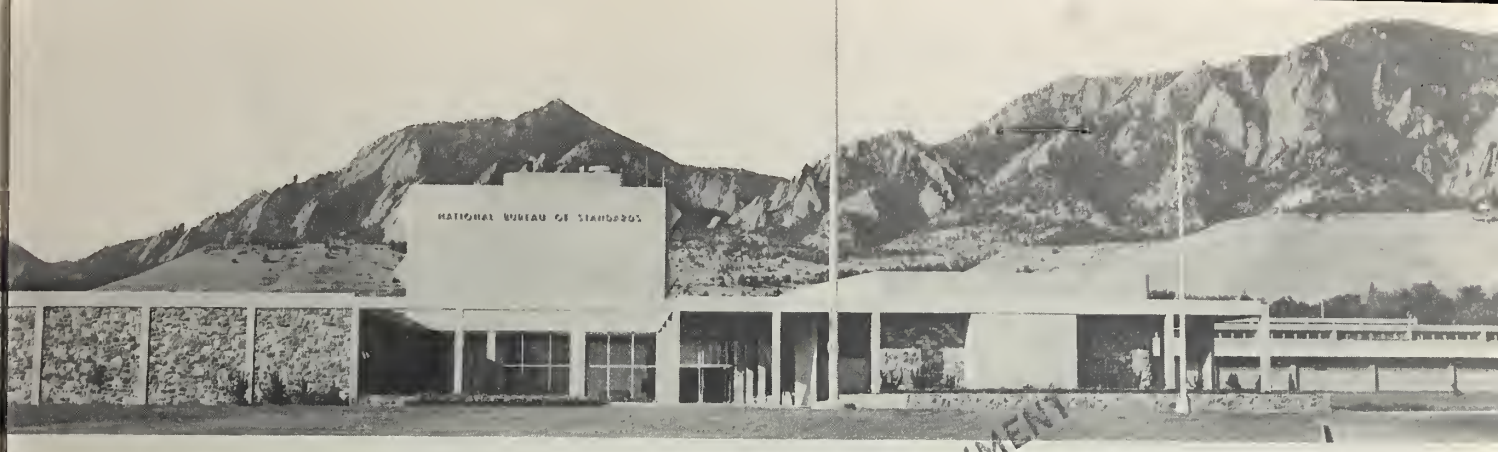

NBS REPORT

5538

TRANSLATION OF

"ADVANTAGES GAINED BY CONSIDERING POLARIZATION IN THE PLANNING OF VHF AND UHF BROADCASTING SERVICES

by

K. H. Kappelhoff
Fernmeldetechnisches Zentralamt
der
Deutschen Bundespost

Technical Report No. 5501
September 15, 1954"

Translation by
A. P. Barsis

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
BOULDER LABORATORIES
Boulder, Colorado

THE NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

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K. H. Kappelhoff

Summary

Measurements of the horizontally and vertically polarized field components of VHF transmissions were performed within the urban areas of Muenster (Westphalia) and Hamburg, and the spatial distribution of the ratio of the field components determined.

Vertically and horizontally polarized fields obtain cross-polarized components by reflections. The relative intensity of these components depends on the number, size, shape, and composition of the reflecting obstacles. For instance, for vertically polarized transmissions, the ratio of the vertically polarized to the horizontally polarized measured field component is infinite over absolutely flat terrain; however, this ratio may become less than unity if measured in the narrow canyons of a large city. In order to obtain estimates of the spatial distribution of this ratio, two series of measurements were performed during which the received field strength was measured simultaneously on the same spot with a vertical and a horizontal antenna. The results were evaluated by use of statistical analysis.

1. Measurements in Muenster

Muenster (Westphalia) is a city of about 130,000 inhabitants located on level terrain and built up in a relatively regular manner, but not too densely for a city of its size. For all practical purposes,

all industry is concentrated in one particular section.

The field strength from transmissions of the Langenberg television station (picture carrier on 203 Mc, horizontal polarization, slot antenna) at about 80 kilometers distance was measured at 220 locations by means of a portable field intensity meter. The 220 locations were evenly distributed over the urban area. The propagation path extends over slightly hilly terrain in the vicinity of the transmitter (maximum elevation about 100 meters) then traverses the Ruhr industrial region, and reaches level terrain about 60 meters above mean sea level at 40 kilometers from the transmitter.

For evaluation of the measurements, the urban area was divided into four zones as follows:

Zone a: City center built up relatively dense with high buildings
Zone b: Somewhat less densely built up suburban area located in the direction toward the transmitter.
Zone c: Similar suburban areas at right angles of the city center relative to the direction of the transmitter.
Zone d: Similar suburban area located beyond the city center as seen from the transmitter.

Fig. 1 shows the four zones and the distribution of the measuring locations. The lighter hatching in the suburban areas indicates more space between buildings in these parts of the city, than for the city center.

Horizontal and vertical components of field strength (F_h and F_v) was measured on building roofs at 150 locations (1 to 1.5 meters above the roof) and at 70 locations 2.5 to 3 meters above ground. Fig. 2 shows the cumulative distribution of antenna heights above ground for the roof measurements. This figure constitutes an example of the distribution of urban building heights, and will be used as a basis for comparison of structures and building characteristics, if subsequent measurements in other towns are to be studied.

The median field strength of the roof measurements using a horizontal antenna was 56 db above 1 microvolt/meter with a 5 - 95% range of 6.8 db. For the ground measurements, the corresponding figures are 52 and 3.2 db. The median values of field strength are practically the same for zones a, c and d, but 2 db greater for zone b. The range is 0.5 db less in zones b and c than in zone a, but 0.5 db

greater in zone d than in zone a.

Fig. 3 shows the distribution of field strength ratios F_h/F_v for the entire urban area. Thus the horizontal component exceeds the vertical component by 17.2 db (median ratio) for the roof measurements; the corresponding figure for the ground measurements is only 13.5 db. For 10% of all locations the figure of 27.6 db for the roof measurements and 21 db for the ground measurements may be exceeded. At 3 meters above ground the vertical component may be equal to, or exceed the horizontal component for 1% of all locations.

Detailed analysis for the four zones results in similar relations as shown by the field strength values above. The medians differ by very little, and the range is somewhat lower in zone b, and somewhat higher in zone d than in zone a.

2. Measurements in Hamburg

The transmitter was located on top of the air raid shelter "Heiligengeistfeld" in the center of the metropolis of Hamburg, which is also located on level terrain. A half-wave vertical dipole was used as a transmitting antenna on 60 Mc. Field strength measurements were made on the city streets along four routes extending radially from the transmitter location. Receiving antennas were 2.3 meters above ground; for vertical polarization a coaxial half-wave dipole was used, and for horizontal polarization a half-wave turnstile.

Fig. 4 shows the averaged measured field strength versus distance along one of the radials. From these graphs, the values of field strength at regular intervals are determined, and serve as a basis for statistical analysis. Fig. 5 shows the resultant distribution of field strength ratios F_v/F_h. The curves are similar to the ones obtained from the Muenster measurements (see Fig. 3). The median corresponding to the city center is approximately the same as the one corresponding to the suburb; however, the range is greater for the suburb. As the transmitter (for Hamburg) is located in the center of town, the Hamburg suburbs correspond to the Muenster zone d.

Again, the horizontal component of field strength may exceed the vertical component for approximately 1% of all locations. The median ratio of the vertical component to the horizontal component as measured in the streets of Hamburg is 9.7 db; for 10% of the locations the ratio of 15 db or more. Therefore, median and range of the ratio F_v/F_h is lower than observed for Muenster. This is to be expected

from the different structure of the two cities.

The results shown above are only preliminary. The problem will finally be solved only when a large number of similar measurements on various frequencies in towns of all sizes will have been performed.

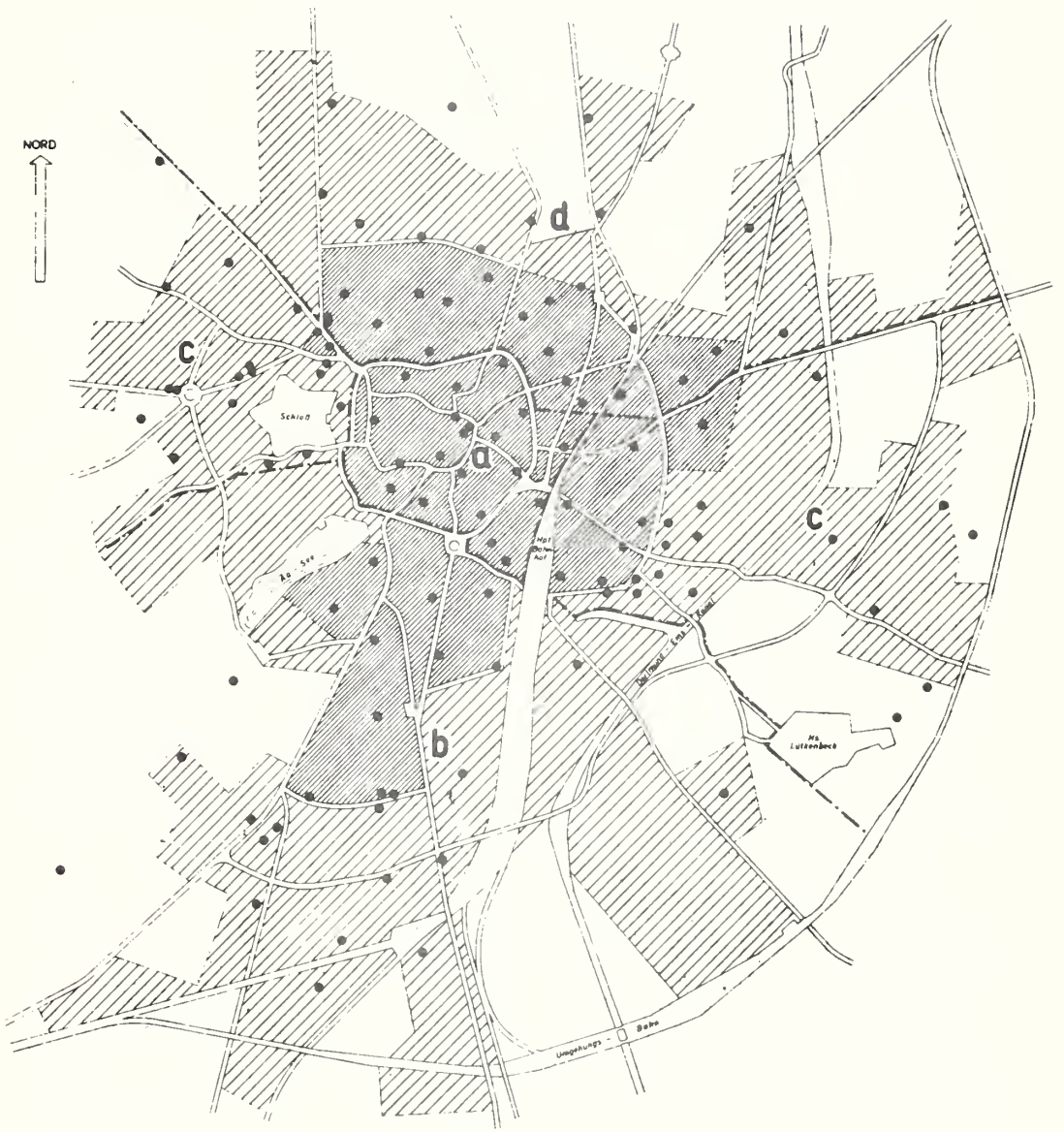

Fig. 1 Zones and distribution of measuring points within Muenster (Westphalia)

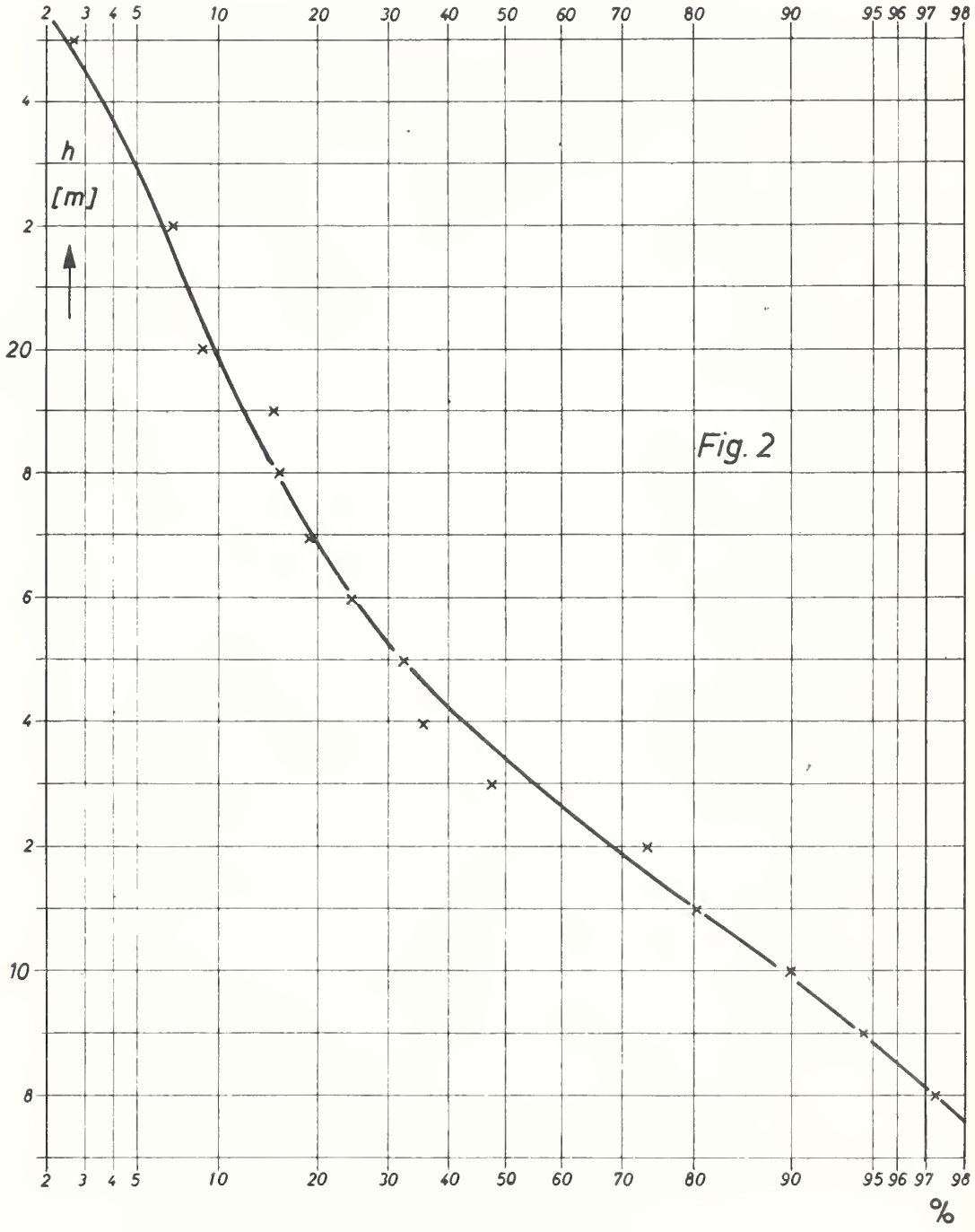

Fig. 2. Cumulative distribution of roof elevations for Muenster (Westphalia)

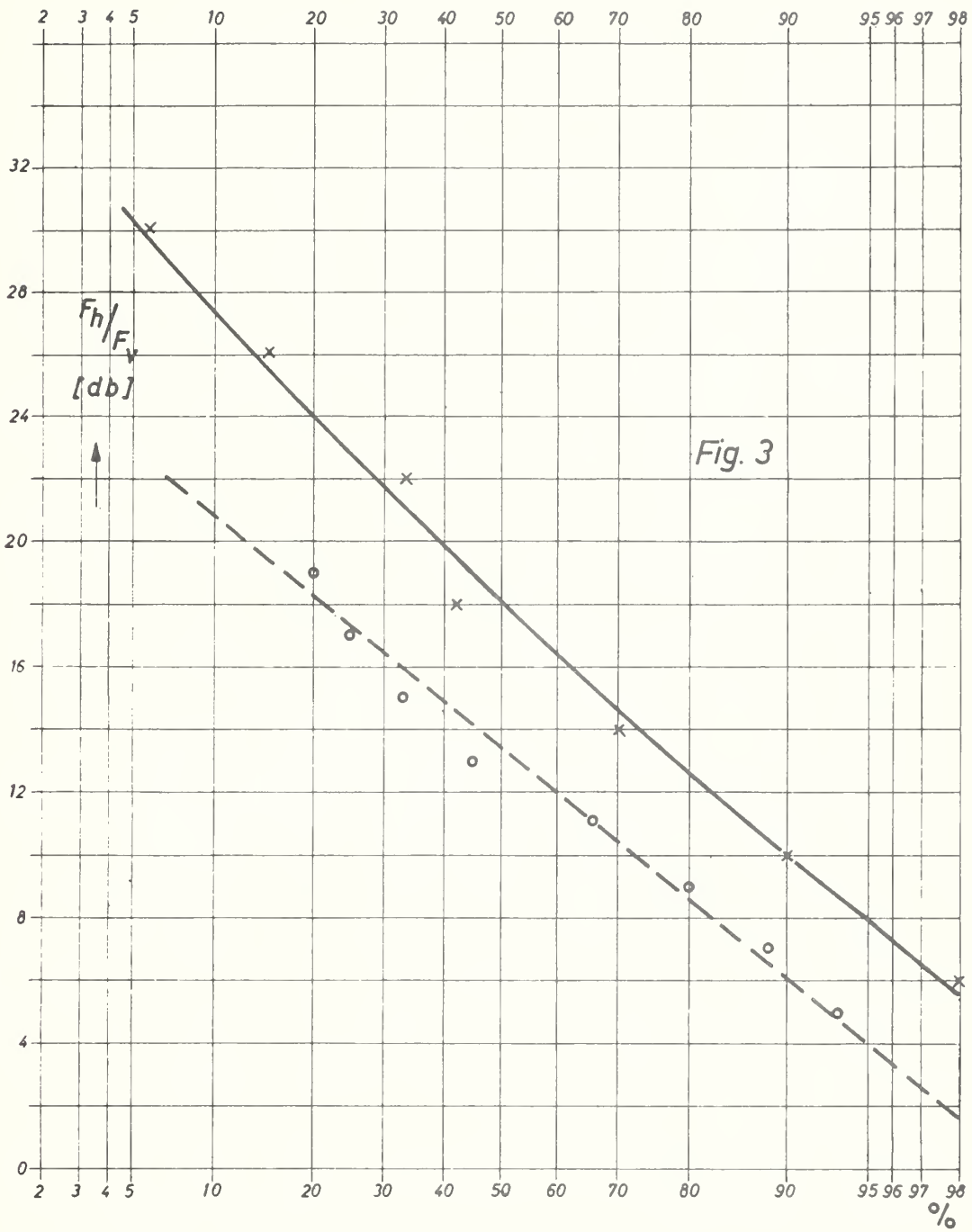

Fig. 3 Cumulative distribution of the ratio F_{h/F_v} for Muenster (Westphalia)
x ——— x roof measurements
o – – – – o ground measurements

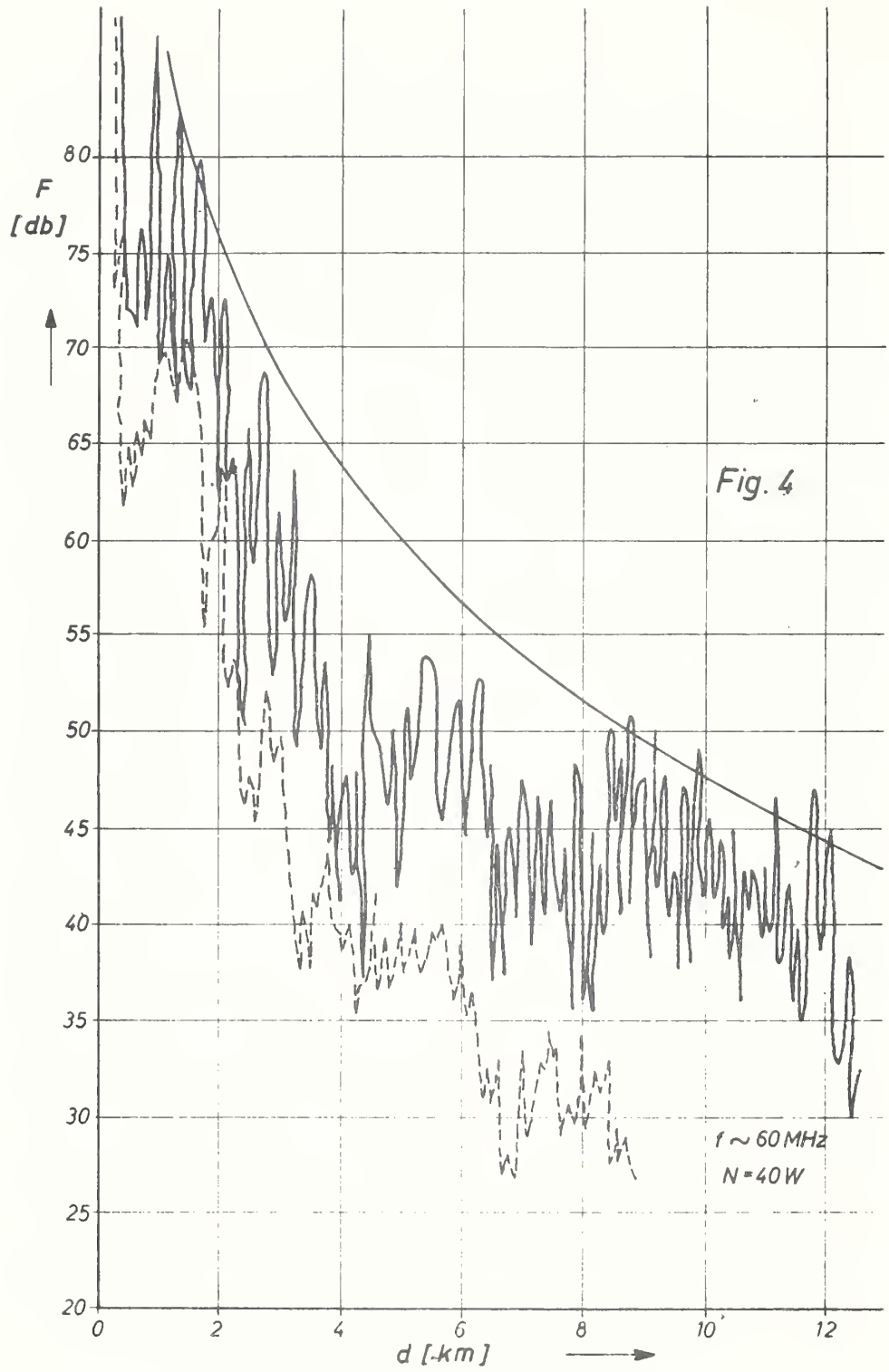

Fig. 4 Measurements of field strength versus distance within the Hamburg urban area, radial 1, vertical polarization

——— receiving antenna vertical

– – – – – receiving antenna horizontal

——— inverse square distance dependence

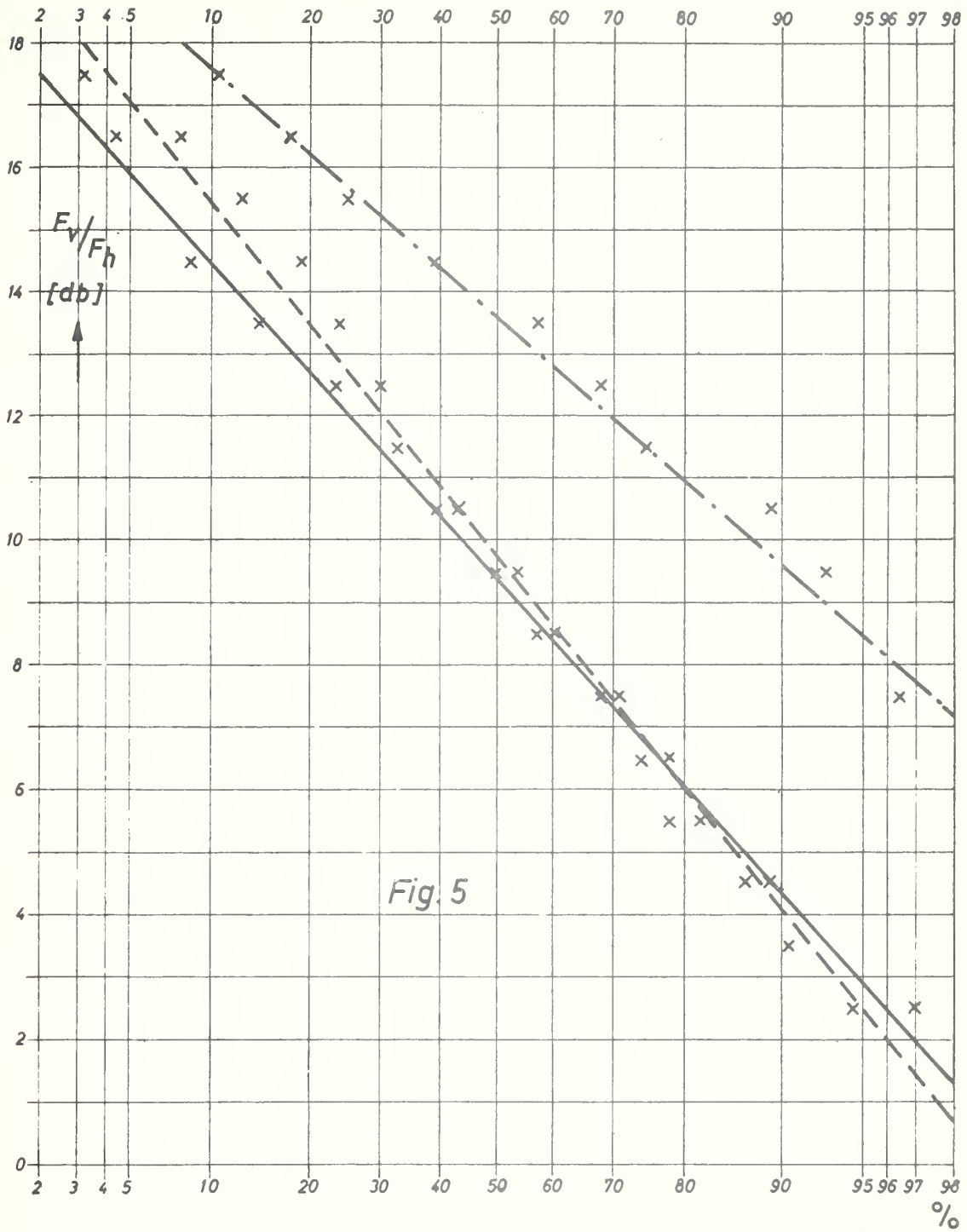

Fig. 5 Cumulative distribution of the ratio F_v/F_h for Hamburg

——— within the city center

– – – – – within the suburbs

—·—·— within extensive war-damaged areas

U. S. DEPARTMENT OF COMMERCE
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THE NATIONAL BUREAU OF STANDARDS

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