Formula 1: $A = \pi L \frac{D}{12}$

Where

A = area in sq. ft.
L = length in ft.
D = diameter in inches.

Formula 2: $I_R = \frac{Sd(1-q)}{1000}$

Where

I_R = current requirement in amps
S = surface area in sq.ft.
d = current density in mA/sq.ft.
q = coating quality as a decimal

Formula 3a: $L = \frac{WCU}{8760I}$ Formula 3b: $W = \frac{8760LI}{CU}$

Where

L = years of life
W= anode weight in lbs.
C = energy capability in amp-hrs per lb.
I = current output in Amps.
U = Utilization factor as a decimal
8760 = hours in 365 days

Note: Energy capability is based on an efficiency of 50% for magnesium
C = (theoretical amp-hrs per lb.)(current efficiency)
For magnesium C = 500
U = 0.85

Formula 4a: Groundbed Resistance for a Single Vertical Anode (Dwight's Formula)

$$R = \left(\frac{0.00521\rho}{L}\right)\left(\ln\left(\frac{8L}{d}\right) - 1\right)$$

Where

R = resistance in ohms
L = anode length (package length) in feet
d = anode diameter (package diameter) in feet
ρ = resistivity in ohm-cm
ln is the natural logarithm function

Formula 4b: Groundbed Resistance for Multiple Vertical Anodes in Parallel (Sunde's Formula)

$$R = \left(\frac{0.00521\rho}{NL}\right)\left(\ln\left(\frac{8L}{d}\right) - 1 + \left(\frac{2L}{S}\right)\ln(0.656N)\right)$$

Where

R = resistance in ohms
L = anode length (package length) in feet
N = number of anodes
S = anode spacing in feet
d = anode diameter (package diameter) in feet
ρ = resistivity in ohm-cm
ln is the natural logarithm function

Formula 4c: Groundbed Resistance for a Single Horizontal Anode (Sunde's Formula)

$$R = \left(\frac{0.00521\rho}{L}\right)\left(\ln\left(\frac{4L^2 + 4L\sqrt{S^2 + L^2}}{dS}\right) + \frac{S}{L} - \frac{\sqrt{S^2 + L^2}}{L} - 1\right)$$

Where

R = resistance in ohms
L = anode (package length) in feet
S = twice the anode depth in feet
d = anode diameter(package diameter) in feet
ρ = resistivity in ohm-cm
ln is the natural logarithm function

Formula 5a: Driving Voltage and Life

$$V_d = \frac{0.0485 W_a N R_{gb}}{L_f}$$

Where

V_d is driving voltage in volts
W_a is the weight of one anode in lbs.
N is the number of anodes
R_{gb} is the groundbed resistance in ohms
L_f is the life of the system in years

Formula 5b: Driving Voltage and Polarized Potential

$$V_d = P_a - P_c$$

Where

V_d is driving voltage in volts
P_a is the open circuit potential of the anode
(1.55V for Standard Potential Magnesium)
(1.75V for High Potential Magnesium)

P_c is the potential of the cathode in volts. (polarized potential of the pipe)

Formula 5c: Driving Voltage and Sunde's Formula

$$V_d = \left(\frac{0.00025268 W_a \rho}{L_f L}\right)\left[\ln\left(\frac{8L}{d}\right) - 1 + \left(\frac{2L}{S}\right)\ln(0.656N)\right]$$

Where

V_d is driving voltage in volts
W_a is the weight of one anode in lbs.
N is the number of anodes
L is the length of the anode (package) in ft.
d is the diameter of the anode (package) in ft.
S is the spacing between anodes in ft.
L_f is the life of the system in years
ln is the natural logarithm

Formula 6: Groundbed Current Output

$$I = \frac{P_a - P_c}{R_{gb}} = \frac{V_d}{R_{gb}}$$

Where

I = Output current in amps
P_a = Anode potential in volts
(1.55V for Standard Potential Magnesium)
(1.75V for High Potential Magnesium)
P_c = Cathode potential in volts
(potential to which the pipe is to be polarized)
R_{gb} = Groundbed resistance in ohms
V_d = Driving voltage

Formula 7: Current Output for One Anode

$$\mathbf{I_1 = (P_a - P_c)/R_{gb}}$$

Where

I_1 is the current output of one anode
P_a is the anode potential
(1.55V for Standard Potential Magnesium)
(1.75V for High Potential Magnesium)
P_c is the cathode potential (0.85V)
R_{gb} is the groundbed resistance for a single anode (from Dwight's formula)