Starting Methods for Large Medium Voltage Motors

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Most ac motors, both synchronous and induction, are started “across the line”; that is, the starting contactor or circuit breaker connects the 3-phase motor winding directly to the 3-phase power supply. However, when motors are large with respect to the capacity of the power system it is often necessary to use a starting method that reduces the impact on the power system caused by starting the large motor. Several methods of accomplishing this task are available. This reduced-impact starting is frequently referred to as reduced voltage starting because most of the common methods involve applying a reduced voltage to the motor winding. Some of the more common methods are described below.

- **Autotransformer:** An autotransformer is connected between the power source and the motor during the starting period. Motor starting autotransformers usually have taps that apply 80%, 65%, or 50% of the line voltage to the motor to start. Line current is reduced by the square of the tap; that is, using the 80% tap on the autotransformer requires only 64% of the across the line starting current. Starting torque is also 64% on the 80% tap. Unless otherwise requested, the autotransformer will be the medium duty type, allowing 3 starts, followed by an hour's rest before repeating the three starts. Modern starters use the closed transition switching sequence, in which the autotransformer winding is converted briefly to a series reactor near the end of the starting sequence, then shorted out. This sequence requires three switching devices (circuit breakers or contactors).

- **Reactor:** A reactor is connected in series with the motor. These reactors usually have taps that apply 80%, 65%, or 50% of the line voltage to the motor to start. Line current is reduced to the tap value; that is, using the 80% tap on the reactor requires 80% of the across the line starting current. Starting torque is reduced by the square of the tap, and is 64% on the 80% tap. The reactor may be placed on the line side of the motor or in the neutral. Reactor start requires only two switching devices.

- **Capacitor:** A bank of capacitors is connected in parallel with the motor during starting, canceling out the large reactive current drawn by the motor on starting. The motor thinks it is seeing a full voltage start, while the power system thinks it is seeing a running motor. The capacitors are removed from the circuit as the motor reaches running speed. Two switching devices are required.

- **Wound Rotor:** For induction motors only. See PTB 69 for further information.

- **Solid-state Drives:** A wide variety of starting and speed control performance can be obtained through the use of modern solid-state drives.

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