

Understanding Trip Multiply

Steve Sabin

Editor, ORBIT magazine

steve.sabin@ge.com

Trip Multiply and various inhibit features are included on many continuous monitoring systems. Within GE's Bently Nevada™ product line, these include the 3500, 3300, 7200, 1701, 1900/65, and numerous other systems released over the years. The purpose of Trip Multiply is to temporarily elevate alarm setpoints by a pre-configured multiple (usually 2X or 3X) based on a signal supplied by the machine's control system. This signal may be a contact closure from the machine control system, or in some cases, it may be via a digital communications link (for example, Modbus® protocol) on selected monitoring systems supporting such interfaces. The Trip Multiply function was developed specifically to address, and is intended only for, channels that monitor a machine's radial vibration while allowing the asset to ramp through regions of operation where a resonance (i.e., "critical speed") exists.

As shown in Figure 1 for a hypothetical machine operating above its first balance resonance, the peak vibration amplitude (A_{res}) occurs at its resonant speed (RPM_{res}). This amplitude is significantly larger than the amplitude A_{norm} encountered when the machine is running at its steady-state running speed RPM_{norm} .

Notice that while the Alert and Danger alarm levels ($Alert_{norm}$ and $Danger_{norm}$) established for the machine during steady-state operation are quite appropriate, they are too low to allow the machine to pass through its resonance. Unless the time delay chosen for the alarms exceeds the time during which the machine ramps through its resonance, the alarms will trigger.

Although these spurious alarms can be dealt with in three ways, as summarized next, Trip Multiply is the preferred method.

1. Trip Multiply can be used to temporarily elevate the alarm levels while the machine is in the RPM ranges

corresponding to its resonance. This is shown in Figure 1 as the alarm levels $Alert_{mult}$ and $Danger_{mult}$, which would be in effect while the machine is between speeds RPM_A and RPM_B . Note that when the machine is outside these RPM ranges, its normal alarm levels are used. Notice also that Trip Multiply provides appropriate alarm levels at all stages of machine operation, ensuring it is never without shut-down protection.

2. Inhibit functionality can be used to temporarily suppress all alarming. However, there are various types of "inhibit" functions supplied with GE's Bently Nevada™ monitoring systems. Some, such as **Rack Inhibit**, essentially disable all functions of the monitoring system — not just alarms. Thus, this type of inhibit will essentially result in running completely "blind" with no indication of vibration levels whatsoever.

Other types of inhibit, such as **Alarm Inhibit**, suppress alarms while allowing the vibration to still be displayed. Still other types of inhibit, such as **Special Inhibit**, are meant to address specific machine types and the need to suppress alarming in certain operating regions. It is important to note, however, that inhibit functionality is almost never intended to take the place of Trip Multiply functionality. Instead, it is normally reserved for situations such as performing maintenance on an instrumentation system while the machine is still running, eliminating the possibility of a false trip.

3. Alarm Time Delays can be used to ensure that a channel must continuously be above its alarm setpoint for a pre-established duration before the alarm will trigger. This can be useful on machines that pass very rapidly through a resonance. For example, if the starting sequence for a machine causes it to accelerate through its resonance region within 2 seconds,

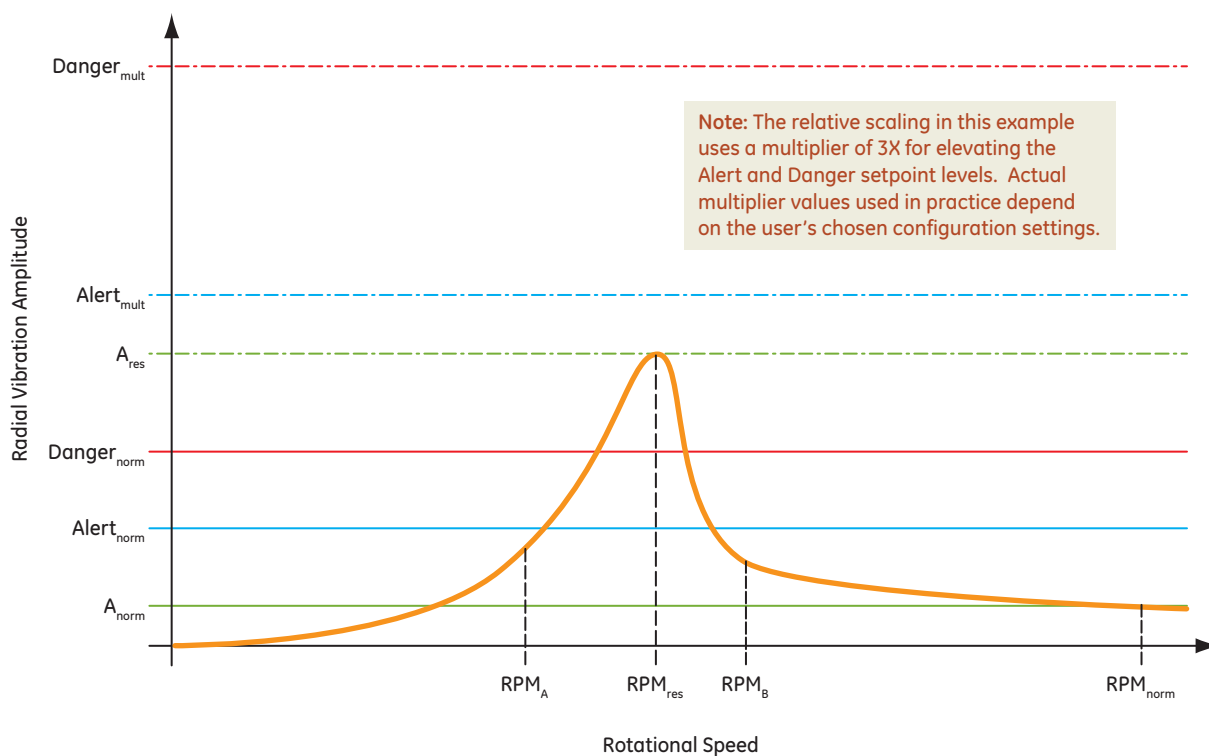


Figure 1 – Trip Multiply Example.

and the alarm time delays are set for 3 seconds, the machine will safely pass through its resonance without generating spurious alarms. A disadvantage to this strategy, however, is that if a problem occurs with the starting sequence and the machine dwells longer than expected in its resonance region, an alarm will occur. Another disadvantage is that the starting sequence for some machines may not be rapid enough to accelerate through the resonance relatively quickly, necessitating unreasonably long alarm delays. Long alarm delays can in turn allow significant machinery damage to occur before an auto-shutdown ensues, particularly with malfunctions such as rubs or severe imbalance that can destroy internals the longer they go unchecked.

For the reasons mentioned above, we recommend the following when establishing a radial vibration alarm strategy:

- Establish alarm levels and time delays based on the machine's normal running speed(s) and load(s)

- If these levels and time delays do not allow the machine to pass through a resonance without generating spurious alarms, consider the use of Trip Multiply.
- Reserve inhibit functionality only for instrument maintenance or other occasions when the machinery protection needs to be knowingly bypassed. It should not generally be used in place of Trip Multiply.

Important: When using Trip Multiply, make certain the multiplied alarm setpoint does not exceed the dynamic range (which may be different than the full-scale range) of the monitor channel. Otherwise, the alarm will never trigger. For example, if a monitor channel has a dynamic range of 10 in/sec, a full-scale range of 2 in/sec, a normal danger setpoint of 1.5 in/sec, and a Trip Multiplier of 8X, this corresponds to a multiplied danger setpoint of 12 in/sec. The monitor will saturate at 10 in/sec and the multiplied alarm (12 in/sec) will not trigger.

Additional information on this topic can be found in Appendix I of *American Petroleum Institute Standard API-670, 4th Edition*. 