Critical Frequency Design Formulas (20091117) R1 >>>

01.0 – *Critical Speed* –

$\omega_n = (\pi/l)^2 * k * (g * E/\gamma)^{0.5}$

Where >>>

ω_n = Frequency in Cycles per second
k = Radius of Gyration
g = Acceleration due to Gravity
E = Young's Modulus of Elasticity
γ = Weight Density
l = Length of shaft in inches
f_n = Cycles per minute or revolutions per minute
Rpm = Revolutions per minute

02.0 - $\omega_n = 2\pi f_n$

03.0 - f_n (cycles per minute or Rpm) $= 30\pi\ (gE/\ \gamma)^{0.5} * k/l^2$ when reduced using at least 4 decimal places and U S Bureau of Standards values for all of the constants it becomes >>>

$$\mathbf{19{,}074{,}672.75 * k/l^2}$$

04.0 - By substituting the k (k = d / 4 for a solid shaft) for a solid shaft the formula becomes >>>

N_1 (Revolutions per minute) $= 4768668.188\ d/l^2$ (As appears in the Machinery's Handbook for Steel))

However, any "k" will give the resonant Rpm frequency of the so called "shaft". Whether it is a tube, triangle, or square all that is required is the proper "k".

Once the resonant Rpm is known then the maximum ***operating*** Rpm is $2^{-½}$ or 0.707 of the resonant Rpm. This is the resonant curve half power point – sometimes referred to as the "3db down point" on resonant curves. Some screw manufacturer's use 0.8 instead of the 0.707 number. Both seem to work, but Vanair has found that on some rare occasions the 0.8 can lead to a slight wobble of the shaft. This is especially true if it is a **"fixed-free"** shaft mount.

Note – Shaft end connections are addressed in another Technical Design Manual (TDM)