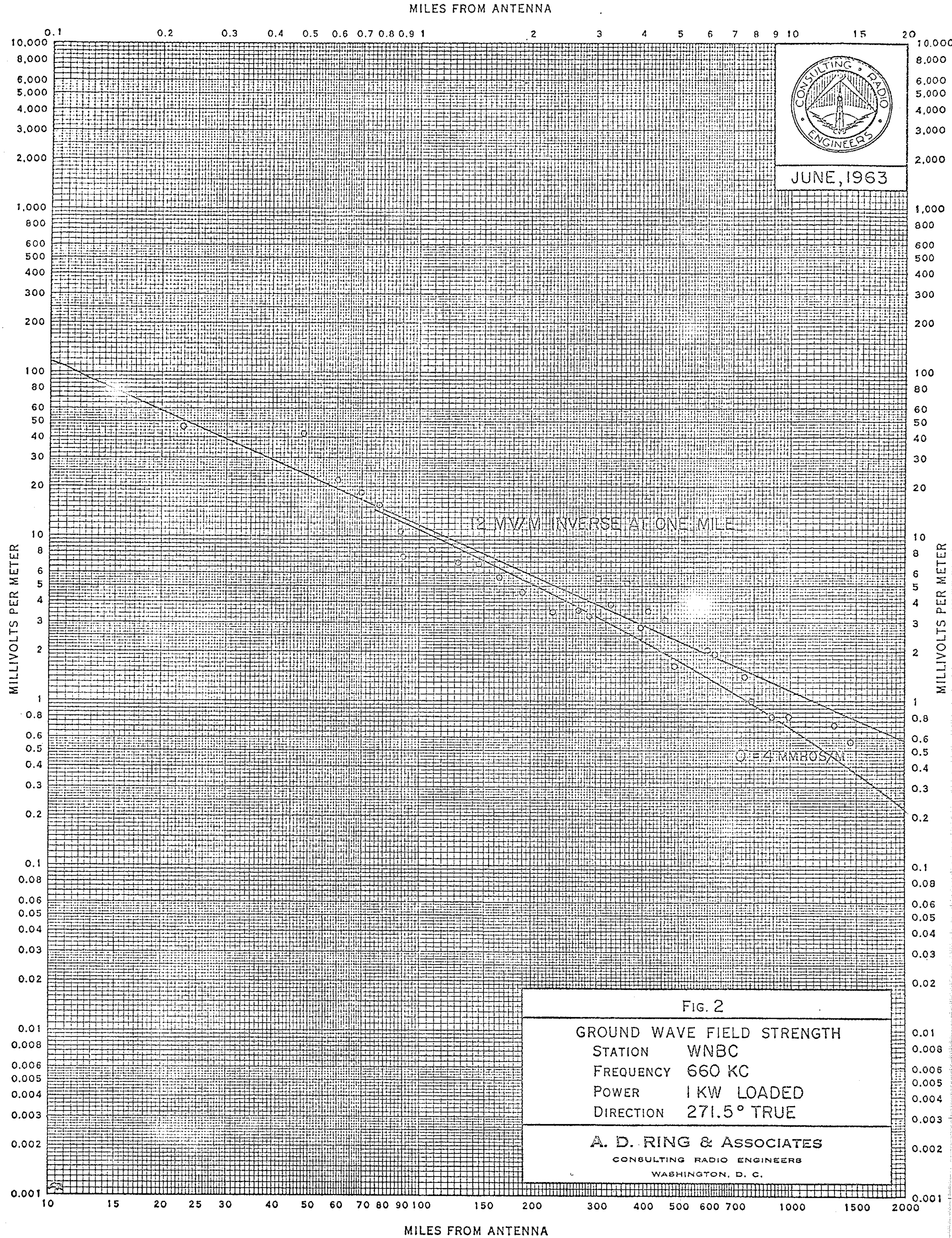


FIG. 2

GROUND WAVE FIELD STRENGTH

STATION WNBC

FREQUENCY 660 KC

POWER 1 KW LOADED

DIRECTION 271.5° TRUE

A. D. RING & ASSOCIATES

CONSULTING RADIO ENGINEERS

WASHINGTON, D. C.

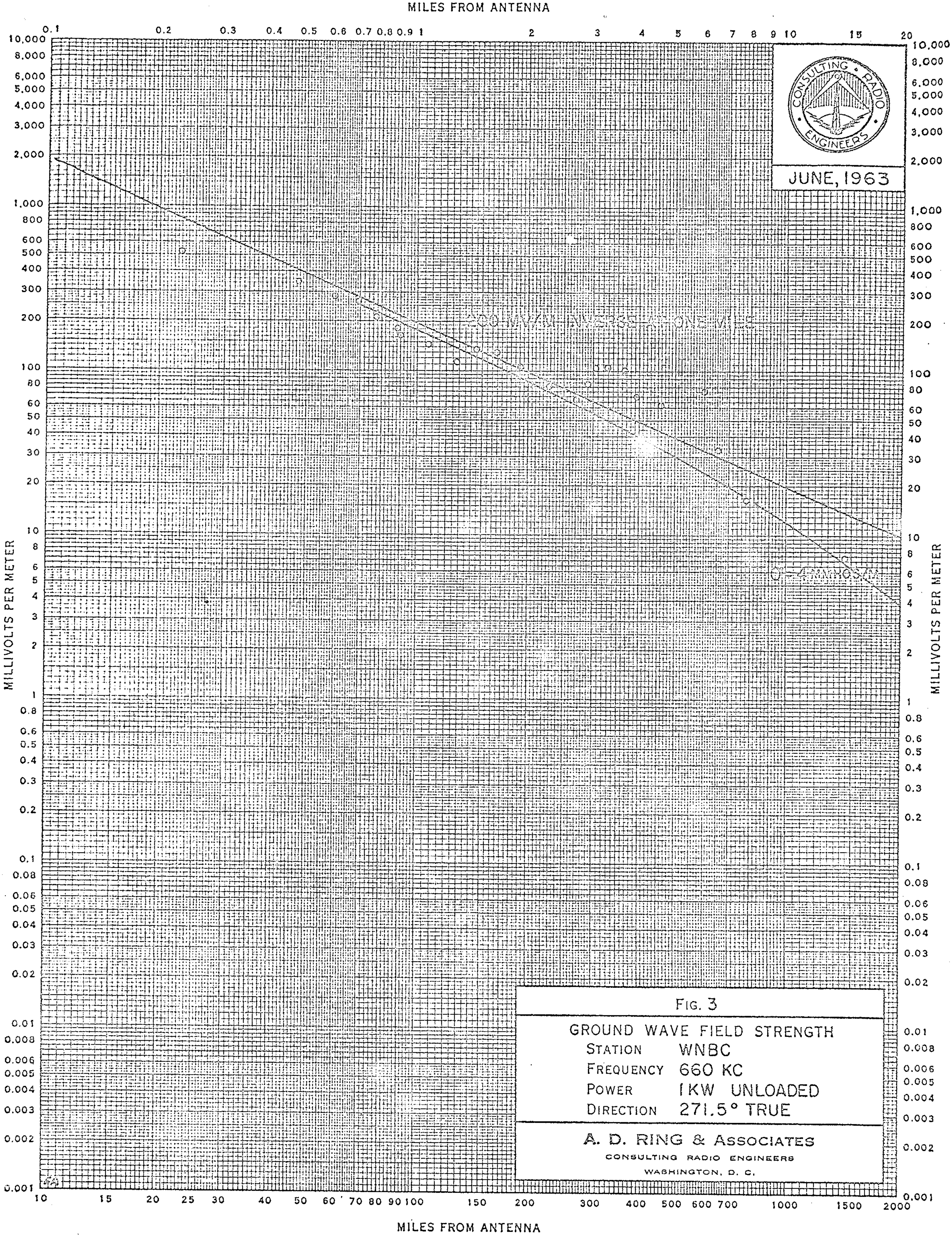


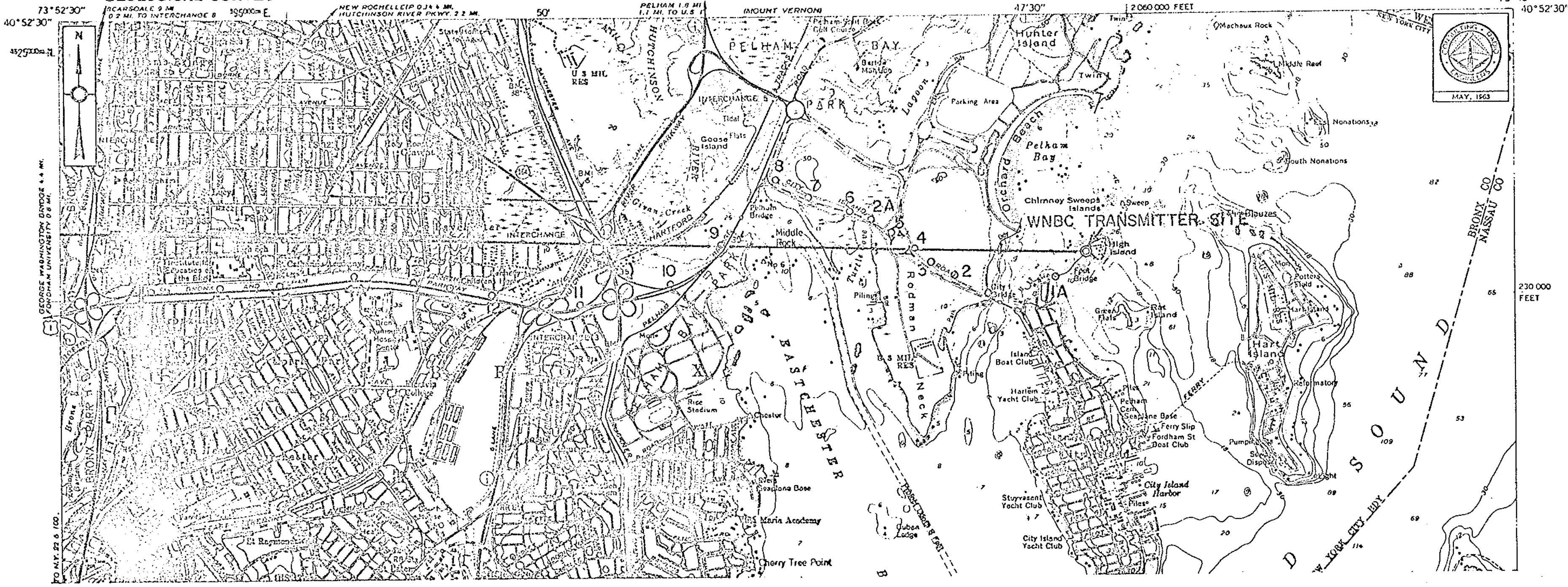
Fig. 3

GROUND WAVE FIELD STRENGTH
STATION WNBC
FREQUENCY 660 KC
POWER 1 KW UNLOADED
DIRECTION 271.5° TRUE

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

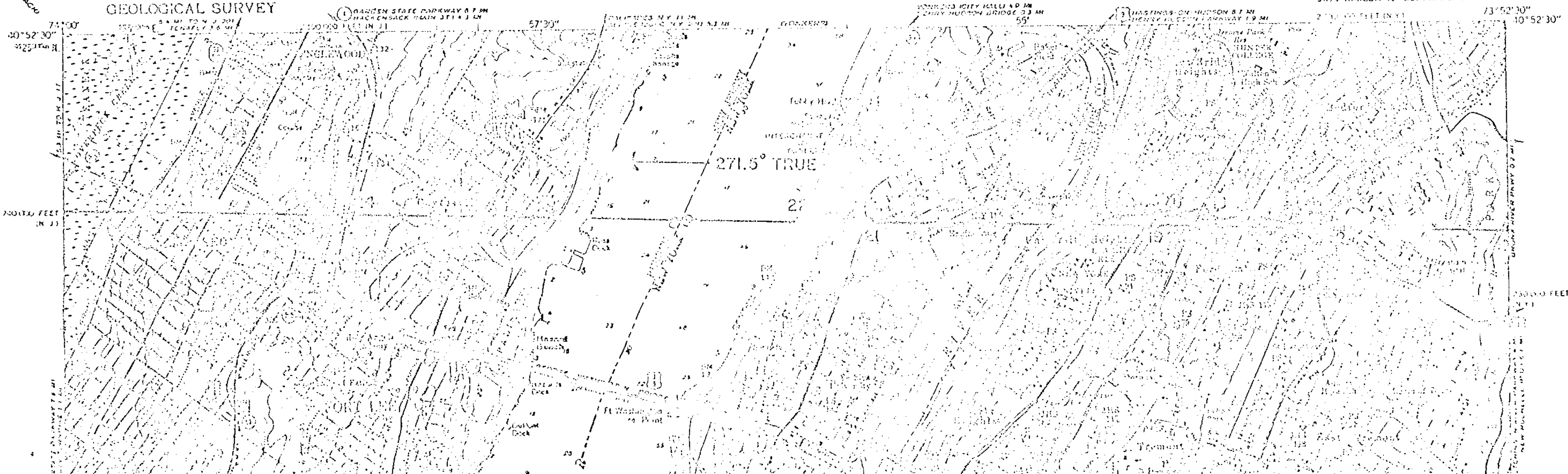
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

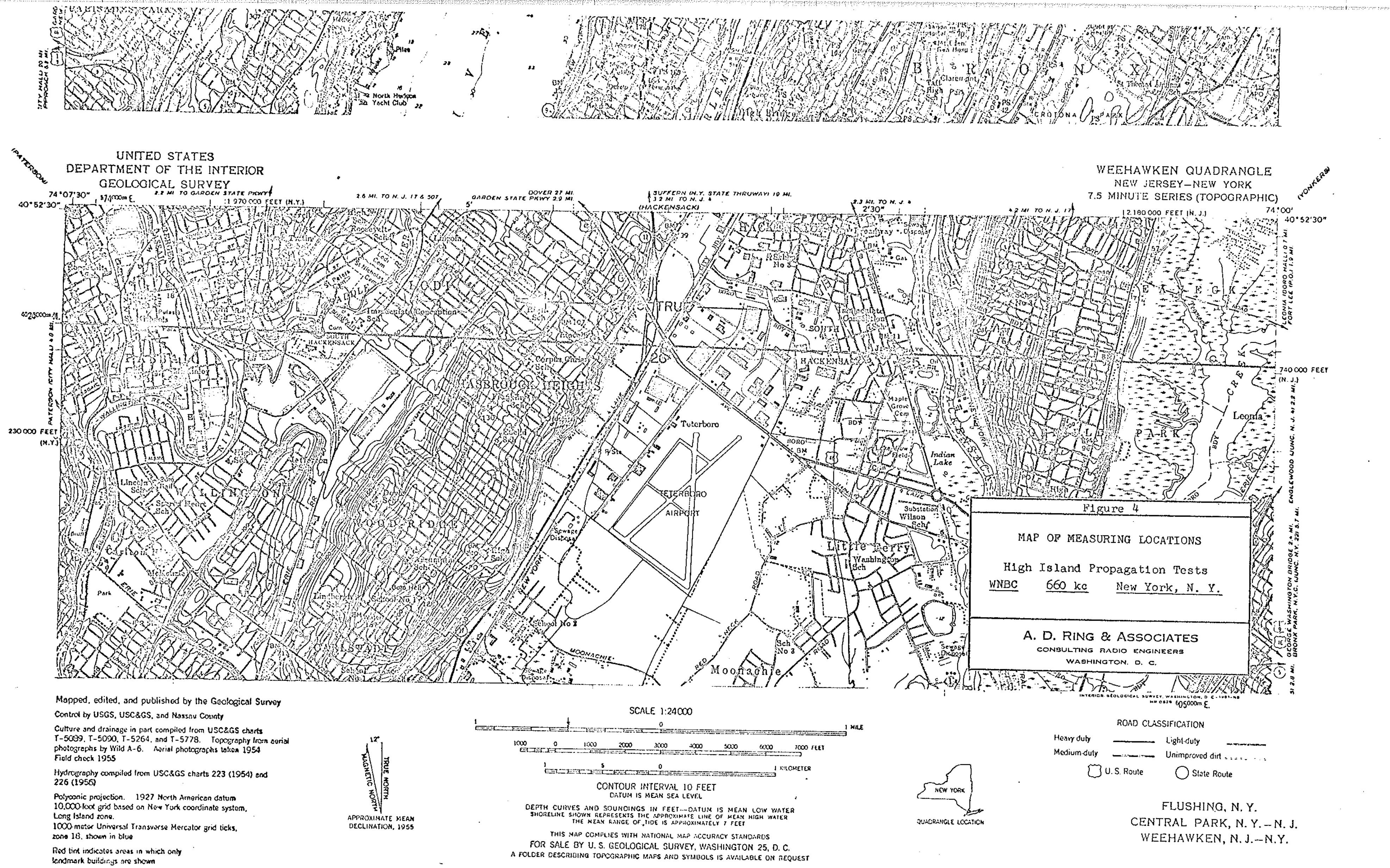
FLUSHING QUADRANGLE
NEW YORK
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 HARLEM 15' QUADRANGLE



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CENTRAL PARK QUADRANGLE
NEW YORK–NEW JERSEY
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 HARLEM 15' QUADRANGLE




UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WEEHAWKEN QUADRANGLE
NEW JERSEY—NEW YORK
7.5 MINUTE SERIES (TOPOGRAPHIC)
(PATERSON)
(YONKERS)
74°07'30"
40°52'30"
74°00'
40°52'30"
2.2 MI. TO GARDEN STATE PKWY
1 970 000 FEET (N.Y.)
2.6 MI. TO N. J. 17 & 507
DOVER 27 MI.
GARDEN STATE PKWY 2.9 MI.
SUFFERN (N.Y. STATE THRUWAY) 19 MI.
3.2 MI. TO N. J. 4
(HACKENSACK)
2.3 MI. TO N. J. 4
2'30"
4.2 MI. TO N. J. 17
12 180 000 FEET (N. J.)
740 000 FEET (N. J.)
230 000 FEET (N.Y.)
PATERSON (CITY HALL) 4.0 MI.
LEONIA (BORO HALL) 0.7 MI.
FORT LEE (P.O.) 1.9 MI.
ENGLEWOOD (JUNC. N. J. 4) 2.2 MI.
GEORGE WASHINGTON BRIDGE 2.4 MI.
BRONX PARK, N.Y.C. (JUNC. N.Y. 22) 5.7 MI.
North Hudson Yacht Club
Clarement
High Pa
CROTONA PARK
LODI
SOUTH HACKENSACK
Immaculate Conception
HASBROUCK HEIGHTS
Corpus Christi Sch
WOOD-RIDGE
Teterboro
TETERBORO AIRPORT
SOUTH HACKENSACK
Maple Grove Cem
Indian Lake
Leonia
PARK
Little Ferry
Washington Sch
Wilson Sch
Moonachie
MOONACHIE
NEW YORK
ERIE
School No 2
Lincoln Sch
Sacred Heart Sch
Jefferson
Lindbergh Sch
Park
Figure 4
MAP OF MEASURING LOCATIONS
High Island Propagation Tests
WNBC 660 kc New York, N. Y.
A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.
Mapped, edited, and published by the Geological Survey
Control by USGS, USC&GS, and Nassau County
Culture and drainage in part compiled from USC&GS charts T-5089, T-5090, T-5264, and T-5778. Topography from aerial photographs by Wild A-6. Aerial photographs taken 1954
Field check 1955
Hydrography compiled from USC&GS charts 223 (1954) and 226 (1956)
Polyconic projection. 1927 North American datum
10,000-foot grid based on New York coordinate system, Long Island zone.
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
Red tint indicates areas in which only landmark buildings are shown
TRUE NORTH
MAGNETIC NORTH
12°
APPROXIMATE MEAN DECLINATION, 1955
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 7 FEET
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
NEW YORK
QUADRANGLE LOCATION
ROAD CLASSIFICATION
Heavy duty
Light-duty
Medium-duty
Unimproved dirt
U. S. Route
State Route
FLUSHING, N. Y.
CENTRAL PARK, N. Y.—N. J.
WEEHAWKEN, N. J.—N.Y.

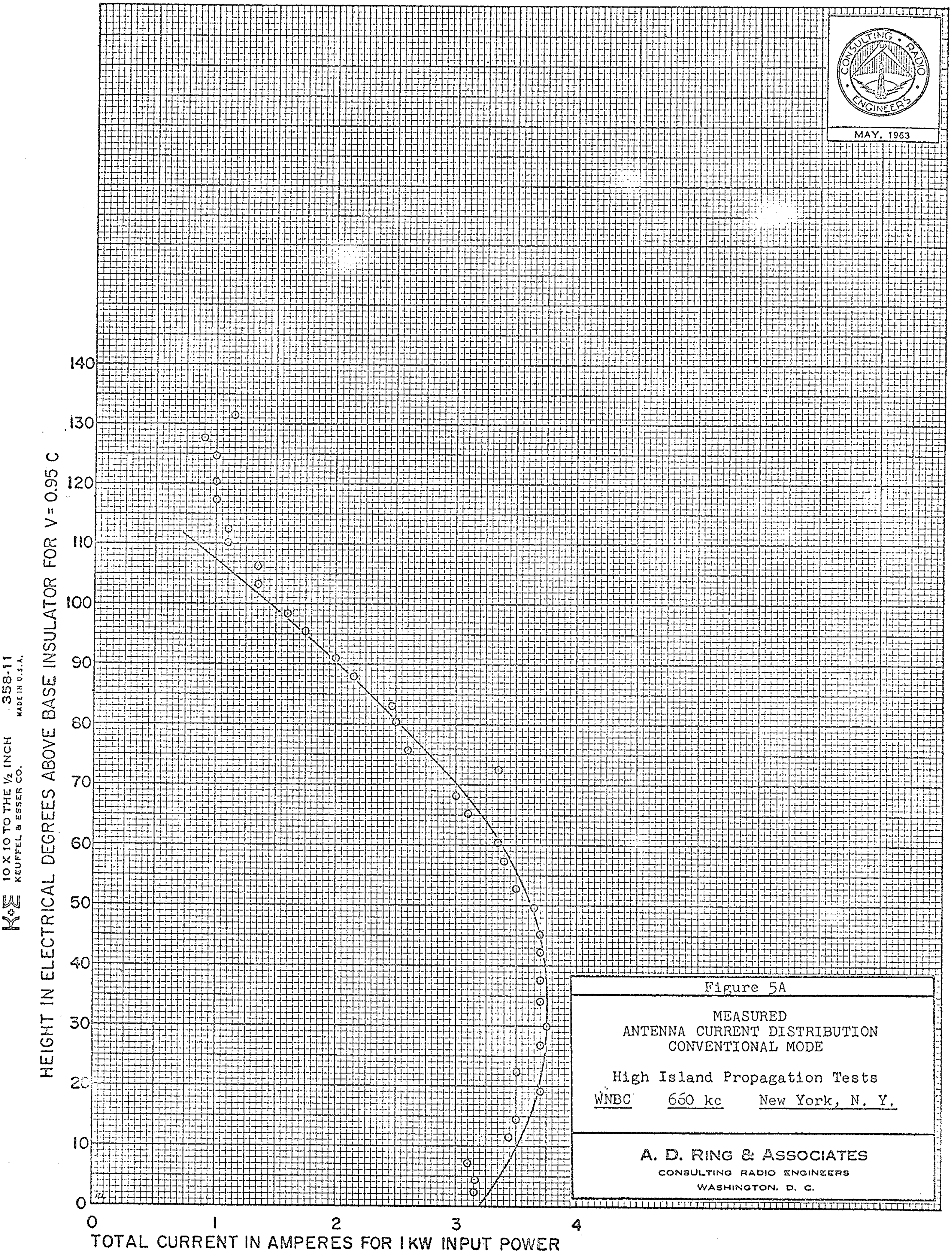


Figure 5A

MEASURED
ANTENNA CURRENT DISTRIBUTION
CONVENTIONAL MODE

High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

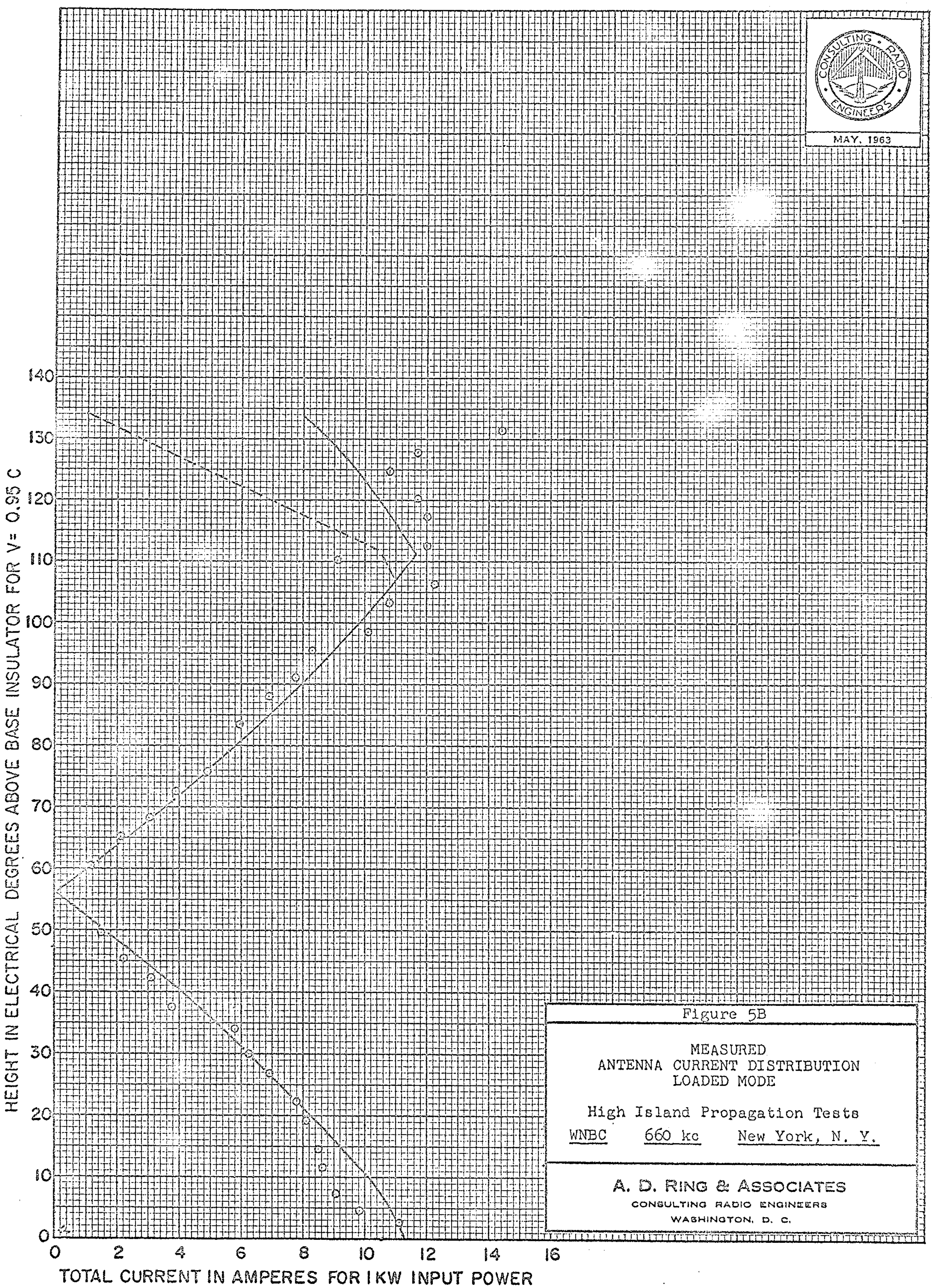


Figure 5B

MEASURED
ANTENNA CURRENT DISTRIBUTION
LOADED MODE

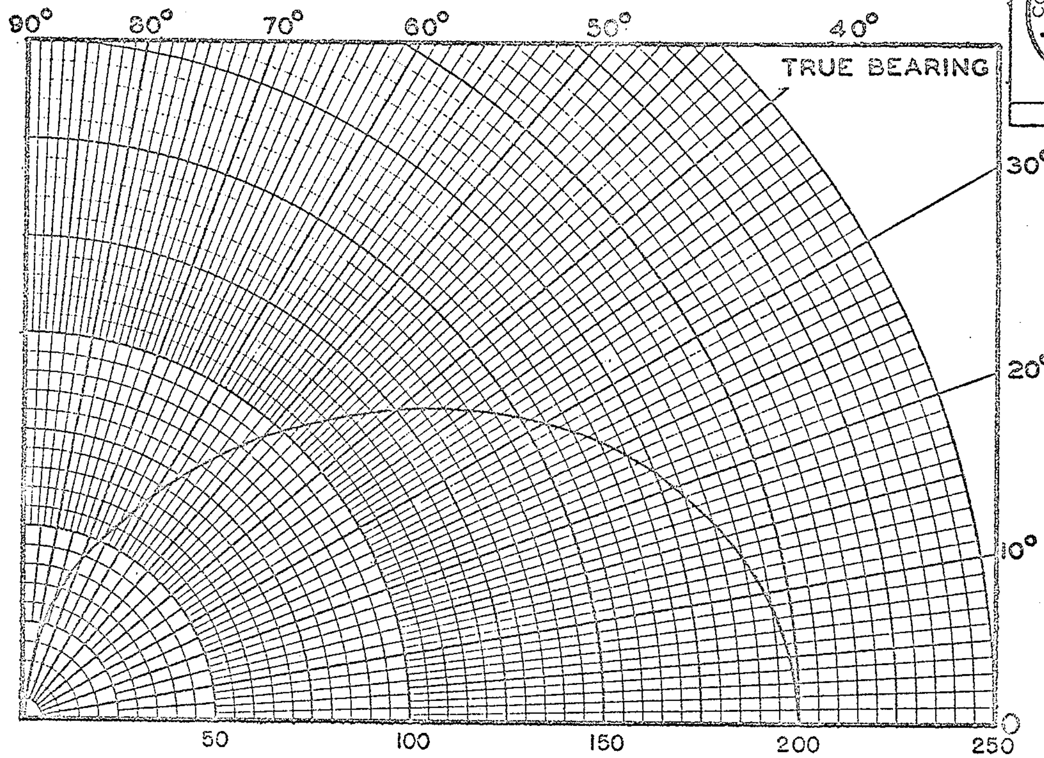
High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

VERTICAL PLANE PATTERNS

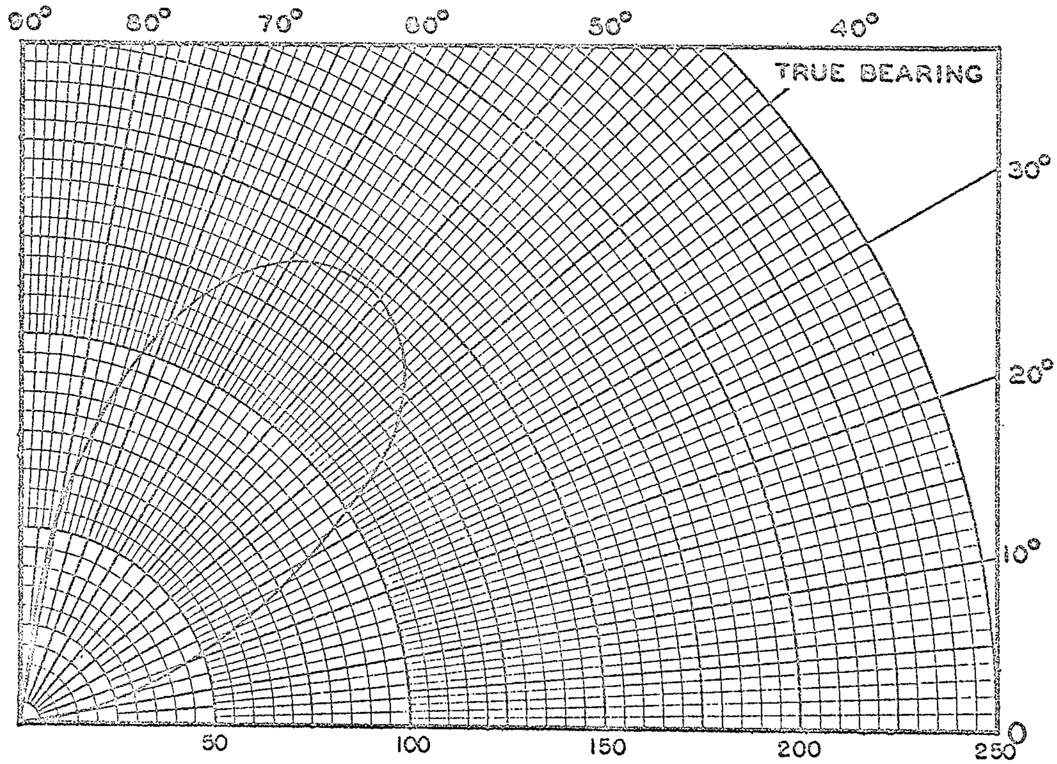
CONSULTING RADIO ENGINEERS
JUNE, 1963



CONVENTIONAL MODE
I KW INPUT POWER.

MV/M

FIGURE 6A



LOADED MODE
I KW INPUT POWER.

MV/M

FIGURE 6B

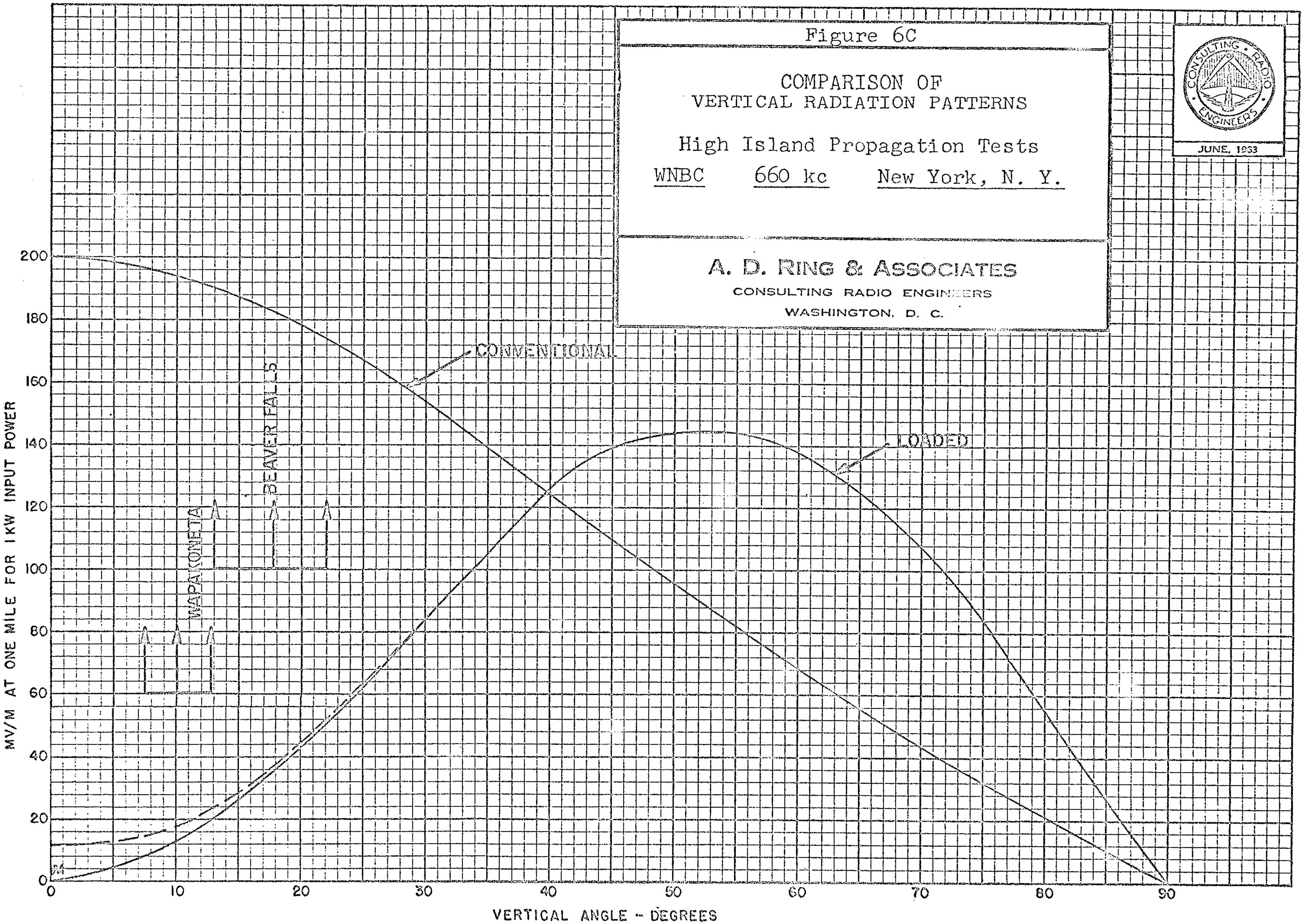


Figure 6C
COMPARISON OF
VERTICAL RADIATION PATTERNS
High Island Propagation Tests
WNBC 660 kc New York, N. Y.
A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.
CONSULTING RADIO ENGINEERS
JUNE, 1953
CONVENTIONAL
LOADED
BEAVER FALLS
WAPAKONETA
MV/M AT ONE MILE FOR 1 KW INPUT POWER
VERTICAL ANGLE - DEGREES

$$P = 4.32 \times 10^{-5} \int E^2 \cos\theta \, d\theta$$

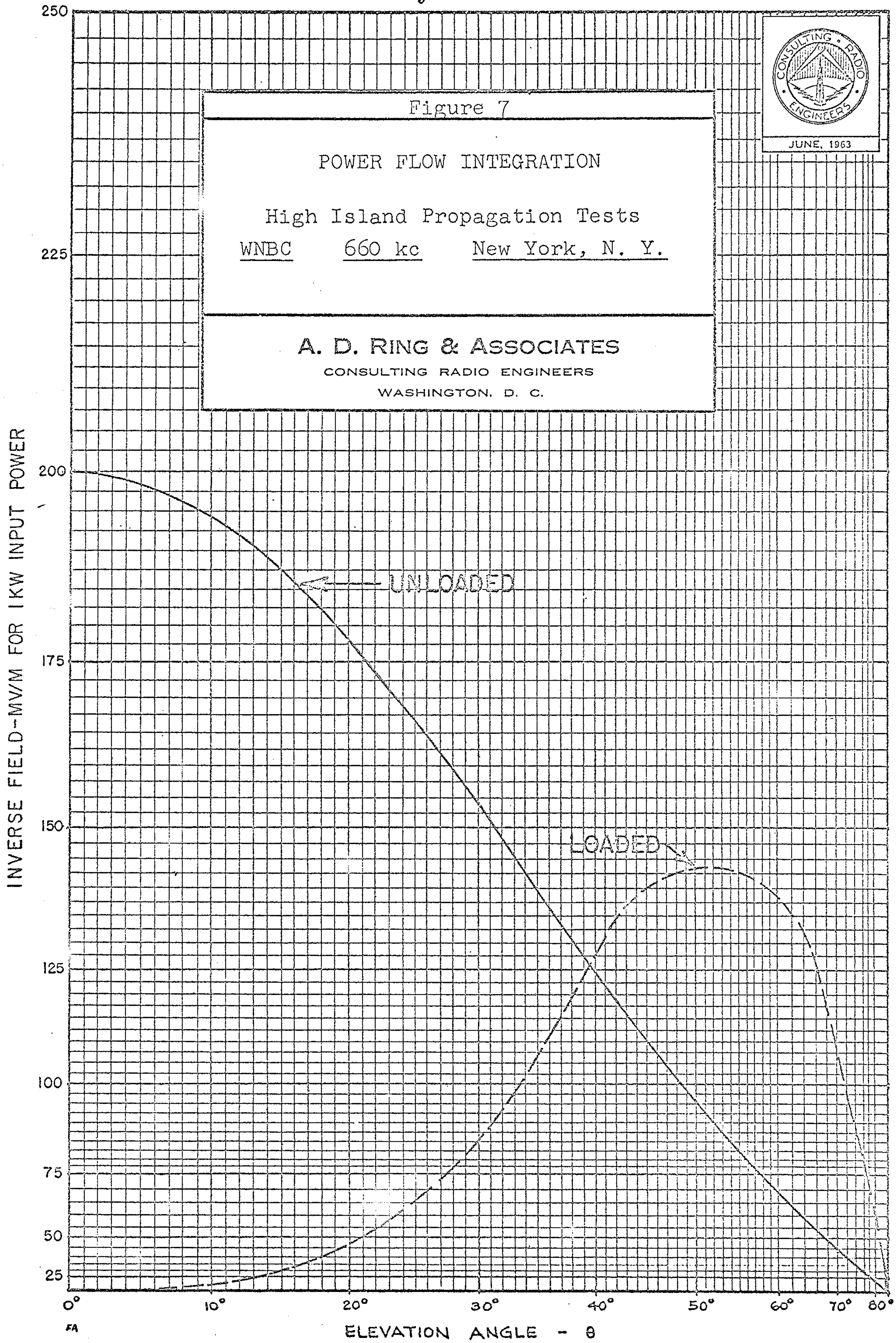


Figure 7

POWER FLOW INTEGRATION

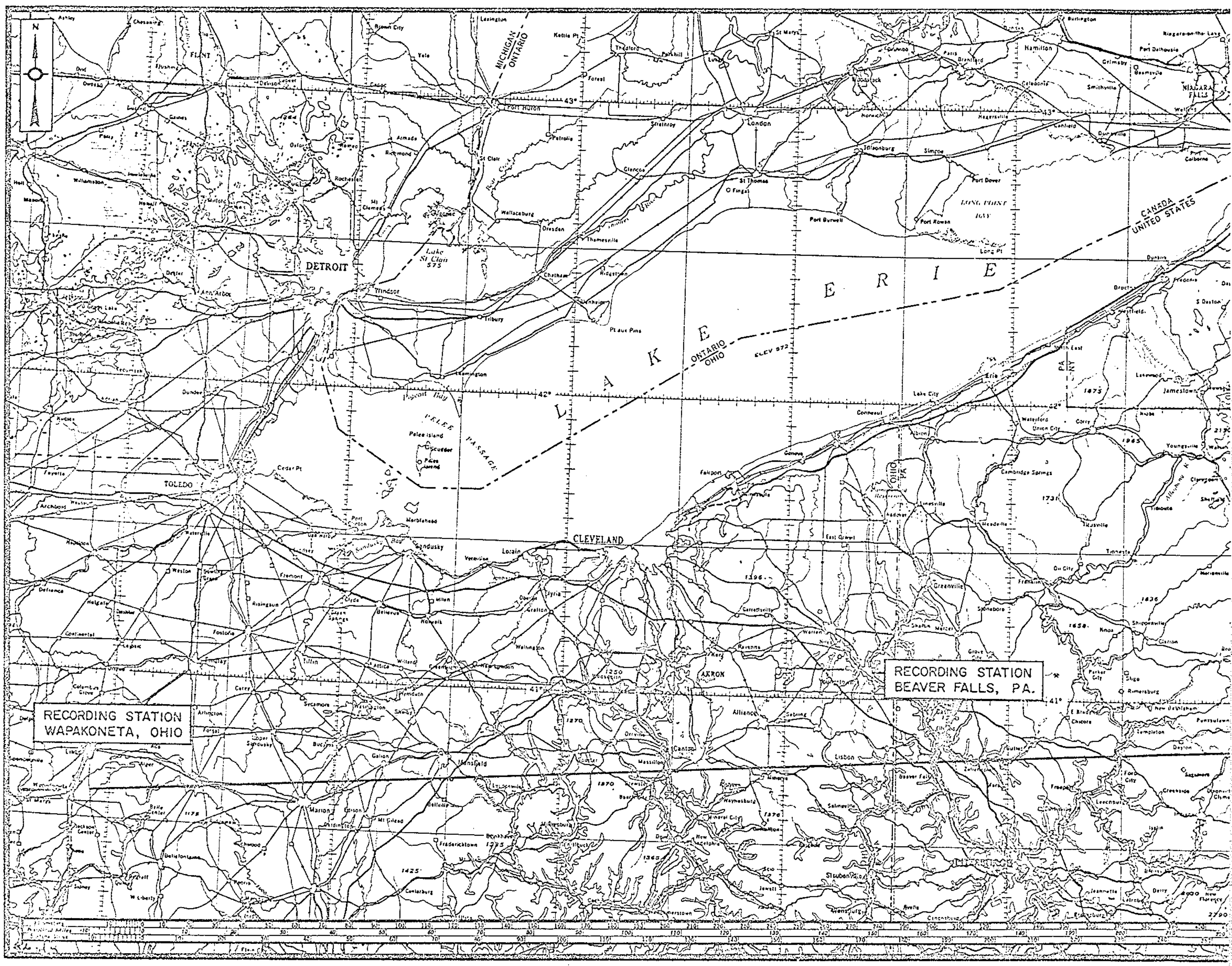
High Island Propagation Tests

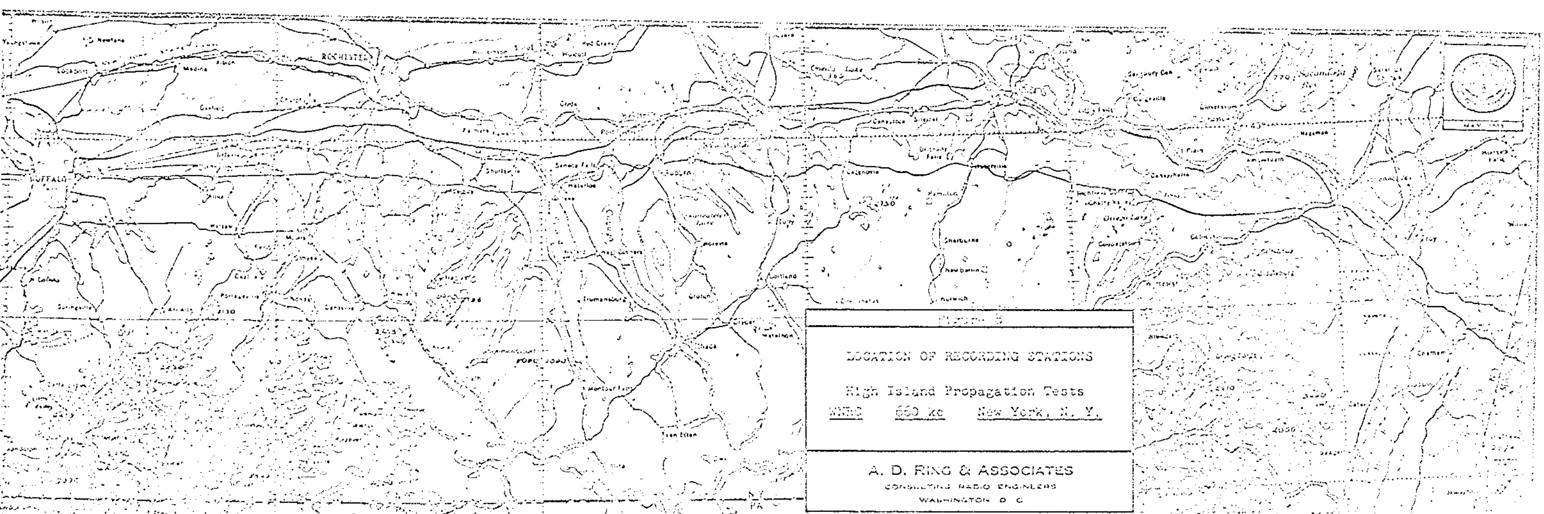
WNBC 660 kc New York, N. Y.

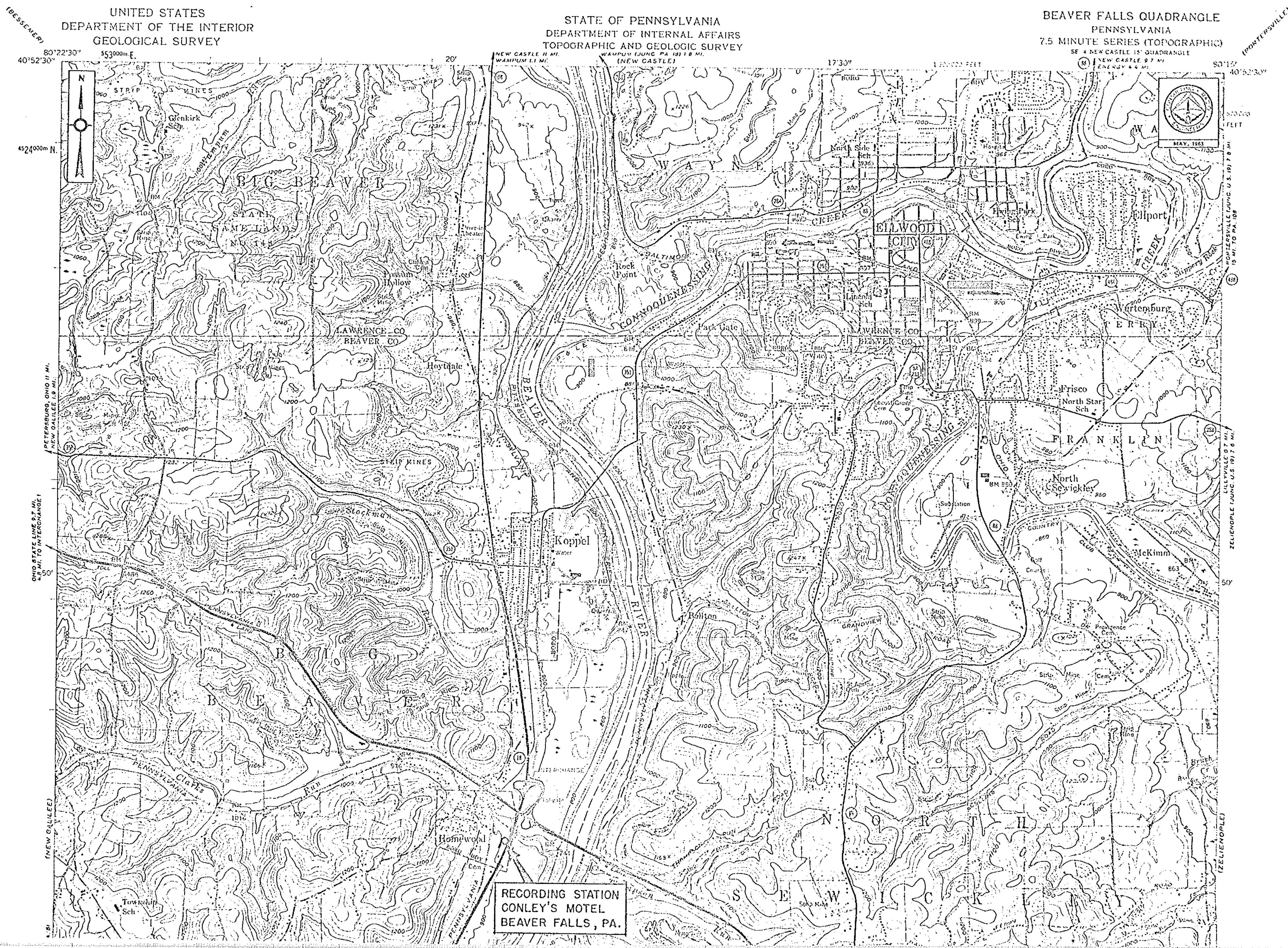
A. D. RING & ASSOCIATES

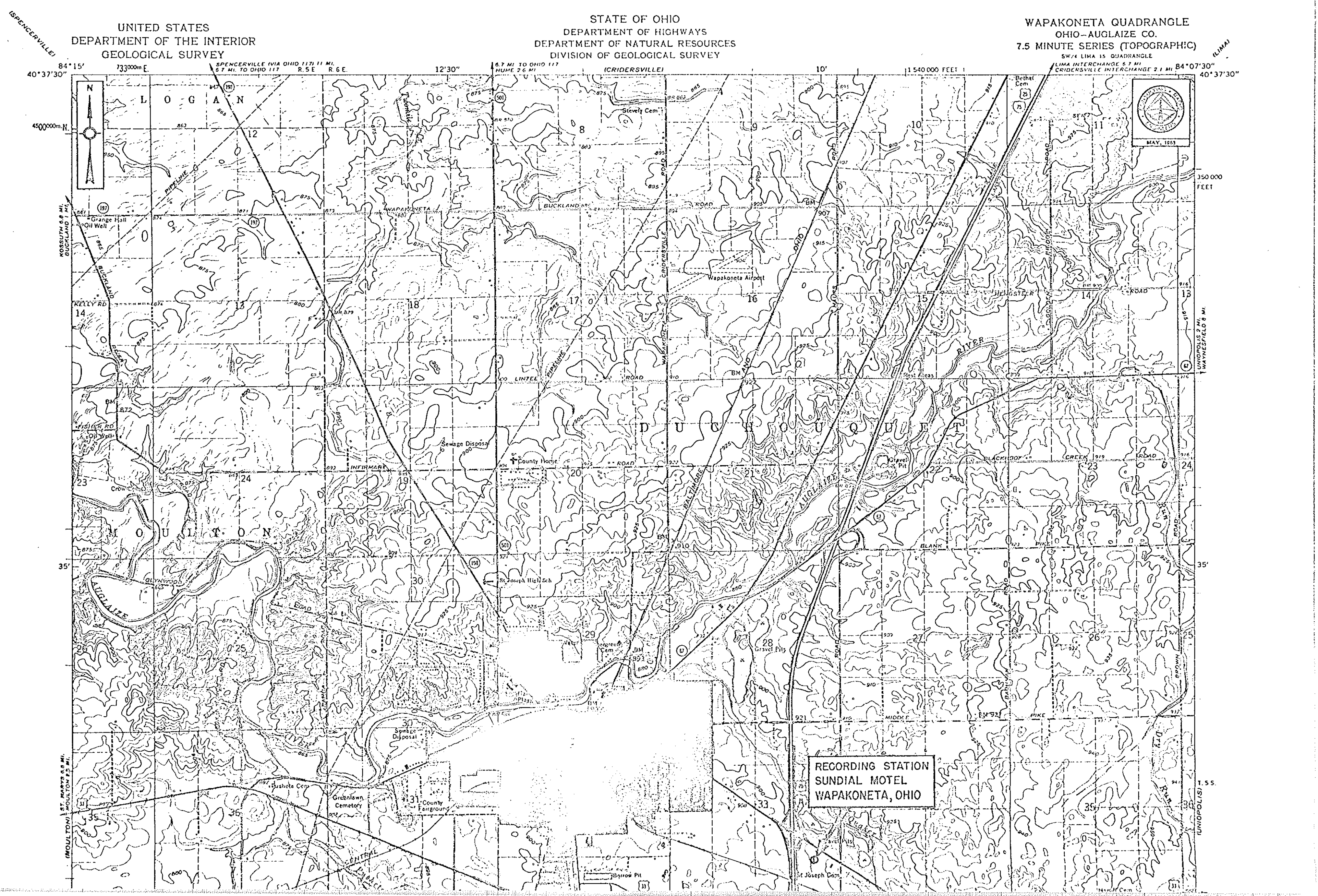
CONSULTING RADIO ENGINEERS

WASHINGTON, D. C.


RECORDING STATION
WAPAKONETA, OHIO
RECORDING STATION
BEAVER FALLS, PA.
LAKE ERIE
DETROIT
TOLEDO
CLEVELAND
AKRON
CANADA
UNITED STATES
MICHIGAN
ONTARIO
OHIO


LOCATION OF RECORDING STATIONS
High Island Propagation Tests
WNBC 660 kc New York, N. Y.
A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON D. C.
TRANSMITTER SITE
HIGH ISLAND, N. Y.
271.5° TRUE
ROCHESTER
BUFFALO
NEWARK
NEW YORK


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
STATE OF PENNSYLVANIA
DEPARTMENT OF INTERNAL AFFAIRS
TOPOGRAPHIC AND GEOLOGIC SURVEY
BEAVER FALLS QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
(BESSEMER)
(PORTERSVILLE)
(NEW GALILEE)
(ZELIENOPLE)
80°22'30"
40°52'30"
20'
17'30"
80°15'
40°52'30"
50'
MAY, 1963
ELLWOOD CITY
Ellport
Wurtemburg
Koppel
Homewood
Hoytdale
Rock Point
Park Gate
Prisco
North Sewickley
McKimm
BEAVER RIVER
CONNOQUENESSING
BIG BEAVER
WAYNE
PERRY
FRANKLIN
NORTH SEWICKLEY
LAWRENCE CO
BEAVER CO
STATE GAME LANDS
RECORDING STATION
CONLEY'S MOTEL
BEAVER FALLS, PA.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
STATE OF OHIO
DEPARTMENT OF HIGHWAYS
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
WAPAKONETA QUADRANGLE
OHIO-AUGLAIZE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 LIMA 15 QUADRANGLE
(SPENCERVILLE)
(CRIDERSVILLE)
(LIMA)
(MOULTON)
(UNIOPOLIS)
84°15'
40°37'30"
84°07'30"
12'30"
10'
35'
R. 5 E.
R. 6 E.
LOGAN
DUCHOUQUET
MOULTON
AUGLAIZE
RIVER
Wapakoneta Airport
County Home
St Joseph High Sch
Sewage Disposal
Greenlawn Cemetery
County Fairground
Gravel Pit
Steely Cem
Bethel Cem
St Joseph Cem
Grange Hall
Oil Well
MAY, 1953
RECORDING STATION
SUNDIAL MOTEL
WAPAKONETA, OHIO

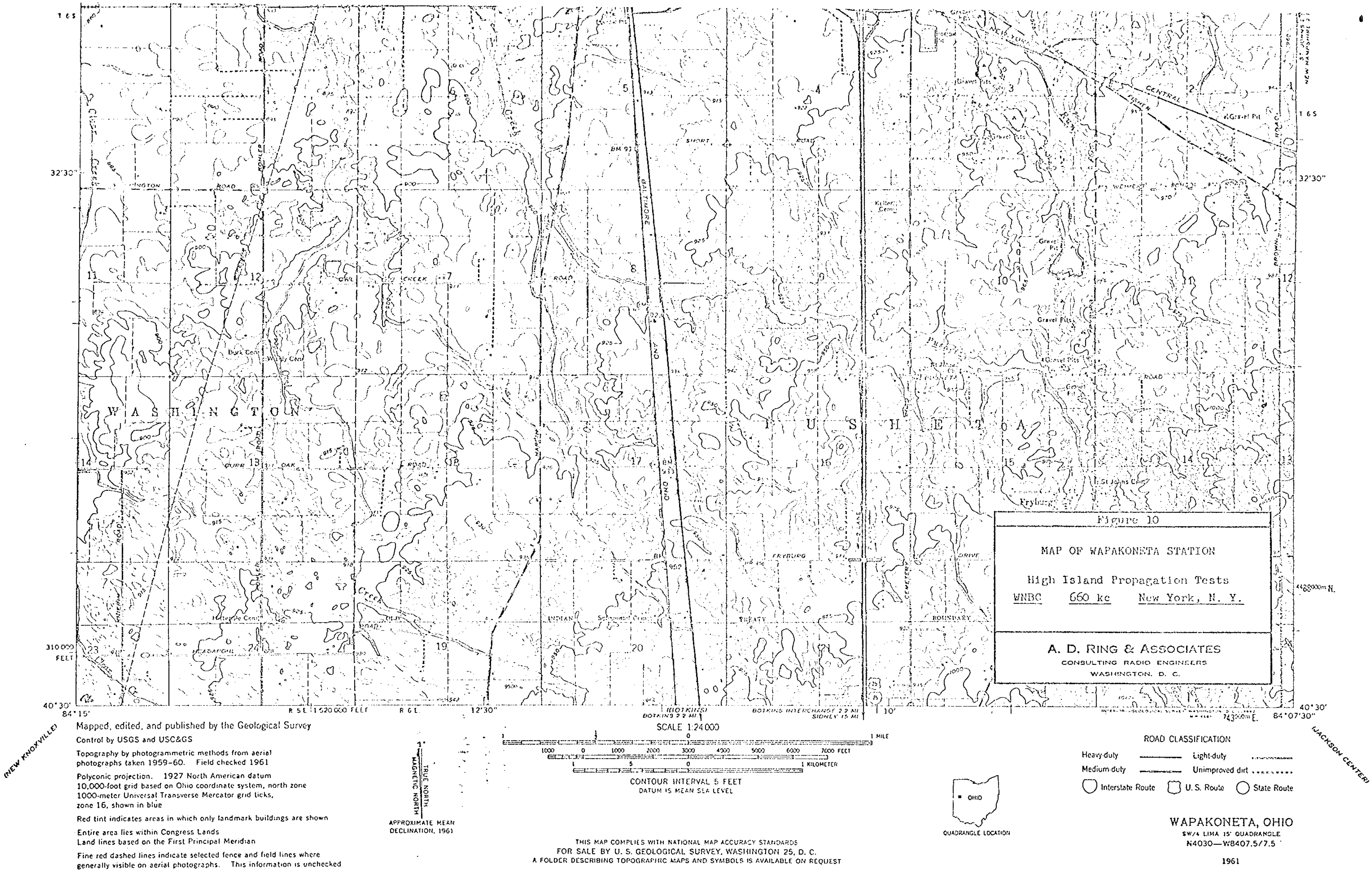


Figure 10
MAP OF WAPAKONETA STATION
High Island Propagation Tests
WNBC 660 kc New York, N. Y.
A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.
W A S H I N G T O N
D U S H E T O A
BALTIMORE AND OHIO
CENTRAL
Gravel Pits
Fryburg
St Johns Cem
Kellerm's Cem
INDIAN
TREATY
BOUNDARY
FRYBURG
SHORT
ROAD
CREEK
Creek
(NEW KNOXVILLE)
(JACKSON CENTER)
(BOTKINS)
BOTKINS 2.2 MI
BOTKINS INTERCHANGE 2.2 MI
SIDNEY 15 MI
40°30'
84°15'
84°07'30"
32'30"
12'30"
10'
T 6 S
R 5 E
R 6 E
1 520 000 FEET
310 000 FEET
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1959-60. Field checked 1961
Polyconic projection. 1927 North American datum
10,000-foot grid based on Ohio coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 16, shown in blue
Red tint indicates areas in which only landmark buildings are shown
Entire area lies within Congress Lands
Land lines based on the First Principal Meridian
Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1961
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
OHIO
QUADRANGLE LOCATION
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
Interstate Route
U. S. Route
State Route
WAPAKONETA, OHIO
SW/4 LIMA 15' QUADRANGLE
N4030—W8407.5/7.5
1961

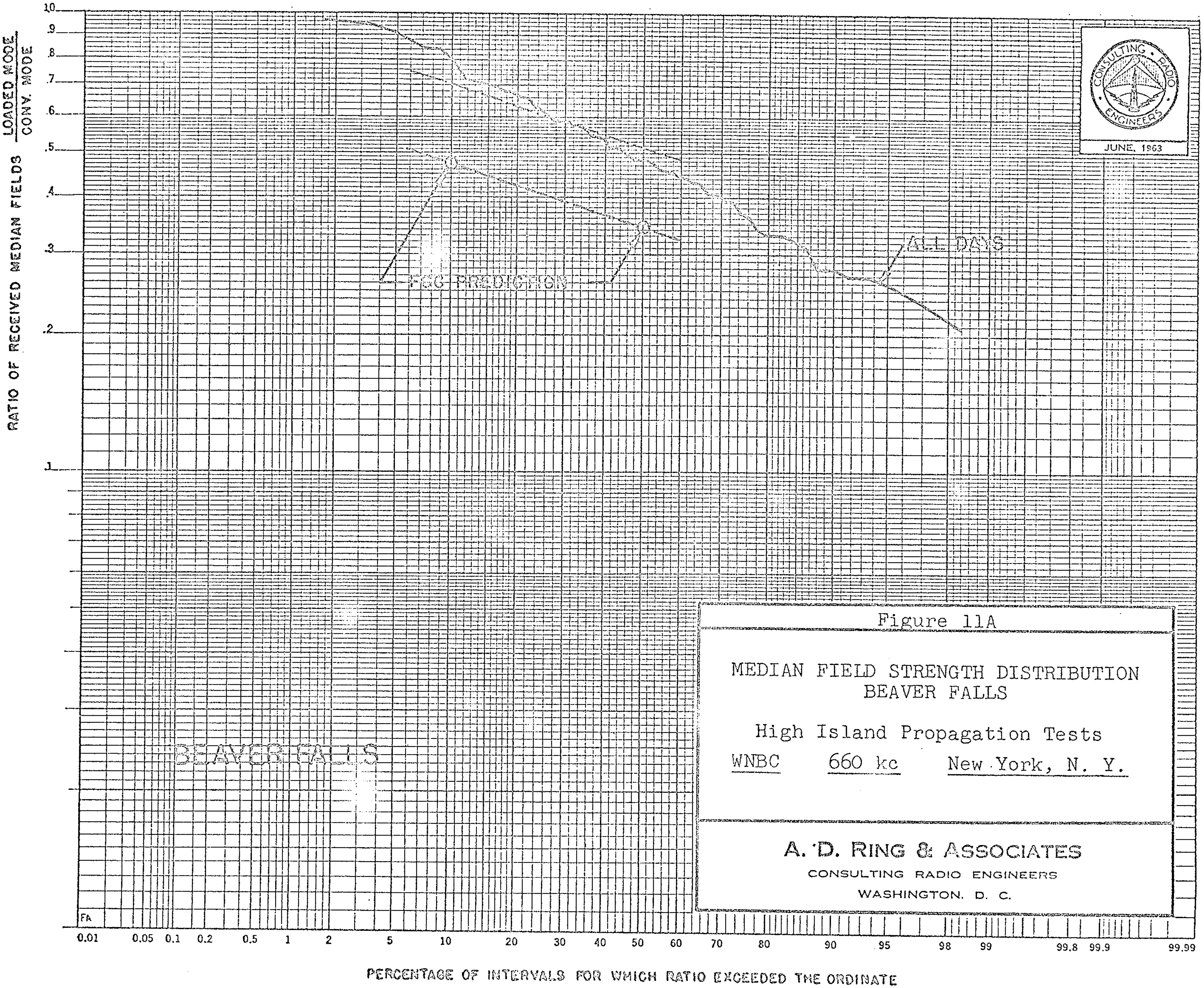


Figure 11A

MEDIAN FIELD STRENGTH DISTRIBUTION
BEAVER FALLS

High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

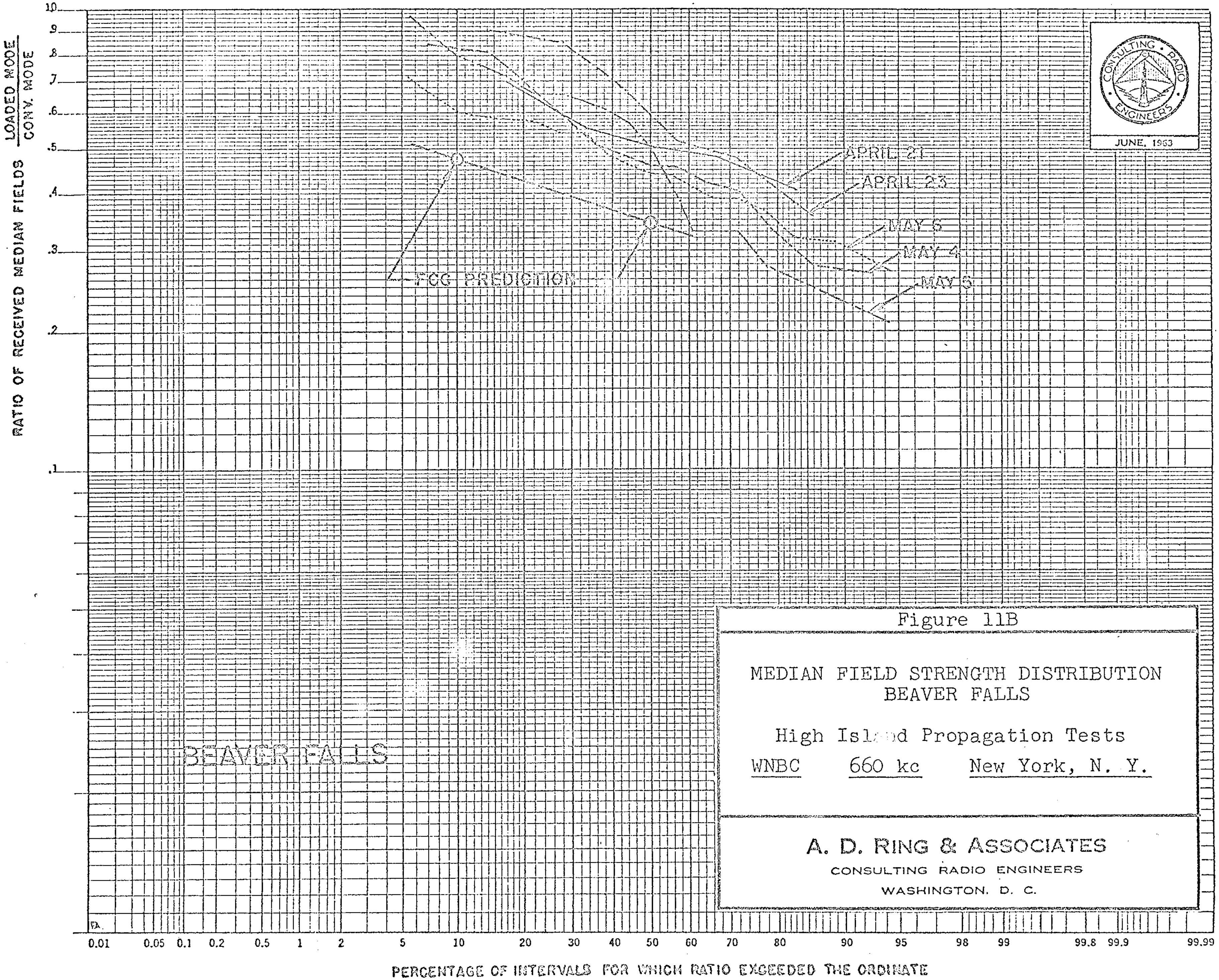


Figure 11B

MEDIAN FIELD STRENGTH DISTRIBUTION
BEAVER FALLS

High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

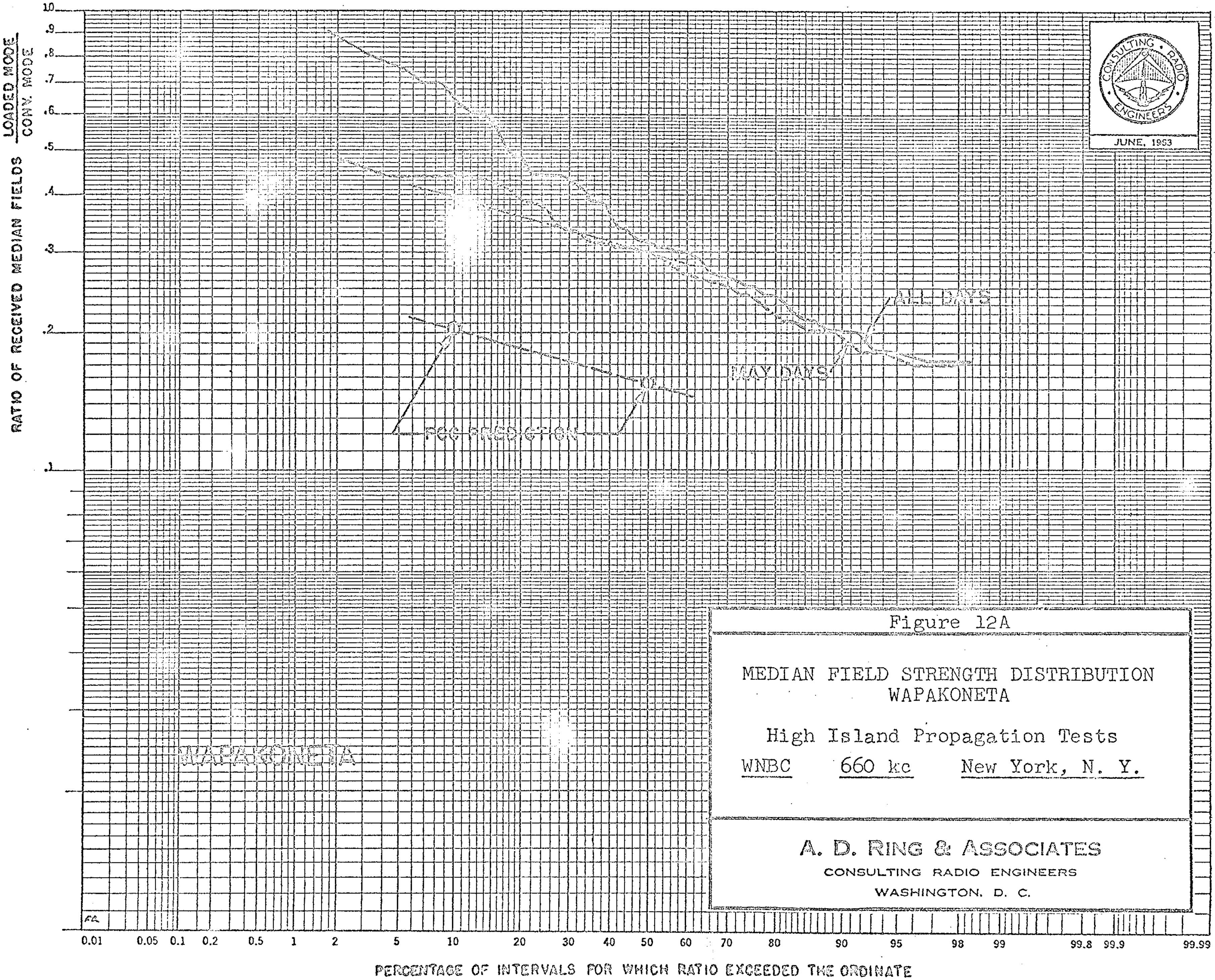


Figure 12A

MEDIAN FIELD STRENGTH DISTRIBUTION
WAPAKONETA

High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.

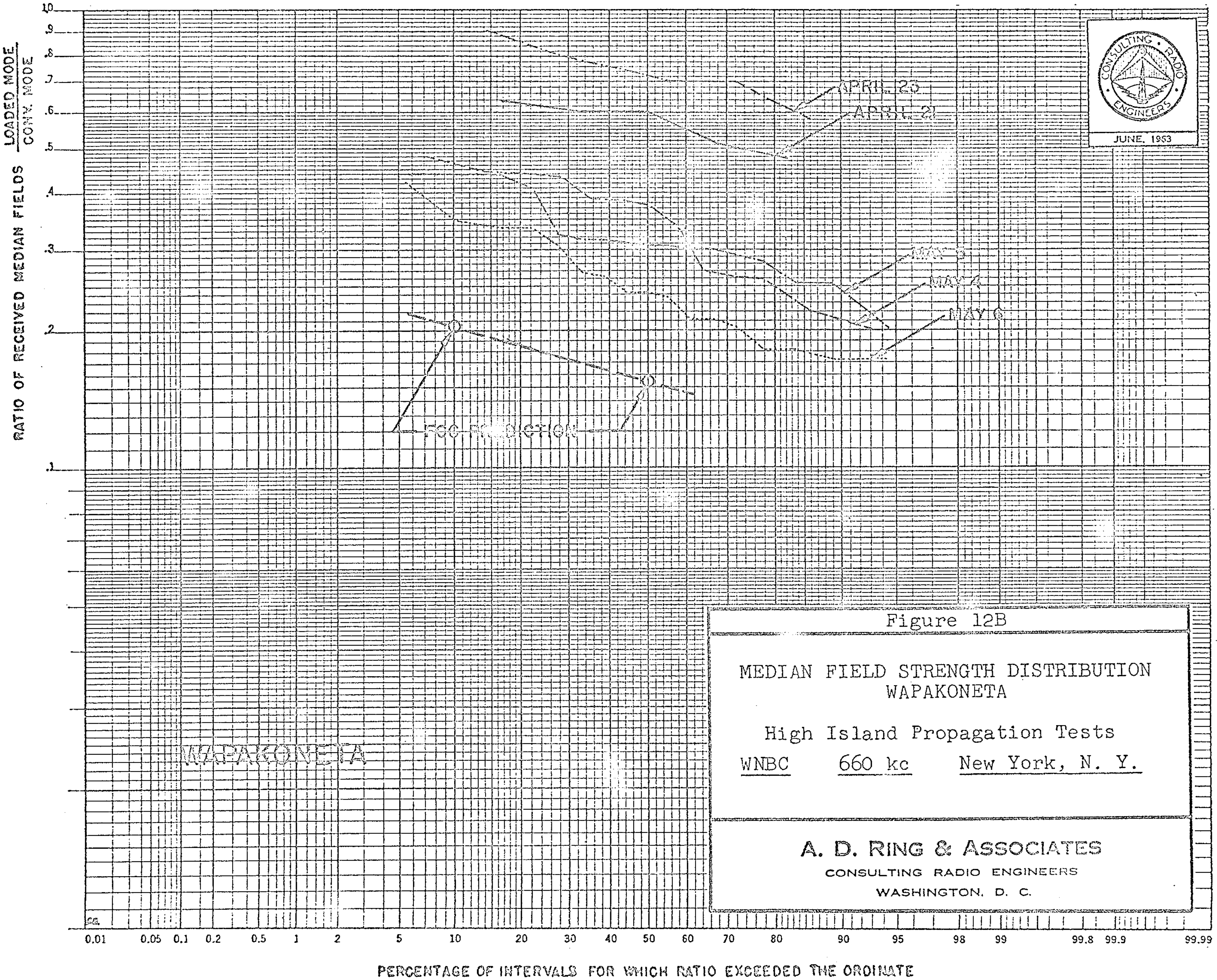


Figure 12B

MEDIAN FIELD STRENGTH DISTRIBUTION
WAPAKONETA

High Island Propagation Tests

WNBC 660 kc New York, N. Y.

A. D. RING & ASSOCIATES
CONSULTING RADIO ENGINEERS
WASHINGTON, D. C.