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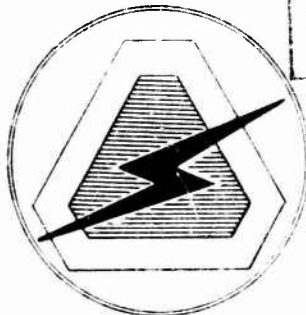


USAELRDL Test Report 1564

"FIELD INTENSITY EFFICIENCY OF VEHICULAR ANTENNA AT-912(XE-2)/VRC"

WATSON P. CZERWINSKI

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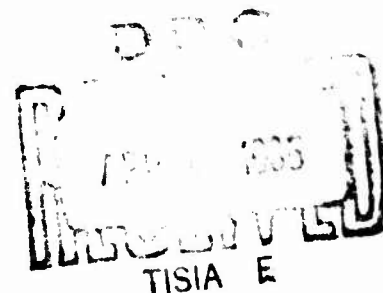
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**"Field Intensity Efficiency of Vehicular Antenna AT-912(XE-2)/VRC"**

**Watson P. Czerwinski**

**Project LA010501B010**

**Abstract**

Field intensity measurements of Antenna AT-912(XE-2)/VRC, also known as "Improved Center-Fed Whip", are compared to measurements of a half-wave, sleeve type, vertical dipole cut to the test frequency. Each antenna, in turn, was mounted on a 3/4-ton weapons carrier vehicle. As pattern circularity was confirmed by other tests,<sup>4)</sup> only head-on readings were taken. The Center-Fed Whip Antenna was found to have at least the same gain as the "unity-gain antennas" throughout the operating range of 30 to 76 mc.

**NOTE ADDED OCTOBER 1964**

**\* THIS ANTENNA HAS BEEN CLASSIFIED STANDARD A AND  
ASSIGNED THE NOMENCLATURE ANTENNA AS-1729 )/VRC.**

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## Field Intensity Efficiency of Vehicular Antenna AT-912(XE-2)/VRC

### INTRODUCTION

The "Improved Center-Fed Whip" Antenna AT-912(XE-2)/VRC<sup>1)</sup> is a result of a continuous effort towards improving the design of tactical antennas. This antenna was designed and developed to replace the first generation antenna AT-912/VRC<sup>2)3)</sup> currently standard, for use with Radio Set AN/VRC-12.

In addition to reduced size, weight and complexity, the "Improved Center-Fed Whip" Antenna was designed for optimum gain along the horizon. The relative light-weight construction of the antenna lends itself to mast mounting, for increased range due to height-gain.

### EXPERIMENTAL EQUIPMENT AND PROCEDURES

A test range was selected in the Wayside Test Area to provide approximately one-mile separation between the transmitting and receiving sites. The receiving station was a field shelter with a vertical ground-plane as the probe antenna, located on its roof. An Empire Devices Company field-intensity meter, type NF-205, was used for these measurements. A 3/4-ton weapons carrier vehicle containing the measuring and transmitting equipment, plus the test antennas, was the transmitting station. Although the sites selected appeared to be free of metallic structures, an electrical check was made prior to the actual measurements, to determine the magnitude of standing-waves present due to any secondary radiation. Movement of the vehicle through a wavelength distance toward the receiving station, at each test frequency had no perceptible effect on the measured carrier amplitude.

Equipment used:

The equipment used at the transmitting site was as follows:

1. One 3/4-ton Weapons Carrier Vehicle, #2429248, with bcws and canvas, to represent normal field operating conditions.
2. One Test Antenna AT-912(XE-2)/VRC, serial #4.
3. Three Reference antennas, half-wave vertical dipoles cut for each test frequency. Communication Products Co., Marlboro, N. J., Catalogue #19-509.
4. One Radio Set AN/PRC-25, with auxiliary silver-cell battery as R-F source.
5. One Rhode & Schwarz Co. admittance diagraph, type ZDU, (for measuring admittance of antenna for input power calculation).
6. One each R-F Vacuum Tube Voltmeter, HP-410B with coaxial "tee" probe.
7. One each Rotary Converter FU-143A/U (to supply the vehicle with 115 VAC power, independent from outside mains).

## TEST PROCEDURE

The antenna mounting bracket was modified to permit placement of each antenna under test, in as near the same location on the weapons carrier vehicle as possible (Fig. 1).

Three test frequencies were selected in the operating band of 30 to 76 mc; 30 mc, 50 mc, and 74 mc. A separate reference dipole was used for each test frequency. The reference half-wave, vertical dipoles were coaxial sleeve antennas of the type marketed commercially for use as base station antennas in the Two-Way Mobile Communications Service.

Each antenna in turn was mounted on the vehicle as shown in Figs. 2 to 5 inclusive, and excited by the AN/PRC-25 transmitter. The power input to each antenna was computed by measuring voltage and admittance at the same point in the antenna feed coaxial and using the relationship:

$$P = E^2 G.$$

The field intensity in db above 1 microvolt, was recorded at the receiving station shelter. The field intensity of each set of antennas under comparison, was normalized to equal input power by adding

$$10 \log_{10} \frac{P_1}{P_2} \quad ( +db )$$

to the field intensity of the antenna with the lower input power.

## RESULTS

The "Improved Center-Fed Whip" antenna exhibited .8 db gain over the reference antenna at both ends of the operating band and 1.7 db gain at the band center. The tabulation on page 3 presents the raw data as measured in the field.

Since the "Improved Center-Fed Whip" antenna was designed to operate as a half-wave radiator, its superiority invited a closer examination into the design of the reference antenna.

The commercial, coaxial sleeve type vertical dipole utilized the area between the support pipe and the inside of the sleeve element, to form a "shorted" quarter-wave coaxial stub. The length of this sleeve element is adjusted during manufacture for zero susceptance at the open end so as to isolate the support pipe from the antenna proper. The characteristic impedance of this "shorted" air-filled stub is

$$Z_0 = 138 \log_{10} \frac{D}{d}$$

where D = inside diameter of the sleeve  
d = outside diameter of the support pipe

then

$$Z_0 = 138 \log_{10} \frac{1.5}{1.062} \quad \text{or } Z_0 = 20.6 \text{ ohms in the reference antennas.}$$

**I. FIELD INTENSITY MEASUREMENTS AT APPROX. ONE-MILE RANGE  
OVER MEDIUM FOLIAGE AND DIRT ROADS**

SUB-BAND	FREQ. (MC)	MEASURED		$\frac{G}{Y_0}$	"G" $(\frac{G}{Y_0} \cdot .02)$	INPUT POWER		MEASURED (f. i. ) DB	FIELD INTENSITY NORMALIZED TO EQUAL INPUT POWER (DB)	C-F WHIP (DB) REF. DIPOLE
		"E"	$\frac{G}{Y_0}$			$E^2 \cdot G$	$10 \log \frac{P_1}{P_2}$ DB			

**REFERENCE HALF-WAVE VERTICAL DIPOLES**

	30.0	2.7	.94	.0188	$P_1 = .137$			14.5	14.5	
	50.0	8.0	1.80	.036	$P_1 = 2.30$			32.5	32.5	
	74.0	9.2	1.15	.023	$P_1 = 1.94$			25.5	25.5	

**IMPROVED C-F WHIP ANTENNA AT-912(XE-2)/VRC**

1	30.0	2.8	.57	.0114	$P_2 = .0894$	+1.8	13.5	15.3	+8	
5	50.0	6.18	2.3	.046	$P_2 = 1.75$	+1.2	33.0	34.2	+1.7	
10	74.0	9.60	.87	.0174	$P_2 = 1.60$	+8	25.5	26.3	+8	

In the "Improved Center-Fed Whip" antenna, with an isolation stub of novel design,  $Z_0 = 600$  ohms.

The attenuation constant in an air-filled isolation stub is given by the following equation: 5)

$$\alpha = \frac{r}{2 Z_0}$$

where  $\alpha$  = attenuation in nepers;  $r$  = resistance per unit length;  $Z_0$  = characteristic impedance.

From the above, we see that attenuation in a coaxial stub is inversely proportional to the characteristic impedance.

#### CONCLUSIONS

The "Improved Center-Fed Whip" antenna AT-912(XE-2)/VRC, mounted on a tactical vehicle, provides a radiation efficiency, throughout the operating band, equal to, or better than a commercial half-wave dipole cut to the test frequency.

The essential half-wave current distribution on the fixed length radiator of the Center-Fed Whip Antenna (Fig. 6) is maintained throughout the frequency range of 30 to 76 mc, to effectively isolate it from its mounting and provide maximum signal along the ground.

#### ACKNOWLEDGMENT

The author is grateful for the assistance of Mr. K. J. Murphy who operated the vehicular transmitting station during this test.

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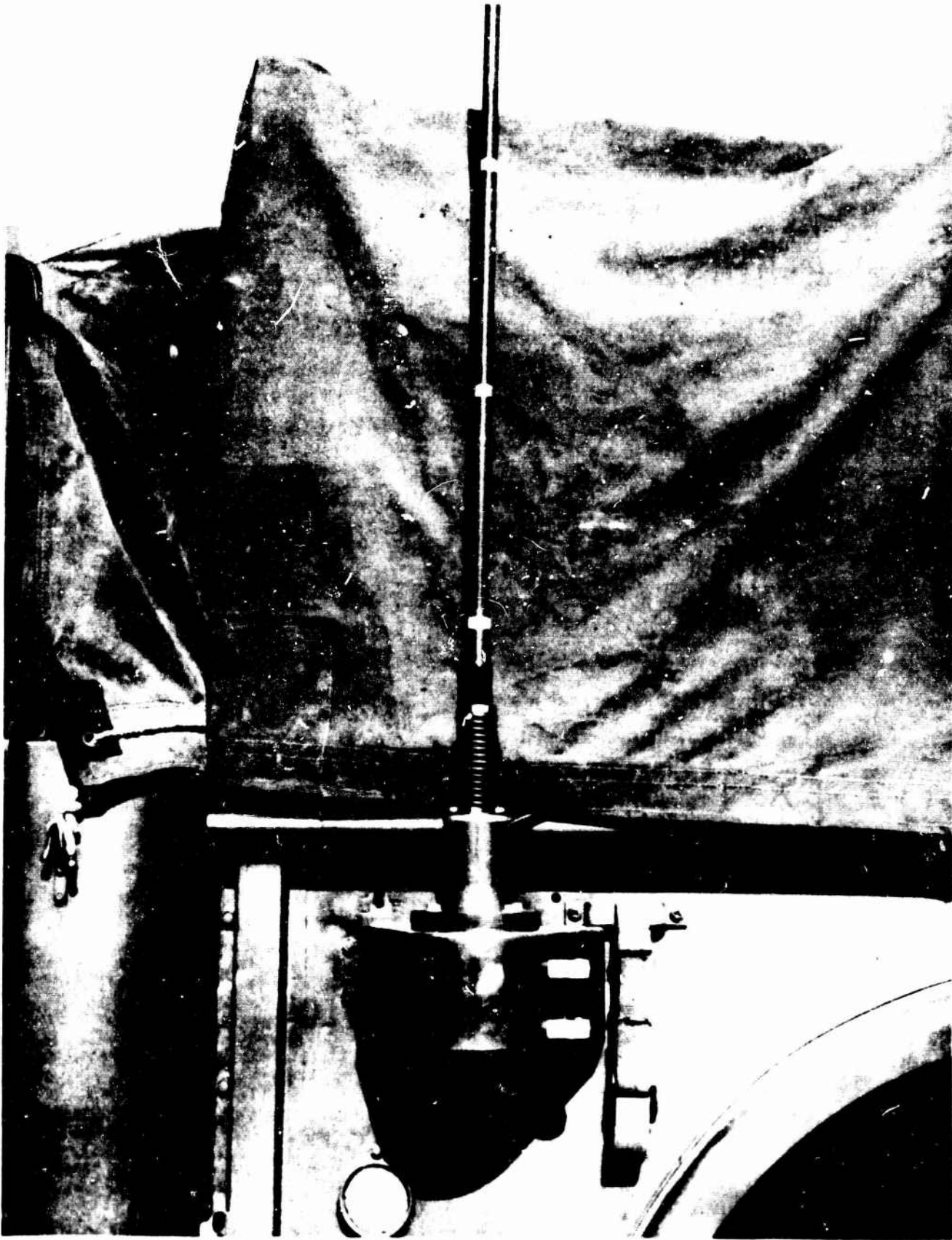


FIGURE 1. Antenna Mounting Bracket on 3/4-ton Weapons Carrier Vehicle.



FIGURE 2. Antenna AT-912(XE-2)/VRC Installed on 3/4-ton Weapons Carrier Vehicle.



FIGURE 3. 30-Mc Reference Antenna Installed on 3/4-ton Weapons Carrier Vehicle.



FIGURE 4. 50-Mc Reference Antenna Installed on 3/4-ton Weapons Carrier Vehicle.

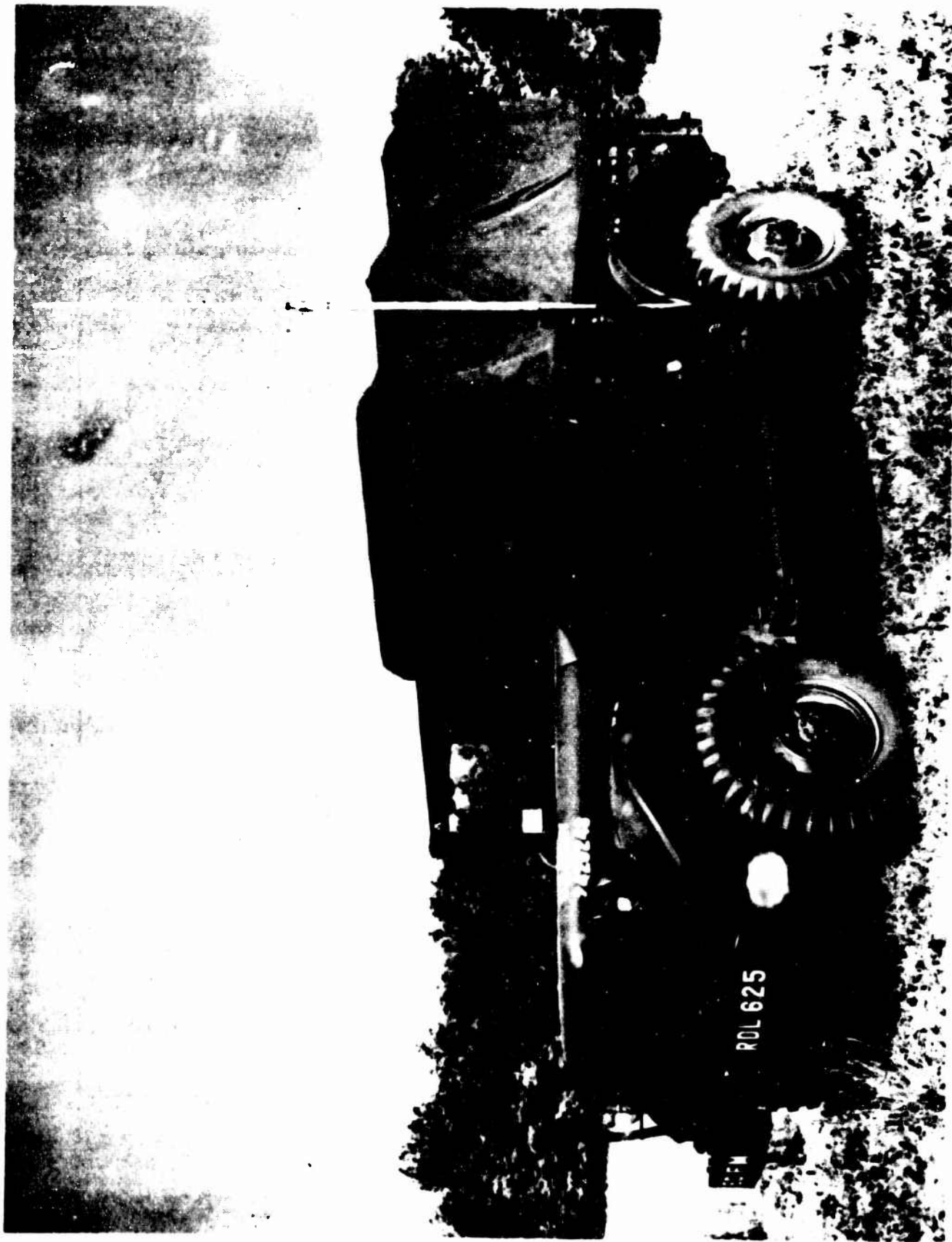
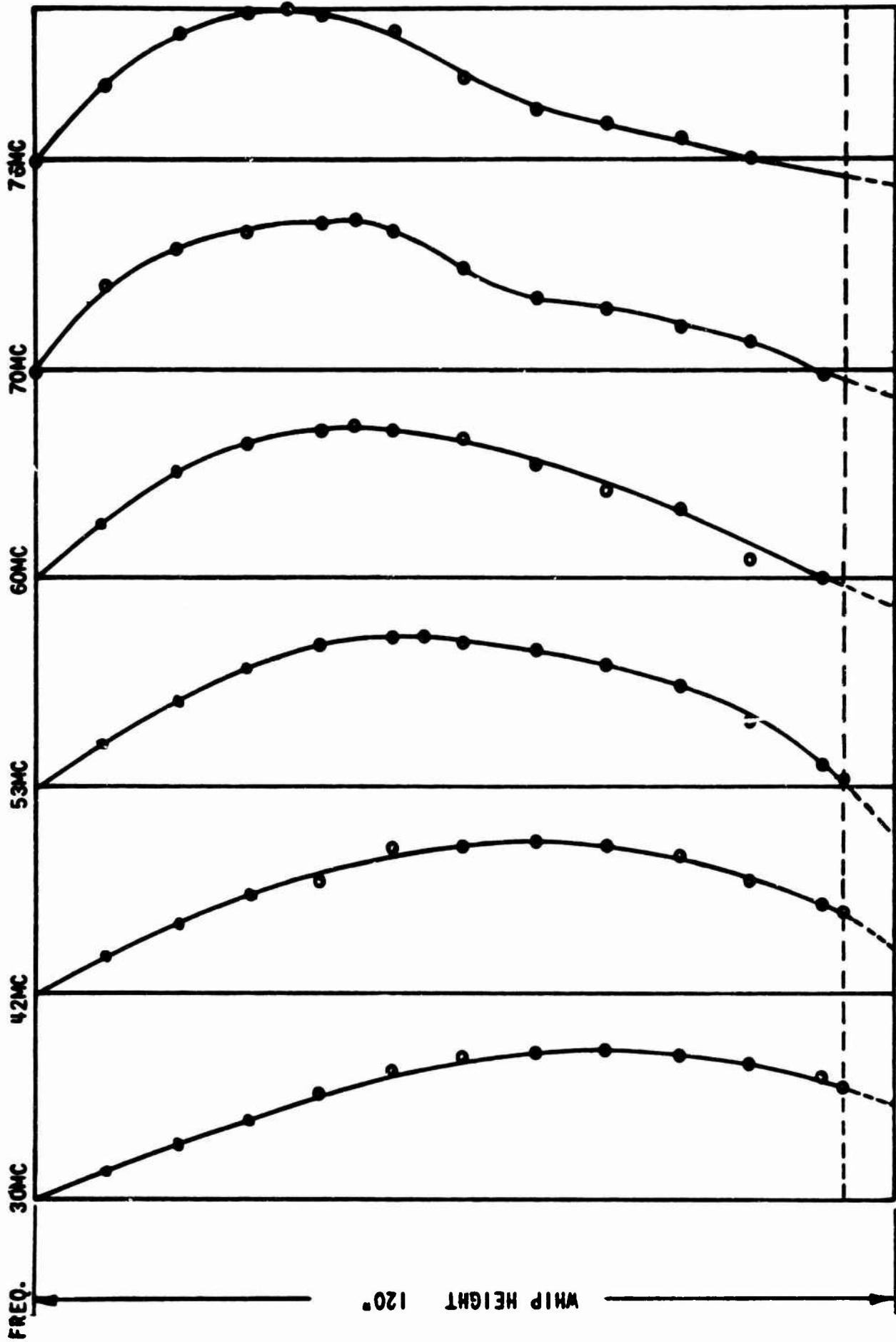


FIGURE 5. 74-Mc Reference Antenna Installed on 3/4-ton Weapons Carrier Vehicle.



MEASURED CURRENT DISTRIBUTION ON WHIP OF ANTENNA AT-912(XE-2)/VRC

FIGURE 6