STEAM TURBINE ROTOR OVERSPEED TRIP

By Timothy Coull

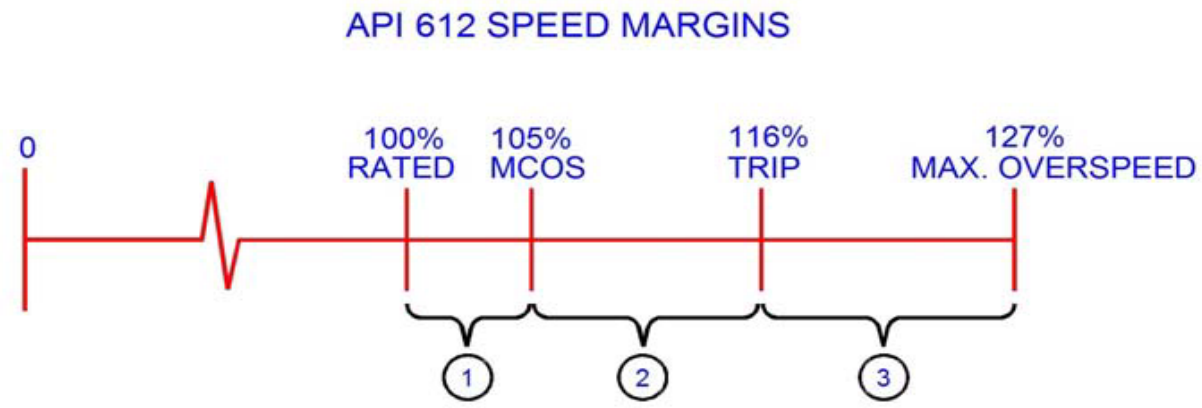
When rerating a steam turbine, determining the trip speed is of great importance to ensure the safety and reliability of the machine. Given the nature of steam turbine design, a number of factors come into play when establishing this critical parameter.

API 612 requires that a steam turbine rotor not exceed 127% of rated speed at an instantaneous loss of coupled load. The figure 127% compiles three different speed margins: 1) 105% from rated to maximum continuous operating speed (MCOS), ensuring that slight variations in operating conditions will not prove detrimental to the long-term operation of the machine; 2) 110% from MCOS to trip speed, allowing for excursions beyond continuous operating conditions without having to cease operation altogether; and 3) 110% from trip to maximum overspeed, accounting for the continued acceleration of the rotor between receiving the trip signal, fully closing the trip valve, and passing the last of the steam through the machine. Practically speaking, every machine has its own unique parameters and conditions, and it can be difficult to fit neatly into API speed margin guidelines. It is sometimes necessary to take exception to API and tweak the speed margins to accommodate individual cases.

Control characteristics and operating condition stability mainly determine a machine's allowable speed margins. However, when setting the trip speed, the two most important parameters to keep in mind are: 1) the maximum overspeed must be defined such that the rotor is temporarily capable of safe operation; and 2) the trip point is set such that the rotor will not exceed that maximum overspeed after instantaneous coupling failure. Ideally, the trip speed should be set such that the machine does not experience nuisance trips, and that the rotor would also be capable of reaching the maximum overspeed without any immediate need for maintenance or repair.

The two parameters that have the greatest affect on the overspeed margin are the rotor inertia and system response time. A low-inertia rotor will reach higher speeds more quickly, and a longer system response allows more time to accelerate to higher speeds. For large rotors, the system response time may not be of great concern and, if other design parameters need to be accommodated, the trip speed could be set a bit closer to the maximum overspeed than what API guidelines recommend. On the other hand, the trip speed on small rotors may need to be set lower and/or the trip system response time may need to be reduced to avoid reaching dangerously high speeds beyond the maximum overspeed.

Of course, there are instances where steam turbines operate with stable conditions, at mechanically-sound speeds, have large rotor inertias, and with quick trip system response time where the trip speed can easily follow API guidelines. However, on a case-by-case basis, this critical parameter often requires more detailed consideration and finesse to achieve the desired outcome of safe, yet effective operation.



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