

# “SULLIVAN” STATOR COUNT DIAGRAM

By William Sullivan, P.E.

The “Sullivan” stator count diagram was developed in order to get all of the frequency avoidance information relating to periodic excitations (e.g., stator vanes) for an axial compressor (or any multi-staged turbo machine) on one page. It is essentially a one-page stage-by-stage Campbell diagram.

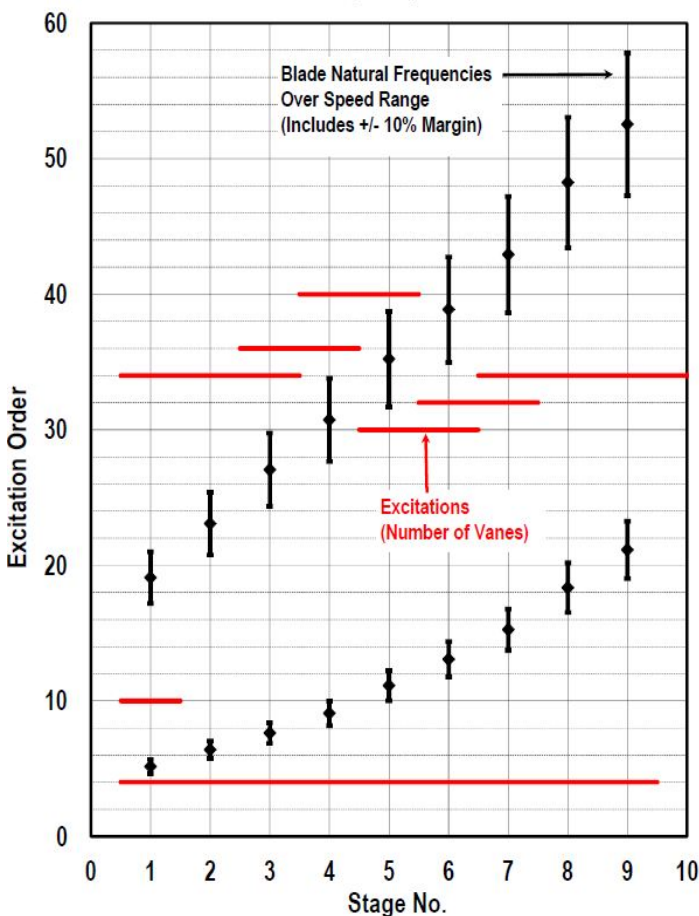


Figure 1: Sullivan Diagram for an Axial Compressor at 6,000 rpm

With a Campbell diagram, the blade and excitation frequencies vs. rotor speed are presented on a single plot for each stage. Therefore, to review the frequency avoidance situation for a multi-stage compressor one has to flip through as many pages as there are stages (probably taking notes for each stage). Furthermore, for many machines, both the upstream and downstream sources of excitation must be examined. In these cases, trying to keep track of the effects of individual stator

counts on the adjoining blade rows can get confusing (and is why the Sullivan diagram was developed in the first place).

Basically, rather than plot the frequencies vs. rotor speed for each stage on a single plot, as is done with a Campbell diagram. The Sullivan diagram has the frequencies for all stages plotted on one chart (Figure 1). What makes the diagram particularly useful for avoiding periodic flowpath excitations is that all of the frequencies are plotted as multiples of rotor speed, thus making the identification of good and bad stator counts immediately evident.

The excitation order equation is  $E = 60 F / N$

Where:

E = Excitation Order, Excitations (Cycles) per Revolution

F = Frequency, Cycles per Second

N = Rotor Speed, Revolutions per Minute

When plotting a particular rotor blade mode of vibration, an excitation order is calculated at the minimum operating speed minus any required separation margin and an excitation is calculated at the maximum operating speed plus the separation margin. The two orders are joined by a thick bar as seen on the sample diagram. The stator counts are plotted directly as excitation orders for whatever stages they affect (or are assumed to affect). For example, for the sample diagram shown, the 30 vanes of the fifth stage affect both the fifth stage blades (upstream) and the sixth stage blades (downstream).

Although this procedure appears rather cumbersome, it is easily adapted to a spreadsheet and has become our preferred tool for setting stator counts for axial compressors.

*For more information:*

Email: [rms@rotatingmachinery.com](mailto:rms@rotatingmachinery.com)

Tel: 484-821-0702

**Headquarters**

2760 Baglyos Cir.  
Bethlehem, PA 18020

**Houston Office**

16676 Northchase Dr., Ste 400  
Houston, TX 77060

**[rotatingmachinery.com](http://rotatingmachinery.com)**

Tel: 484-821-0702

Parts: [rms@rotatingmachinery.com](mailto:rms@rotatingmachinery.com)



**Rotating Machinery Services, Inc.** | 2760 Baglyos Circle, Bethlehem, PA 18020 | Tel: 484-821-0702