

jacket for outside installations) to protect against contact by personnel in the area.

**427.26 Isolation Transformer.** A dual-winding transformer with a grounded shield between the primary and secondary windings shall be used to isolate the distribution system from the heating system.

**427.27 Voltage Limitations.** The secondary winding of the isolation transformer connected to the pipeline or vessel being heated shall not have an output voltage greater than 30 volts ac.

*Exception No. 1: In industrial establishments, the isolation transformer connected to the pipeline or vessel being heated shall be permitted to have an output voltage greater than 30 but not more than 80 volts ac to ground where all of the following conditions apply:*

- (1) *Conditions of guarding, maintenance, and supervision ensure that only qualified persons have access to the installed systems.*
- (2) *Ground-fault protection of equipment is provided.*

*Exception No. 2: In industrial establishments, the isolation transformer connected to the pipeline or vessel being heated shall be permitted to have an output voltage not greater than 132 volts ac to ground where all of the following conditions apply:*

- (1) *Conditions of guarding, maintenance, and supervision ensure that only qualified persons service the installed systems.*
- (2) *Ground-fault protection of equipment is provided.*
- (3) *The pipeline or vessel being heated is completely enclosed in a grounded metal enclosure.*
- (4) *The transformer secondary connections to the pipeline or vessel being heated are completely enclosed in a grounded metal mesh or metal enclosure.*

The general requirement is that the secondary winding of the isolation transformer connected to the pipeline or vessel being heated is not permitted to have an output voltage greater than 30 volts ac. However, for installations in industrial establishments, Exception No. 1 permits a maximum voltage of up to 80 volts ac to ground, provided that the two listed conditions are met. Exception No. 2 permits a voltage of not more than 132 volts ac to ground for impedance heating of the pipeline or vessel where installed in industrial establishments, provided that the four listed conditions are met.

**427.28 Induced Currents.** All current-carrying components shall be installed in accordance with 300.20.

**427.29 Grounding.** The pipeline, vessel, or both, that is being heated and operating at a voltage greater than 30 but not more than 80 shall be grounded at designated points.

**427.30 Secondary Conductor Sizing.** The ampacity of the conductors connected to the secondary of the transformer shall be at least 100 percent of the total load of the heater.

## Part V. Induction Heating

**427.36 Personnel Protection.** Induction coils that operate or may operate at a voltage greater than 30 volts ac shall be enclosed in a nonmetallic or split metallic enclosure, isolated, or made inaccessible by location to protect personnel in the area.

**427.37 Induced Current.** Induction coils shall be prevented from inducing circulating currents in surrounding metallic equipment, supports, or structures by shielding, isolation, or insulation of the current paths. Stray current paths shall be bonded to prevent arcing.

## Part VI. Skin-Effect Heating

**427.45 Conductor Ampacity.** The ampacity of the electrically insulated conductor inside the ferromagnetic envelope shall be permitted to exceed the values given in Table 310.16, provided it is identified as suitable for this use.

**427.46 Pull Boxes.** Pull boxes for pulling the electrically insulated conductor in the ferromagnetic envelope shall be permitted to be buried under the thermal insulation, provided their locations are indicated by permanent markings on the insulation jacket surface and on drawings. For outdoor installations, pull boxes shall be of watertight construction.

**427.47 Single Conductor in Enclosure.** The provisions of 300.20 shall not apply to the installation of a single conductor in a ferromagnetic envelope (metal enclosure).

**Δ 427.48 Grounding.** The ferromagnetic envelope shall be grounded at both ends, and, in addition, it shall be permitted to be grounded at intermediate points as required by its design. The ferromagnetic envelope shall be bonded at all joints to ensure electrical continuity.

The provisions of 250.30 shall not apply to the installation of skin-effect heating systems.

## Part VII. Control and Protection

### 427.55 Disconnecting Means.

**(A) Switch or Circuit Breaker.** Means shall be provided to simultaneously disconnect all fixed electric pipeline or vessel heating equipment from all ungrounded conductors. The branch-circuit switch or circuit breaker, where readily accessible to the user of the equipment, shall be permitted to serve as the disconnecting means. The disconnecting means shall be of the indicating type and shall be capable of being locked in the open (off) position. The disconnecting means shall be installed in accordance with 110.25.

**(B) Cord-and-Plug-Connected Equipment.** The factory-installed attachment plug of cord-and-plug-connected equipment