(2) Transformers. Protection shall be permitted to be provided in accordance with 450.3.

(3) Less Than 50 Volt-Amperes. Control circuit transformers rated less than 50 volt-amperes (VA) and that are an integral part of the motor controller and located within the motor controller enclosure shall be permitted to be protected by primary overcurrent devices, impedance limiting means, or other inherent protective means.

(4) Primary Less Than 2 Amperes. Where the control circuit transformer rated primary current is less than 2 amperes, an overcurrent device rated or set at not more than 500 percent of the rated primary current shall be permitted in the primary circuit.

(5) Other Means. Protection shall be permitted to be provided by other approved means.

Motor control circuits can receive their power either from the load side of the motor short-circuit and ground-fault protective device or from a separate source, such as a panelboard.

Motor control circuits that receive their power from a separate source must be protected against overcurrent in accordance with 724.43 for Class 1 circuits. Conductor sizes 14 AWG and larger must be protected according to their ampacity listed in Tables 310.16 through 310.20. Conductor sizes 16 and 18 AWG must be protected at not more than 10 and 7 amperes, respectively, as specified in Table 430.72(B)(2).

If a motor control circuit is tapped from the load side of the motor branch-circuit short-circuit and ground-fault protective device, the size of the tapped conductor and the rating of the overcurrent device are based on whether the conductor stays within the motor control enclosure or leaves it. The load on a motor control circuit is similar to a motor branch-circuit load in that there is a predetermined connected load. An initial high inrush of current also occurs until the armature of the relay is seated and the current decreases to a steady state. Therefore, the overcurrent protection is similar to the short-circuit and ground-fault protection provided for a motor and is allowed to be greater than the ampacity of the control circuit conductor.

430.73 Protection of Conductors from Physical Damage. Where damage to a motor control circuit would constitute a hazard, all conductors of such a remote motor control circuit that are outside the control device itself shall be installed in a raceway or be otherwise protected from physical damage.

If damage to the control circuit conductors could result in an accidental ground fault or short circuit, causing the device to operate or rendering the device inoperative (either condition could constitute a hazard to persons or property), conductors must be installed in a raceway. Where boilers or furnaces are equipped with an automatic safety control device, damage to the conductors of the low-voltage control circuit (e.g., a thermostat) does not constitute a hazard (see Article 725, Part II).

430.74 Electrical Arrangement of Control Circuits. Where one conductor of the motor control circuit is grounded, the motor control circuit shall be arranged so that a ground fault in the control circuit remote from the motor controller will (1) not start the motor and (2) not bypass manually operated shutdown devices or automatic safety shutdown devices.

The inadvertent grounding of control circuits is a significant safety issue. Section 430.74 requires that if one side of the motor control circuit is grounded, the circuit must be arranged so that a ground fault in the remote-control device will not start the motor. For example, in the control wiring illustrated in Exhibit 430.14, the control circuit is a 120-volt, single-phase circuit derived from a 208-volt, 3-phase wye system supplying the motor, and one side of the control circuit is the grounded neutral. If the start button of the motor control circuit is connected to the grounded neutral, a ground fault on the coil side of the start button can start the motor. As shown in Exhibit 430.15, the same condition exists if the ground fault is in the wiring rather than in the control device itself. This hazardous condition can be alleviated by locating the start button in the ungrounded side of the control circuit, as shown in Exhibit 430.15.

Combinations of ground faults in motor and motor control circuits can also result in inadvertent motor starting. If the circuit

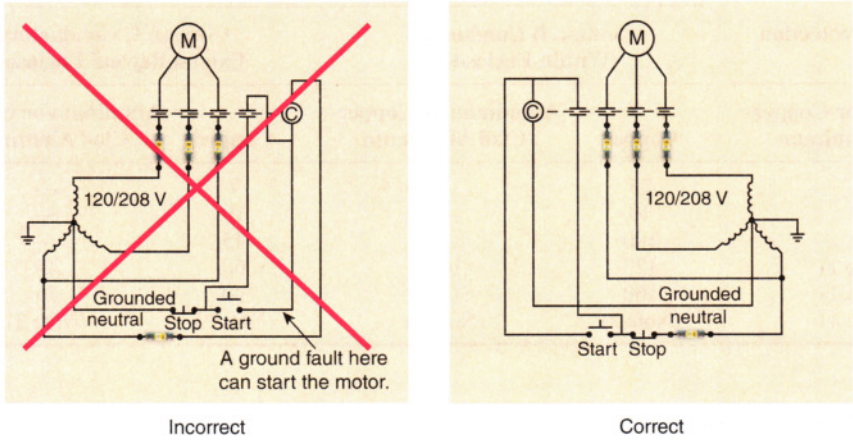

EXHIBIT 430.14 An example of control wiring in violation of 430.74 *(left)* and in compliance with 430.74 *(right)*. (For simplification, motor overload elements and disconnecting means are not shown.)