Stator Overheating Protection

Stator Overheating Protection (on photo bottom of the Motor Stator Winding; by electrical-forensics.com)

Overheating

All motors need protection against overheating resulting from ***overload***, ***stalled rotor***, or***unbalanced stator currents***.

For complete protection, **three-phase motors** should have an ***overload element in each phase***. This is because an open circuit in the supply to the power transformer feeding a motor will cause twice as much current to flow in one phase of the motor as in either of the other two phases, as shown in ***Figure 1***.

Consequently, to be sure that there will be an overload element in the most heavily loaded phase no matter which power-transformer phase is open-circuited, one should provide overload elements in all three phases.

In spite of the desirability of overload elements in all three phases, motors rated about ***1500 hp***and below are generally provided with elements in only two phases, on the assumption that the open-phase condition will be detected and corrected before **any motor can overheat**.

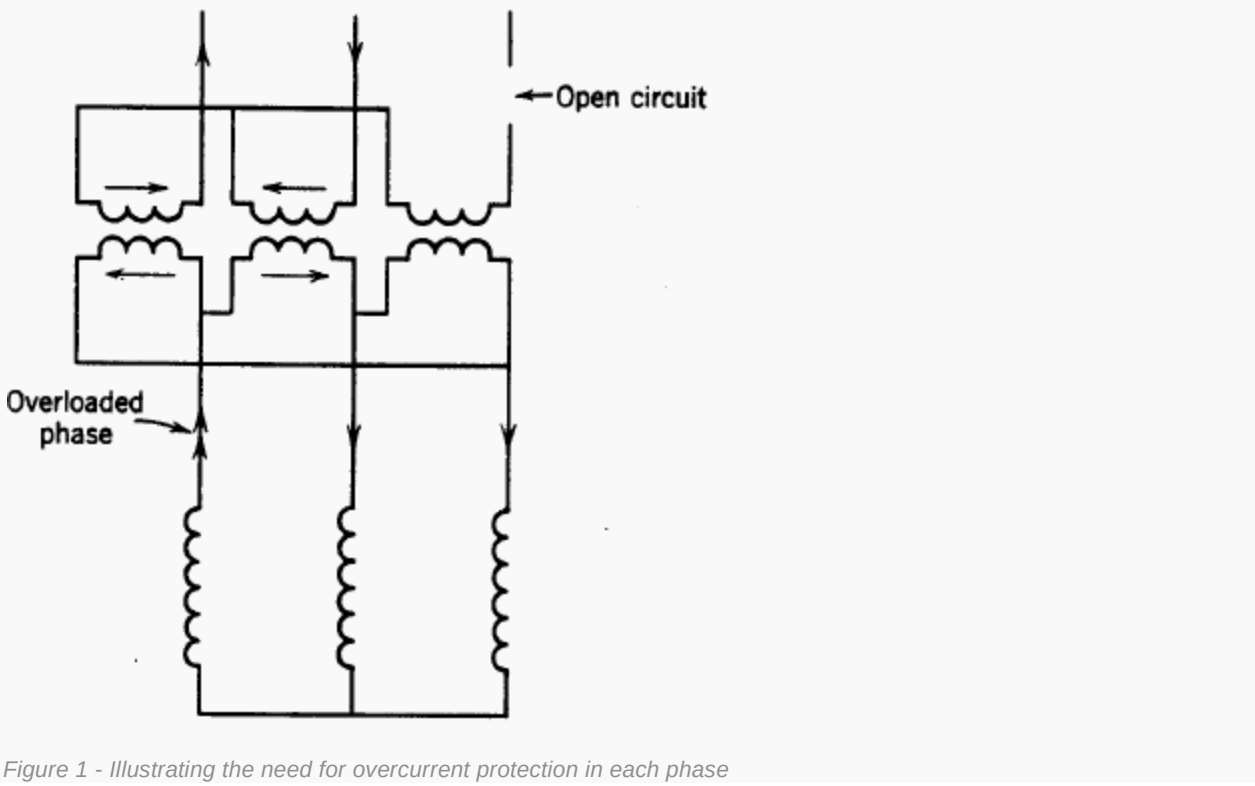

Figure 1 - Illustrating the need for overcurrent protection in each phase

Single-phase motors require an overload element in ***only one of the two conductors***.

Motors Other than Essential Service

Except for some essential-service motors, whose protection will be discussed later, it is the practice for motors rated less than about 1500 hp to provide either replica-type **thermal-overload relays** or long-time inverse-time-overcurrent relays or direct-acting tripping devices to disconnect a motor from its source of supply in the event of overload.

Which type of relay to use is largely a matter of ***personal preference***.

Other things being equal, the replica type will generally provide the best protection because, as shown in ***Figure 2***, its time-current characteristic more nearly matches the heating characteristic of a motor over the full range of overcurrent; also, it may take into account the heating effect of the load on the motor before the overload condition occurred.

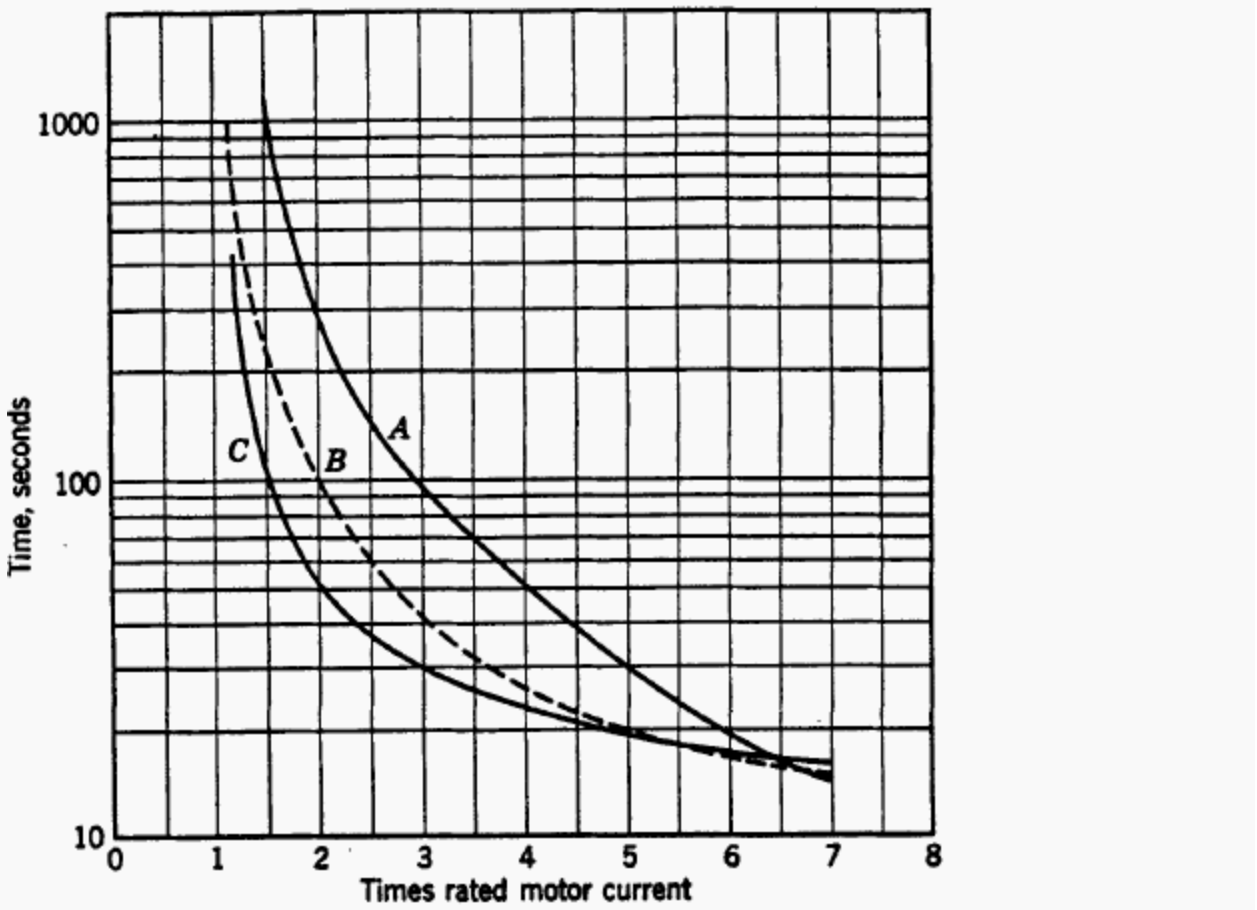

Figure 2 - Typical motor-heating and protective-relay characteristics. A, motor; B, replica relay; C, inverse-time relay.

The ***inverse-time-overcurrent relay*** will tend to "***overprotect***" at low currents and to "***under protect***" at high currents, as shown in ***Figure 2***.

Inverse-Time Overcurrent type e ICM 21 - ABB

However, the overcurrent relay is very easy to adjust and test, and it is self-reset. For continuous-rated motors without service factor or short-time overload ratings, the protective relays or devices should be adjusted to trip at not more than about 115% of rated motor current.

For motors with ***115% service factor***, tripping should occur at ***not more than about 125% of rated motor current***. For motors with special short-time overload ratings, or with other service factors, the motor characteristic will determine the required tripping characteristic, but the tripping current should not exceed about 140% of rated motor current.

The manufacturer's recommendations should be obtained in each case.

The overload relays will also provide protection in the event of phase-to-phase short circuits, and in practice one set of such relays serves for both purposes wherever possible.

A survey of the practice of a number of power companies45 showed that a single set of longtime inverse-time-overcurrent relays, adjusted to pick up at ***125% to 150% of rated motor current***, is used for combined short-circuit and overload protection of non-essential auxiliary motors; they are supplemented by instantaneous overcurrent relays adjusted as already described.

Such inverse-time overload relays must withstand short-circuit currents without damage for as long as it takes to trip the breaker. Also the minimum requirements as to the number of relays or devices for either function must be fulfilled.

Motors rated higher than about 1500 hp are generally provided with resistance temperature detectors embedded in the stator slots between the windings. If such temperature detectors are provided, a single relay operating from these detectors is used instead of the replica-type or inverse-time-overcurrent relays.

Also, ***current-balance relays*** capable of operating on about 25% or less unbalance between the phase currents should be supplied. If the motor does not have resistance temperature detectors, but is provided with current-balance relays, a single replica-type thermal overload relay may be substitutedfor the resistance-temperature-detector relay.

Specially cooled or ventilated motors may require other types of protective equipment than those recommended here. For such motors, the manufacturer's recommendations should be obtained.

Reference 50 gives more useful information on the subject of **industrial-motor protection**.

Essential-Service Motors

The protection recommended for some ***essential-service motors*** is based on minimizing the possibility of unnecessarily tripping the motor, even though such practice may sometimes endanger the motor. In other words, long-time inverse-time overcurrent relays are provided for all motor ratings, but they merely control an alarm and leave tripping in the control of an operator. Then, for motors that can suffer locked rotor, supplementary instantaneous overcurrent relays, adjusted to pick up at about ***200%*** to ***300%*** of rated motor current are used, and their contacts are connected in series with the contacts of the inverse time-overcurrent relays to trip the motor breaker automatically.

The instantaneous relays should be of the high-reset type to be sure that they will reset when the current returns to normal after the starting inrush has subsided. The protection provided by this type of equipment is illustrated in ***Figure 3***.

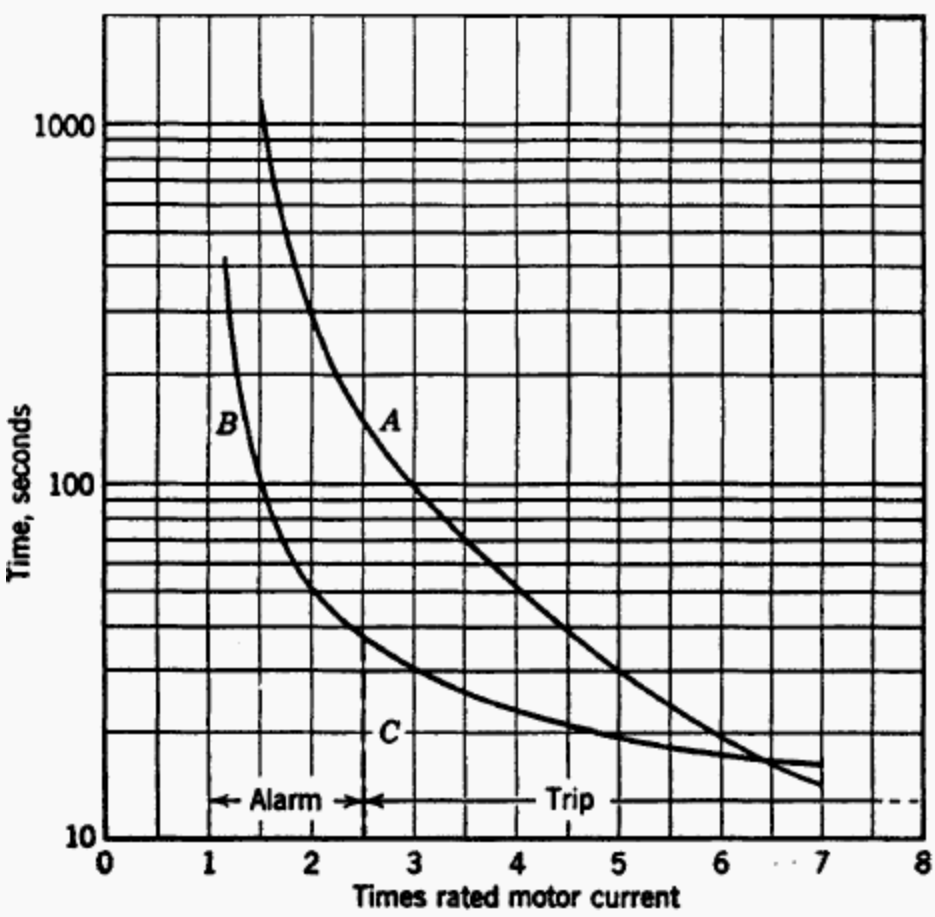

Figure 3 - Protection characteristic for essential-service motors. A, motor; B, inverse-time relay; C, instanteneous relay.

For essential-service motors for which ***automatic tripping*** is desired in addition to the alarm for overloads between about ***115% of rated current*** and the pickup of the instantaneous overcurrent relays, thermal relays of either the replica type or the resistance temperature-detector type should be used, depending on the size of the motor.
Such relays permit operation for overloads as far as possible beyond the point where the alarm will be sounded, but without damaging the motor to the extent that it must be repaired before it can be used again.

Resource: *The ART & SCIENCE of protective relaying – C. Russell Mason*

Source:

http://electrical-engineering-portal.com/stator-overheating-protection