

## Technical Notes on Equivalent Flatplate Area and Wind Loading given in Kathrein, Scala Division Catalogs

Calculating the equivalent flat plate area is a simple matter of determining the drag coefficient and multiplying it by the frontal cross-sectional area.

### Equivalent Flatplate Area

$$EFA = C_D A \quad (\text{Equation 1})^*$$

Where: EFA is the Equivalent Flatplate Area  
 $C_D$  is the Drag coefficient  
 A is the cross sectional area

The difficulty is in determining the drag coefficient itself, which varies considerably depending on the shape of the antenna. The drag coefficient may be determined experimentally if a known drag force is measured with a known airstream velocity by:

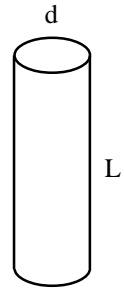
$$C_D = \frac{F_D}{\frac{1}{2} \rho V^2 A} \quad (\text{Equation 2})^*$$

Where: V is the freestream velocity  
 $\rho$  is the air density (1.29 kg/m<sup>3</sup> for STP)  
 $F_D$  is the drag force

\*These equations are valid for moderate wind speeds that are typically encountered for ground based antennas and should not be applied to aircraft antennas, for instance, where the air speed is much higher and laminar air flow may not occur. Likewise, the equations and coefficients apply to smooth surfaces, with minimal roughness. Either increased speeds or excessive surface roughness would lead to a transition from laminar to turbulent air flow.

The problem is determining the drag coefficient,  $C_D$ . Different references give the  $C_D$  for the common cross sections that are encountered. For instance for cylinders (a common omnidirectional antenna shape) the following Table can be used:

L/d	$C_D$	
$\infty$	1.20	(Table 1)
40	0.98	
20	0.91	
10	0.82	
5	0.74	
2	0.68	
1	0.64	

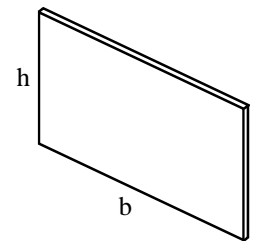


for other common shapes

Cube (face forward)	$C_D = 1.07$	(Table 2)
Cube (edge forward)	$C_D = 0.81$	
60° cone	$C_D = 0.5$	
Flat Disk	$C_D = 1.17$	

For a rectangular plate ( $C_D$  depends on aspect ratio)

b/h**	$C_D$	
$\infty$	2.0	(Table 3)
20	1.5	
10	1.3	
5	1.2	
1	1.18	



continued.....



All of these shapes can be used to approximate the antenna drag coefficient. For odd shaped antennas, the drag coefficients would need to be characterized either experimentally or by finite element analysis using computer analysis.

To conform to TIA/EIA Standard 222-F Structural standards for Steel Antenna Towers and Antenna Supporting Structures the drag coefficients for flat and cylindrical structures are summarized in Table 4:

	Aspect Ratio < 7	Aspect Ratio > 25	
Flat	1.4	2.0	(Table 4)
Cylindrical	0.8	1.2	

(linear interpolation may be used for aspect ratios other than shown).

These figures are in agreement with the data from other sources, such as DIN 1055 Part 4, Design Loading for Construction, and the previous Tables.

The equivalent flatplate areas given for Kathrein, Scala Division antennas are based on calculating the  $C_D$  for common shapes and adjusted using measured and computed data where available. The equivalent wind loads are computed using Equation 2 when those numbers are printed in our catalogs.

To use only the frontal cross-sectional area of the antenna for the equivalent flatplate area is not correct and does not conform to TIA/EIA –222-F standards for loads on antenna towers. The reason is that it considers neither the full frontal drag coefficient nor other wind incidence angles that may present greater drag coefficients. For example, panel antennas often have a more aerodynamic shape from the front than from the back.

Kathrein specifications state the worst case equivalent plate area, thereby removing the uncertainty factors introduced by wind direction. Large differences in specifications between similar competing products may be caused by not using the drag coefficient correctly. Users are cautioned to view with suspicion equivalent flat plate areas that are simply the antenna height multiplied by the antenna width since they are typically too low for panels and too high for omnis.

