## Proper Fitting/Substitution of Capacitors

How important is it to match the capacitance rating specified by the motor? In short, it's very important -- even critical. In order to ensure the proper motor operation that the manufacturer designed it for, and to prevent damage to the motor, always use the exact same nominal rating of capacitance specified by the motor nameplate.

There is always a tolerance level on the microfarad (µF) rating. A typical tolerance on the capacitance of a motor run capacitor for HVAC applications is +/-6%. With this being said, that means that a 40 µF capacitor can rate from 37.6 to 42.4 µF and still be considered a passing capacitor.

When engineers design motors, they take into consideration this type of tolerance range. They specify the nominal (40 µF) rating along with a tolerance (+/-6%) to make sure that if the capacitor is to be replaced, the motor will provide the same performance that it was designed for.

Given the explanation above for the tolerance ranges, it is not suggested to use a 35 µF in place of a 40 µF.

**40 µF ±6% = 37.6 to 42.4 µF  35 µF ±6% = 32.9 to 37.1 µF**

As you can see, the high side of the 35 µF capacitance tolerance (37.1 µF) does not meet the low side of the capacitance tolerance of the 40 µF (37.6 µF) capacitor you are trying to replace it with. This also is the same for 5 µF and the 4 µF capacitors.

**5 µF ±6% = 4.7 to 5.3 µF  4 µF ±6% = 3.76 to 4.24 µF**

Using improperly sized capacitors can have a variety of detrimental effects on the motor. If the capacitor's µF rating is less than the motor was designed for, the motor winding current will be too high. If the capacitor's µF rating is higher than the motor was designed for, the motor winding current will be too low. Either scenario can lead to one or more of the following:

- Reduced motor speeds
    - reduces system airflow/cooling
    - increases system noise
- Temperature increase
    - causes bearing wear and lubrication loss
    - results in insulation breakdown
    - increases noise
- Lower motor efficiency
    - increases energy consumption
    - reduces system and motor life
- Improper equipment operation
    - results in improper cycling
    - increased noise
    - stresses other components

Motors are designed with a specific, nominal rating and tolerance.