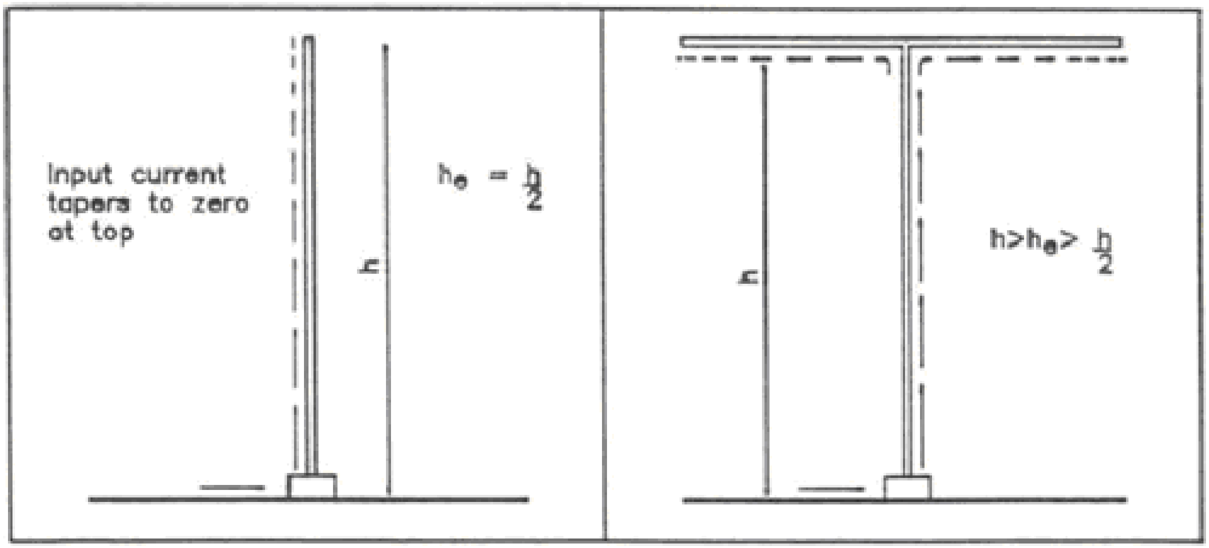


Figure 3.1 (a) Figure 3.1 (b)

onsidering a second example, shown in ***Figure 3.1 (b)***, of a base insulated, top loaded ertical radiator, it can be seen that the current then tapers to zero at the extremities of the apacity top hat. The average current flowing in the vertical section is clearly increased bove that in the first example; hence, the effective height h_e is said to be increased.

quantitative terms, the increase in h_e is dependent upon the relative values of the apacities of the mast and the top hat, such that the effective height, h_e is given by:

$$H_e = h\left[1 - \frac{1}{2}\left(\frac{C_M}{C_M + C_H}\right)\right]$$

Equation 7

Vhere:

- **h** = actual height
- $\mathbf{C_M}$ = capacity of vertical section
- $\mathbf{C_H}$ = capacity of horizontal section

(*See paragraph 3.2 to estimate the capacity of antenna sections*).

op loading is often achieved by the use of guys that are electrically connected to the top of e tower with insulators placed part way down their length. It is obvious that if these sulators are positioned close to the ground the top capacity will be increased but the verage height of the top hat will be reduced. As a compromise, the insulators are usually laced at a vertical height above ground level equal to 4/7 of the height of the tower.

third example may be considered in which the mast is grounded and an insulator is placed etween the top of the mast and the capacity top hat. With this arrangement, the loading coil ust also be positioned at the top of the mast. The total input current I then flows through e full height of the mast therefore $h_e = h$.

s shown in equations (1) and (2), the radiation resistance $R_R \propto h_e^2$ and efficiency $N \propto R_R$ approximately).

Hence, efficiency N ∝ h_e^2 (approximately).

It is, therefore, important to obtain as much effective height as possible which, in turn, is achieved by positioning the loading coil as high as possible on the antennas structure.

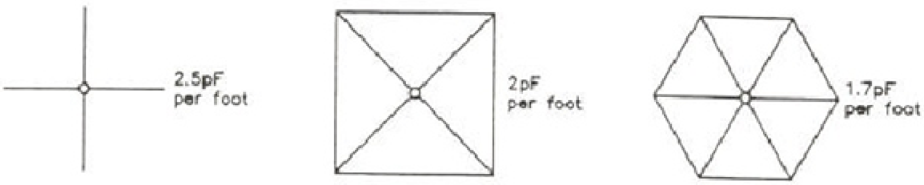
3.2 Antenna Capacity:

Increasing the antenna capacity increases the system bandwidth and efficiency by reducing the necessary value of loading coil inductance together with its series loss resistance.

Antenna capacities can be roughly estimated using the following data:

Antenna	Approximate Capacitance Allowance
Base-insulated vertical lattice tower	5 – 6pF per foot
Whip or other than vertical radiator	4pF per foot
Single horizontal or vertical wire	3pF per foot

Where more than a single wire is used, the effective capacity per foot is reduced by mutual coupling between the wires therefore they should be positioned as far apart as possible. Considering the plan view of the top loading umbrella perpendicular to the mast, the following capacitance can be estimated for the total length of the radiating elements.



When top loading guys are used, the capacity per foot is reduced because they do not lie in a single plane and the coupling between the guys are vertical radiator is increased. Where four top loading guys at 45° to the mast are used, a capacity of 1.5pF per foot may be estimated.

3.3 Ground Loss Resistance

Calculation of the effective series loss resistance of particular ground mat configuration is rather complex and is not covered in detail here. Instead, examples of some commonly used arrangements using sets of radial conductors placed symmetrically around the antenna base are shown. These may be used as a guide to estimate the ground loss resistance for similar configurations.

Number of Radials	Length of Radials	Ground Resistance (ohms) at Operating Frequency (Fo)			
		200kHz	300kHz	400kHz	500kHz
6	165ft	15	8	6	5
18	500ft	4.5	4	3.5	3
120	1000ft	2.5	2	1	0.5

It should be emphasized that these values are approximate, being somewhat dependent upon the effective height of the associated antenna and the ground conductivity in the vicinity of the ground mat.

3.4 Antenna Loss Resistance

This resistance is usually quite small and can be ignored in all but the most efficient antennas. A figure of $R_A = 0.1$ ohm could be used as a rough approximation.

3.5 Sample Calculations of Antenna Characteristics

Consider a base insulated, 150ft lattice tower with umbrella top loading consisting of four radials each 50ft long. Its ground plane uses 24 x 500ft radials. The antenna is fed from a 1kW transmitter at 300kHz modulated at 1020Hz. Estimate the antenna reactance, effective height, radiation resistance, ground loss resistance, efficiency, bandwidth, sideband attenuation and peak voltage (assume a coil Q of 300).

3.5.1 Antenna Capacities:

Mast capacity $C_M = 6 \times 150 = 900\text{pF}$

Top hat capacity $C_H = 4 \times 50 \times 1.5 = 300\text{pF}$

Total capacity = 1200pF

Antenna reactance $X_L = -j\left[\frac{1}{2\pi F_O C}\right] = -j\left[\frac{1}{2\pi \times 300 \times 10^3 \times 1200 \times 10^{-12}}\right]$

$X_C = -j\ 442$ ohms

The loading coil reactance must be +j 442. Assuming of coil Q factor of 300 the coil loss resistance

$R_L = \frac{442}{300} = 1.47$ ohm

3.5.2 Radiation Resistance

From **Equation 7**

Effective height $h_e = h\left[1 - \frac{1}{2}\left(\frac{C}{C_M + C_H}\right)\right]$

$$= 150\left[1 - \frac{1}{2}\left(\frac{900}{900 + 300}\right)\right]$$

$h_e = 93.75$ ft.

wavelength at 300kHz = $\frac{300x10^6 m}{300x10^3} = 1000m$

= 3280ft

from **Equation 1**

Radiation resistance $R_R = 160x\pi^2 x \left(\frac{93.75}{3280}\right)^2$

R_R = 1.29 ohm

3.5.3 Ground Loss Resistance:

From table in paragraph 3.3 the ground loss resistance will be less than 4 ohms, say 3.9 ohms.

3.5.4 Antenna Efficiency:

from **Equation 2**

Antenna Efficiency N = $\frac{R_R}{R_R + R_L + R_A + R_G} x100\%$

$= \frac{1.29x100\%}{1.29 + 1.47 + 0.1 + 3.9} = 19.1\%$

Hence, radiated carrier power = 1kW x $\frac{19.1}{100}$ = 191W

The radiated power = I_A^2 x R_R = 191W

From equation **Equation 4**

$$A_S = 10\log_{10} \frac{1}{1 + Q_A{}^2 x \left(\frac{2F_M}{F_O}\right)^2} dB$$

Sideband Attenuation =

$$10\log \left| \frac{1}{1 + 65.38^2 \left(\frac{2040}{300x10^3}\right)^2} dB \right|$$

= 0.78dB
or mod depth is reduced by 8.6%

i.e. if mod depth were 95% at the input, the radiated mod depth would be 95 x .914 = 86.8%.

Hence, effective modulation component of antenna current = I_A x .868.

3.5.6 Peak Antenna Voltage:

At the peak of the modulation envelope the antenna voltage is given by

V_p = (I_A + .868 I_A) √2 X_C
= 1.868 x 12.16 x √2 x 442 = 14,196V peak