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UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

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AUTUMN COURSE ON GEOMAGNETISM, THE IONOSPHERE AND MAGNETOSPHERE

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ASSORTED NOTES

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MULTIPLE DIFFRACTION PATHS

* Considering a smooth surface at the top of the diffracting obstacles, with radius of curvature much larger than the wavelenght, it is possible to treat the problem theoretically.

To do that:

* The surface at the top is considered a surface of second ~~order~~ degree with a finete radius of curvature, then the attenuation coefficient can be deduced in a similar way than the case of diffraction by large spherical surfaces.

MULTIPLE DIFFRACTION PATHS

Two obstacles:

Complete mathematical treatment:

(1962) Millington G., Hewitt, R. and Immirzi F.S.; "Double knife-edge diffraction in field-strength predictions", IEE Monograph 507E, p. 419-429

(1963) Furutsu, K. "On the theory of radio wave propagation over inhomogeneous earth" J. Res. NBS (Radio Propagation) V.67D p.39.

(The ~~theoretical~~ theoretical solutions involve the calculation of multiple Fresnel integral)

Approximated treatment:

(1947) Bullington, K. "Radio propagation at frequencies above 30 Mc"; Proc. IRE, V. 35, p1122-1136

(1953) Epstein, J. and Peterson, D.W.; "An experimental study of wave propagation at 850 MHz"; Proc. IRE, v. 41 p. 595-611.

(1966) Deygout, J. "Multiple knife-edge diffraction of microwaves" IEEE Trans. Ant. Prop. v. AP-14, pp. 480-489.

(1982) Lopez Giovaneli, C. "Multiple knife-edge diffraction comparative analysis of simplified solutions" (sent for publication)

Validity of approximated treatments:

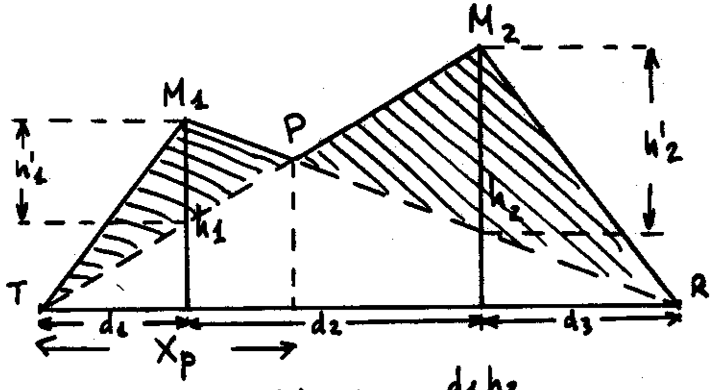
Bullington : optimistic estimates of signal strength. Up to 20 dB overestimation.

Epstein and Peterson : closer to reality but still optimistic. Up to 10 dB over estimation.

Deygout : good agreement with the theoretical treatment by Hillington et al.. At maximum value of diffraction loss obtains pessimistic estimates of signal strength, of up to 5 dB above the real values.

Lopez Giovaneli : good agreement with the theoretical treatment by Hillington et al.. Replaces well Deygout solution when this becomes pessimistic, like in case of short spacing of obstacles.

Lopez Giovaneli method



$$h'_1 = h_1 - \frac{d_1 h_2}{d_1 + d_2}$$

$$h'_2 = h_2 - \frac{d_3 h_1}{d_2 + d_3}$$

The total diffraction loss is:

$$a_{mT} = a_{m1} + a_{m2}$$

where:

$$a_{m1} = f(d_1, k_1 d_2, h = h'_1)$$

$$a_{m2} = f(d_3, k_2 d_2, h = h'_2)$$

with:

$$K_1 = \frac{X_p - d_1}{d_2}$$

$$K_2 = \frac{(d_1 + d_2) - X_p}{d_2}$$

and:

$$X_p = \frac{h_1 d (d_1 + d_2)}{h_1(d_1+d_2) + h_2(d_2+d_3)}$$

where:

$$d = d_1 + d_2 + d_3$$

For actual links is:

$$X_p \cong TP$$

Finally the diffraction losses a_{m1} and a_{m2} can be expressed as function of the dimensionless parameter ν.

$$\nu_1 = h'_1 \sqrt{\frac{2}{\lambda}(1/d_1 + 1/k_0 d_2)}$$

$$\nu_2 = h'_2 \sqrt{\frac{2}{\lambda}(1/k_0 d_2 + 1/d_3)}$$

where λ is the wavelenght in meters.

And:

$$a_m(\nu) = 13 + 20 \log_{10}(\nu) \quad [dB]$$

The total transmission loss is

$$a_T = a_0 + a_{mT}$$

STUDY OF AN ACTUAL VHF-TV LINK WITH DOUBLE DIFFRACTION PATHS

Frequency : 213 MHz (Channel 13)

Peak video Transm. Power : 260 W (actual average value 130 W)

Transmitter antenna : Vertical array with five corner reflector type units.

Transmitter antenna tower: 24 m

Measurements at receiver site : Half wave dipole at 6 m above ground

Distances involved : 3162 m

Point T height : 2000 m

Point M_1 height : 1870 m

Point M_2 height = 181 m

h_1 = 167.57 m

h_2 = 29 m

h'_1 = 35 m

h'_2

$X_p = 63.016$ Km

$h_p = 1924.53$ m

$K_1 = 0.4542$

$K_2 = 0.5458$

Comparison of results:

	L.G. Solution	Deygout Solution
a_{m1}	12 dB	18.3
a_{m2}	13	10.
a_0	117.5	117.5
a_T	142.5	145.8

MEASURED VALUE: 143 dB

The result obtained tells that to obtain a fine video image with a signal level of 56 dBμ at the input of the receiver of the repeater station it will be necessary to install a Yagi array with total gain of 16 dB at 36 m above the ground. The average power at the transmitter must be 1.6 KW.

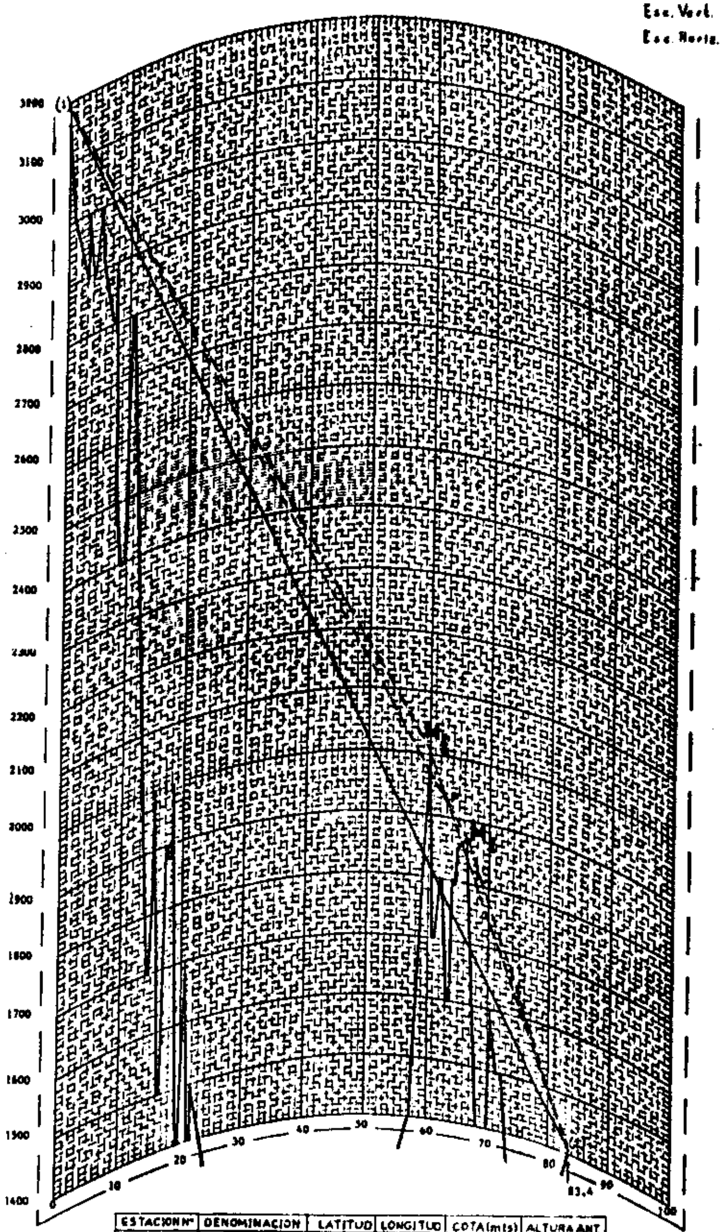
Where:

$$a_o = 32.5 + 20 \log_{10} F\,[\mathrm{MHz}] + 20 \log_{10} d\,[\mathrm{Km}]$$

is the free space loss in dB between two isotropic antennas separated by d Km at a frequency F in MHz.

GIVEN THE CHARACTERISTICS OF THE LINK, INCLUDING THE NECESSARY CONTOUR MAPS OF THE REGION OF INTEREST, IT IS POSSIBLE TO PREDICT THE FIELD STRENGHT VALUE AFTER DIFFRACTION USING THE METHOD DESCRIBED. THE PREDICTED VALUE, IF IT IS ABOVE A CERTAIN THRESHOLD THAT ENSURES PROPAGATION RELIABILITY, CAN BE USED FOR THE DESIGN OF THE LINK.

Coeficiente K=4/3
Esc. Vert. 1:5000
Esc. Horiz. 1:500000



ESTACION N°	DENOMINACION	LATITUD	LONGITUD	COTA(mts)	ALTURA ANT.
1	Puesto Corralitos	31°17' S	67°54' O	3162	26 m.
2	C° El Dique (V.P.)	30°38' S	67°10' O	1400	6 m.

LONG. DE TRAYECTO: 83,4 Km.

Fig. 4.5