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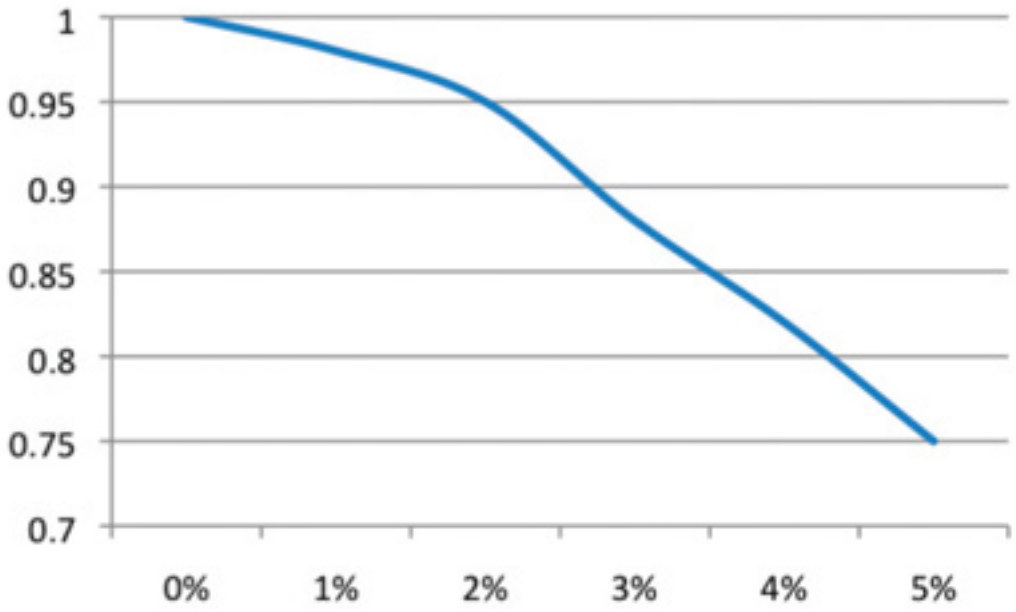
Voltage unbalance and its most severe form—*single phasing*—cause up to 14% of motor failures [1]. It's important to understand that maximum current unbalance isn't defined in standards for motors in the field. Voltage unbalance, which has direct impact on the operating life and characteristics of an electric motor, is defined.

The National Electrical Manufacturers Association (NEMA) standard MG-1 defines the maximum voltage unbalance to be applied to an electric motor as 5%, and notes that a derating factor must be applied to a motor operating with a voltage unbalance.



Voltage Unbalance Derating Factor

Voltage unbalance is relatively simple to calculate. It requires measurement of the phase-to-phase voltage of the supply to a three-phase motor. The first step is to take all three measured voltages, add them together and divide by three. This will be your V_{ave}. Next, subtract the voltage furthest from the V

ave

, change it to a positive value, then divide by V

ave
and multiply by 100%.

For example, if you have V_{a-b} = 465V, V_{a-c} = 480V and V_{b-c} = 467V, then (465V + 480V + 467V)/3 = 471V $_{ave}$. Then ((480-471)/471) x 100% = 1.9%. Applied to the above chart, you would then multiply the horsepower or kilowatt rating of the motor times 0.95. In effect, a 10-hp motor would have to operate as a 9.5-hp motor.

If voltage unbalance is detected, you should identify the cause. If you see a current unbalance with a low-voltage unbalance, try rotating the phases, then recheck current. (Rotate phases by moving the lead from phase A to phase B, phase B to phase C and phase C to phase A. This doesn't change the direction of rotation.) If, upon rechecking current, the unbalance moves, it's motor-related. If the unbalance stays in the same location or disappears, it's supply-related. **MT**

1. Cooper Bussman Corp., Motor Protection: Voltage Unbalance and Single-Phasing, 2003.

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