



Recommended Practice for  
Installing and Maintaining

# Industrial Heat Tracing Systems



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National Electrical  
Contractors Association



**An American National Standard**

**NECA 202–2001**

*Recommended Practice for*

**Installing and Maintaining  
Industrial Heat Tracing Systems**



*National  
Electrical  
Installation  
Standards*<sup>TM</sup>

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**National Electrical  
Contractors Association**



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(This foreword is not a part of the standard)

# Foreword

*National Electrical Installation Standards™* are designed to improve communication among specifiers, purchasers, and suppliers of electrical construction services. They define a minimum baseline of quality and workmanship for installing electrical products and systems. *NEIS™* are intended to be referenced in contract documents for electrical construction projects. The following language is recommended:

Industrial heat tracing systems shall be installed in accordance with NECA 202-2001,  
*Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems* (ANSI).

Use of *NEIS™* is voluntary, and neither the National Electrical Contractors Association nor The Aluminum Association assume any obligation or liability to users of this publication. Existence of a standard shall not preclude any member or nonmember of either organization from specifying or using alternate construction methods permitted by applicable regulations.

This publication is intended to comply with the edition of the National Electrical Code® (NEC) in effect at the time of publication. Because they are quality standards, *NEIS* may in some cases go beyond the minimum safety requirements of the NEC. It is the

responsibility of users of this publication to comply with state and local electrical codes when installing electrical products and systems.

Suggestions for revisions and improvements to this standard are welcome. They should be addressed to:

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# 1. Scope

## 1.1 Electrical Heat Tracing of Pipes, Vessels and Associated Equipment Included

This recommended practice covers procedures for the installation, testing, and documentation of electrical freeze protection and process heat tracing systems. Heat tracing cable types covered by this publication include: self-regulating heating cables, zone heating cables, series resistance heating cables, and mineral insulated (MI) heating cables (*see Figures 1.1(a)-1.1(e)*).

System components used with these types of heat tracing cables include power transformers, control panels, temperature sensors, temperature controllers, contactors, circuit breakers, enclosures, conduit, wire, and all necessary auxiliary equipment and controls.

## 1.2 Electrical Heating Systems Excluded

The following types of heat tracing systems are specifically excluded from this publication:

- Skin Effect Heating Systems
- Impedance Heating Systems
- Inductance Heating Systems

## 1.3 Related Construction Materials

In addition to the electrical heat tracing components described in 1.1, this publication includes related construction materials including labels, adhesive tapes, attachment wire and components, and thermal insulation and cladding.

## 1.4 Code Requirements and Manufacturer's Recommendations

All recommendations of this publication are intended to comply with the National Electrical Code<sup>7</sup> (NFPA Standard 70) and, in general, the typical recommendations of electrical heat tracing manufacturers. However, regardless of these recommendations, installers should always follow the NEC, applicable state and local codes, and manufacturer's instructions. Articles 427 (ordinary areas) and 500 (classified areas) of the National Electrical Code govern the installation of electrical heat tracing systems. IEEE 515 and 515.1 are accepted industry standards that are also contain useful information about installing electrical heat tracing.

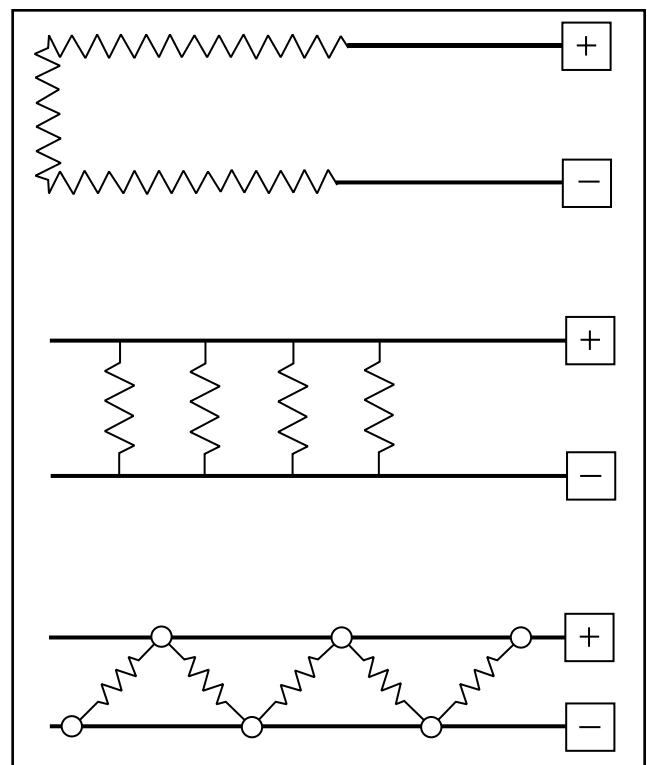


Figure 1.1(a). Types of electrical heating

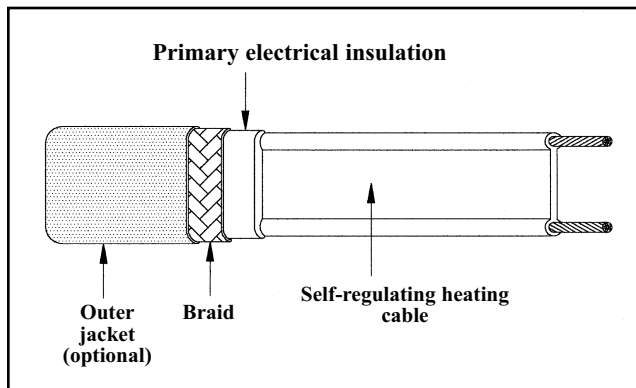


Figure 1.1(b). Self-regulating conductor polymer heating cable

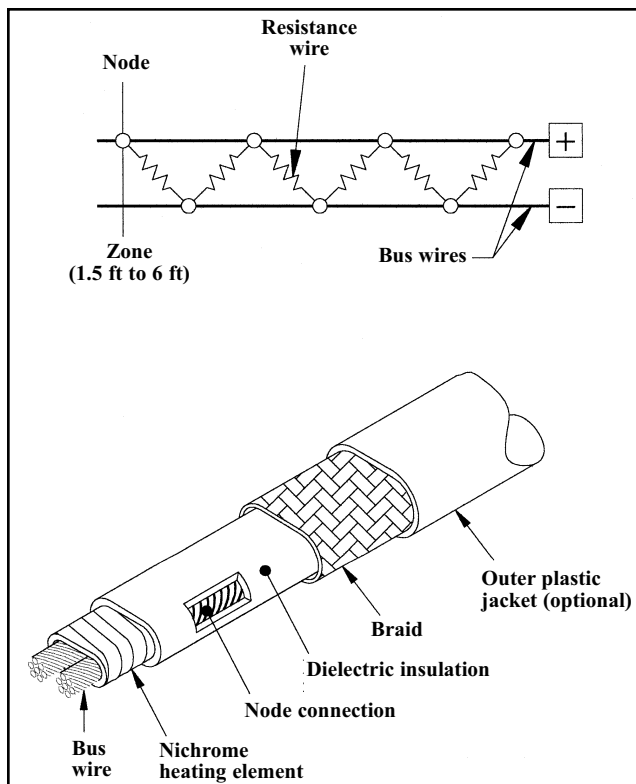


Figure 1.1(c). Zone heaters – polymer heating cable

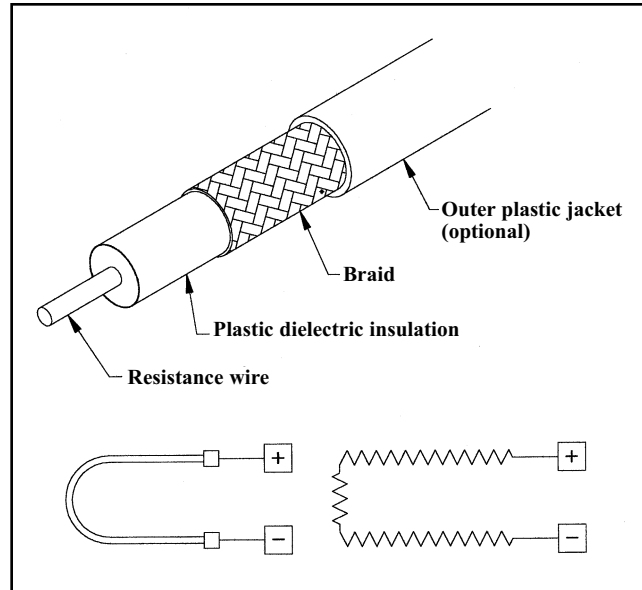


Figure 1.1(d). Series resistance cables

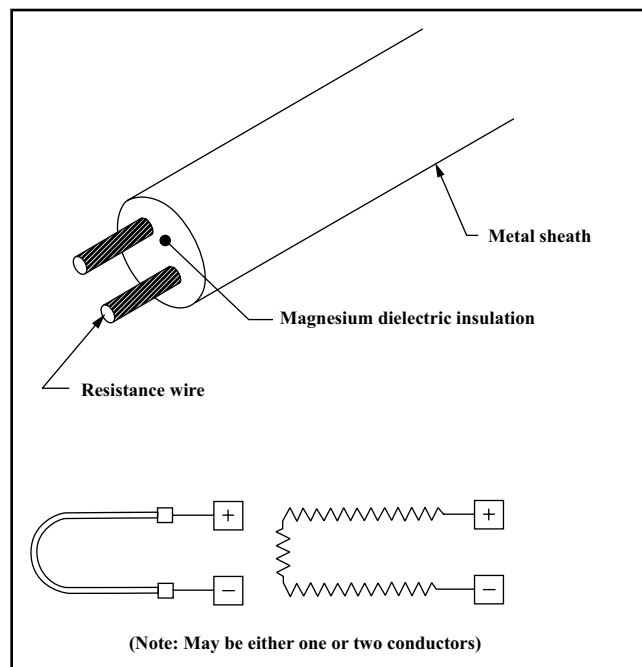


Figure 1.1(e). Mineral insulated (MI) cable

## 2. Definitions

### **Ground-Fault Protection of Equipment (GFPE)**

A system intended to provide protection of equipment from damaging line-to-ground-fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent device but high enough to protect equipment.

### **Electrical Heat Tracing Design Specification**

Information used to instruct designers and installers on required parts and construction methods for installing electrical heat tracing systems.

### **Piping System**

A length or lengths of pipe including pumps, valves, flanges, control devices, strainers, and/or similar equipment for conveying fluids.

### **Resistance Heaters**

A separate element to generate heat that is applied to a pipeline or vessel, externally or internally. Heating cable, heating tape, heating blankets, MI cable, self-regulating cable, and zone constant wattage cables are examples of resistance heaters.

### **Vessel**

A container such as a barrel, drum, or tank for holding fluids or other material.

# 3. Pre-Installation Checks

## 3.1 Check the Pipe to be Heat Traced

- a) Verify that the pipe has been pressure-tested, and that all equipment and supports are installed.
- b) Verify that any paint or coatings used on the pipe are dry.
- c) Walk the pipe systems and plan the routing of the heating cable on the pipe. Note the accessibility of all parts of the line, including power locations.
- d) Verify construction welding has been completed in the area.
- e) Remove any sharp edges or burrs that could damage the heating cable.

a vivid-color spray paint or a marker.

- b) In cases where the connection kit cannot be mounted on the pipe, construct brackets or other supports.

## 3.2 Plan the Installation

Compare design drawings with the actual pipe and note any differences in:

- Pipe length and pipe sizes
- Number of valves, indicator gauges, flanges, and other components
- Number of pipe supports (*NOTE: These may not be marked on the design drawing, but there should be a note indicating the amount of heating cable designed into each circuit for pipe supports.*)

Ensure that the heat tracing system meets minimum requirements of the area classification as specified in NEC Articles 427 and 500-516.

## 3.3 Mark Location of Terminations

- a) While walking the pipe, mark the location of power connections, splices, and tees on the pipe with

# 4. General Installation Practices

## 4.1 Receiving, Storing, Protecting, and Delivering

### 4.1.1 Receiving material on site

- a) Unload carefully, observing all packing label warnings.
- b) Use forklifts or other loading equipment only for palletized and large reel shipment.
- c) Leaving protective coverings in place as much as possible, open and inspect the heating cable and components for in-transit damage completely and, as quickly as possible, initiate recovery of loss due to shipping damage. Undamaged materials should be carefully re-packed unless intended for immediate installation. *(NOTE: Depending on specifications, company policy, or project circumstances, it may be necessary to receive, unpack and check all material at the company shop or other staging area, in which case careful repackaging is essential.)*
- d) Verify receipt of manufacturer's installation instruction literature on electrical heat tracing systems and the maintenance of the systems.
- e) Verify the heating cable catalog number and quantity against the bill of materials. The heating cable catalog number is typically printed on the cable jacket, immediately or overjacket. *(See Figure 4.1.1(e)).*
- f) For braided heating cable, measure the cable insulation resistance for each reel by using the procedure outlined in 12.1.2.

### 4.1.2 Cable reel or carton marking requirements

The carton, container, spool, or reel in or on which the heating device is delivered should be marked with the following information:

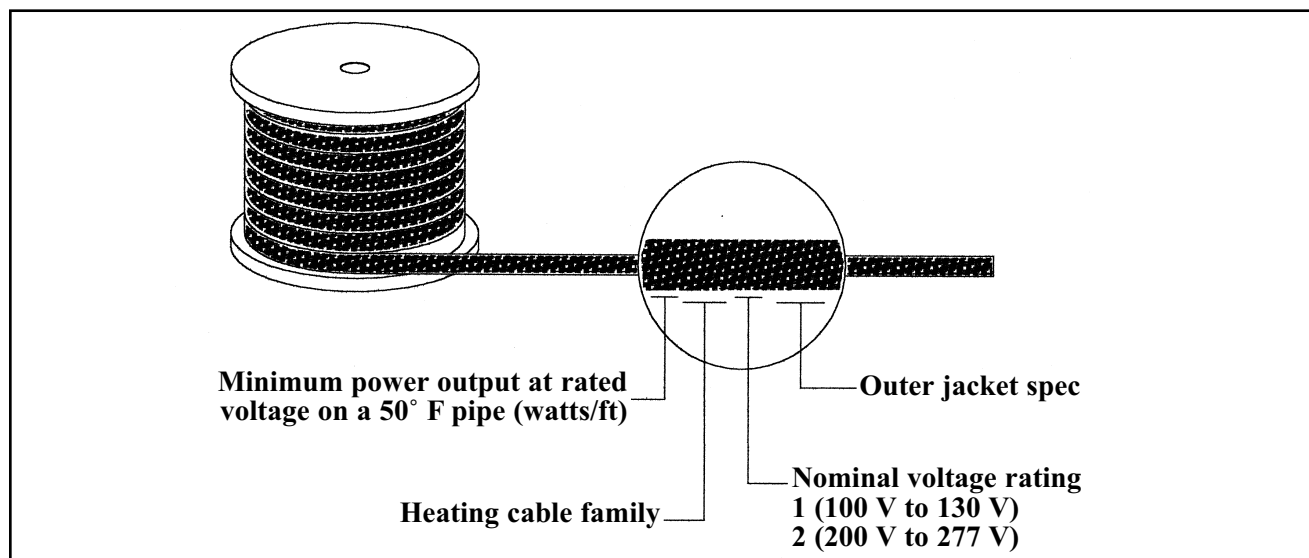


Figure 4.1.1(e). Typical cable marking information required on jacket

- a) The manufacturer's name, trademark, or other recognized symbol or identification.
- b) The catalog number, reference number, or model.
- c) The rated voltage.
- d) The rated power output in watts per unit length at rated voltage, and at a stated reference temperature for cables that change output with temperature.
- e) The statement, "Refer to installation instructions and any other warnings or notices."
- f) Listing agency marking.
- g) Area classification (if applicable).
- h) Temperature class or maximum surface temperature (if applicable).

#### **4.1.3 Storage and protection**

- a) Store material in a clean, dry location at temperatures between -40°F and 140°F (-40°C and 60°C). Especially avoid areas where water accumulate or where significant airborne dust or dirt is present. If a clean, dry location is not available, store material on pallets or other means to raise above floor and possible water levels, and wrap in protective plastic sheeting.
- b) Stack or otherwise store equipment carefully to prevent damage. Observe warnings and stacking instructions on packaging or shipping materials.
- c) Do not stack boxes that are partially crushed, even if the products are intact.
- d) Should any event occur, such as a water leak, which could damage stored material, immediately reinspect it and obtain replacements for damaged goods.
- e) Protection should be provided for the ends of all heat tracing cables to preclude water entrance and migration in the heater cable.

#### **4.1.4 Moving material on site**

- a) In general, move heat tracing cable reels and other materials as few times as possible.
- b) Move material by hand, dolly, or other device in a manner so as not to damage material.
- c) Leave material in original packing until ready to prepare to install.

### **4.2 Site Preparation**

#### **4.2.1 General**

- a) Clean the work area to prevent scratching or damaging material.
- b) Organize material and trash areas.
- c) Set up a place for staging.

#### **4.2.2 Assuring structural and piping readiness**

Make certain that the structural and piping components for the heat tracing system are complete.

#### **4.2.3 Assuring electrical readiness**

Make sure the electrical supply arrangements are as specified and match design drawings.

### **4.3 Unpacking and Handling Material**

#### **4.3.1 Unpacking**

- a) Remove material from shipping packaging.
- b) Leave protective coverings in place as long as possible.
- c) Move material to staging area.

#### **4.3.2 Special care items**

- a) Carefully unpack electronic control components, connection components and other parts that can be broken, marred, damaged, or lost.
- b) Set breakable parts aside, using extra padding or other means to prevent damage.

c) When removing electronic circuit boards, handle by edges and take precautions to avoid electrostatic discharge while handling boards.

#### **4.4 Proper Type and Application**

- a) Determine that the heating cables are the types specified and approved for the application.
- b) Advise the general contractor, architect/engineer, or owner if any heating cable or other component appears to be of the incorrect type, wrong voltage, or inappropriately listed for its intended application.

#### **4.5 Coordination with Other Trades**

##### **4.5.1 General**

In general, heat tracing will be applied directly on pipes and other components to be electrically traced. Obtain direction from code officials or owner when conflicts or code issues exist. Expect the general contractor, architect/engineer, or owner to coordinate building systems and to reconcile conflicts.

##### **4.5.2 General trades**

- a) Determine that all general construction is sufficiently complete to allow installation of electrical heat tracing systems without further removal or damage to components.
- b) Make design drawings agree with actual “field as built” piping and electrical drawings. If not, appropriate changes should be made before proceeding with heat tracing installation.

##### **4.5.3 Mechanical trades**

- a) Determine that mechanical systems are sufficiently complete to allow installation of heat tracing systems without future removal or damage to material.
- b) Make certain thermal insulation tolerance is sufficient for future installation.

##### **4.5.4 Electrical systems**

- a) Determine that other electrical systems are sufficiently complete to allow installation of heat tracing

systems without compromising design and requiring future removal or damage.

- b) Resolve conflicts among electrical systems in accordance with applicable codes.

#### **4.6 Securing Components in Place**

##### **4.6.1 General**

Consult the electrical plans and manufacturer’s installation literature for proper installation. The principal means for securing the tracing cable to the pipe is tape, and tiewraps. Determine which to use with each cable type.

##### **4.6.2 Reinforcements**

- a) Attach power and termination components to the pipe or equipment in accordance with manufacturer’s instructions.
- b) If required, seismic reinforcements will be specified in the design drawings. Follow these details for compliance with seismic requirements.

#### **4.7 Wiring Connections**

##### **4.7.1 General**

- a) Check that the temperature of supply conductors match the design specifications and/or drawings.
- b) Make sure the connection terminals are rated for the wire gauge specified and installed.
- c) Terminations for hazardous (classified) locations should be suitable for the Class/Division or Zone involved.

##### **4.7.2 Controls and monitoring**

- a) Determine whether the heat tracing system has any special monitoring or control requirements. Follow system manufacturer’s wiring diagrams and recommendations.
- b) NEC Section 427-22 requires ground-fault protection of equipment for all electrical heat tracing

circuits. Ensure they are in place and the alarm wiring is complete when alarms are specified.

#### **4.7.3 Testing**

- a) Before installing thermal insulation, energize each electrical heat tracing circuit and make certain each is operating properly.
- b) Repair or replace defective components.
- c) After thermal insulation is installed, energize system and verify that proper temperature maintenance is possible. Perform test with pipe empty and allow adequate time for pipe mass to heat up.
- d) Check calibration of temperature controls with independent means if performance seems incorrect.

#### **4.7.4 Site clean-up**

- a) Depending on terms of contract, clean up site as required.
- b) When recycling options are available at the job site, separate used packing materials by type and recycle them.
- c) Dispose of non-recyclable packing materials appropriately.

#### **4.7.5 Punchlist and acceptance**

*(NOTE: This should precede the walk-through that may be conducted by the owner and other consultants responsible for preparing punchlists).*

- a) Walk through and assure completeness of project and clean-up.
- b) Note minor defects.
- c) Touch-up and repair all defects.
- d) Turn project over to owner or general contractor, as required by contract.

#### **4.7.6 Controls setting and adjustment**

With participation of the owner, set control set points and alarm set points in an agreed-upon manner.

#### **4.7.7 Spare parts**

Unless otherwise specified, turn over to the owner or general contractor all spare parts that were provided by the manufacturer with the installed cabling system and one set of any special tools necessary to maintain the system. Obtain a delivery receipt.

# 5. Heating Cable Installation

Use the “run and loop” method to install the cable on the pipe. This method involves three steps:

1. Paying out the cable (see 5.1)
2. Attaching the cable to the pipe (see 5.2)
3. Wrapping heat sinks (see 5.4)

Determine whether the manufacturer allows cable to overlap or touch. Self-regulating cables may overlap or touch. For constant wattage cables follow the manufacturer’s instructions on whether to overlap or not.

## 5.1 Paying Out the Cable

### 5.1.1 General

- a) Mount the reel on a holder and place it near either end of the pipe run to be traced. Use a reel holder that pays out smoothly with little tension. Avoid jerking the cable while pulling.
- b) Pay out the cable and loosely string it along the pipe, making sure that the cable is always next to the pipe when crossing obstacles. If the cable is on the wrong side of a crossing pipe or I-beam, it will be necessary to reinstall it or cut and splice it (see Figure 5.1.1 for a general layout).

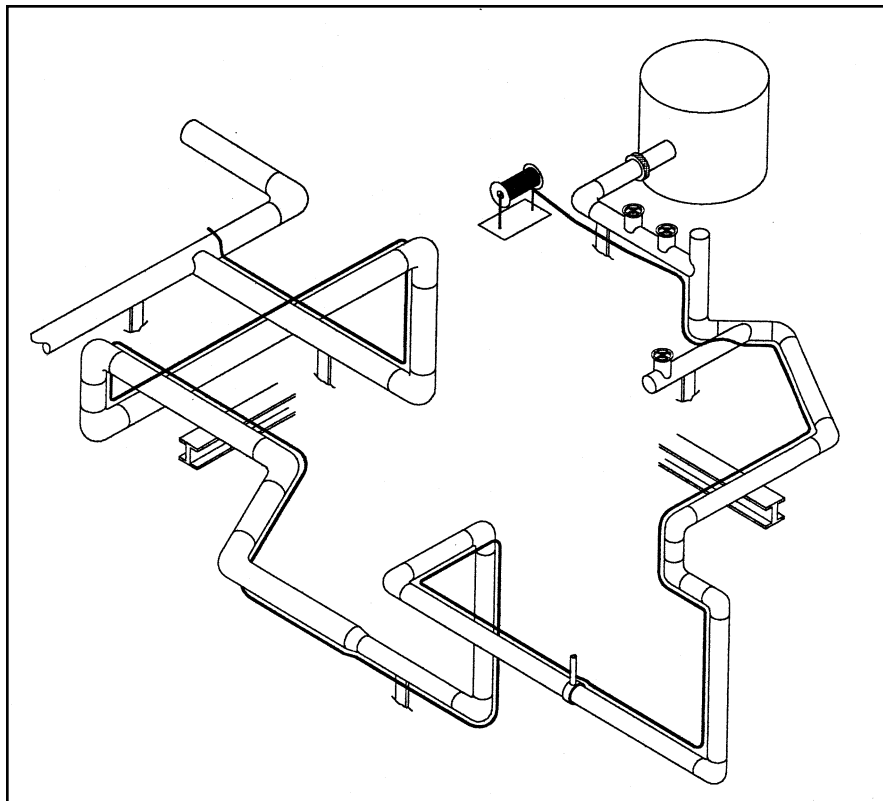


Figure 5.1.1. Paying out the cable

### 5.1.2 Multiple cables paid out from two reels

One method of paying out heating cables is from multiple reels simultaneously (see Figure 5.1.2). This method works with two or more heating cables. However, it may increase waste by leaving unused lengths from multiple reels.

### 5.1.3 Multiple cable run paid out from one reel

Alternatively, a single reel may be used (see Figure 5.1.3). This method is generally the easiest for relatively straight, simple pipe runs. With this method, one large loop is pulled for the entire circuit while one end remains secured with tape at the beginning of the circuit.

## 5.2 Attaching the Heating Cable

The heating cable may be installed straight, spiraled, or in multiple runs as required by the design.

### 5.2.1 Straight heat tracing (See Figure 5.2.1)

- Whenever possible, position the heating cable on the lower section of the pipe as shown in Figure 5.2.1(a).
- For pipe diameters of 2 inches and larger, heating cable should be installed on the outside (long) radius of the elbow as illustrated in Figure 5.2.1(b).
- Starting from the end opposite to the reel, tape the heating cable on the pipe at every foot as shown in Figure 5.2.1(c).

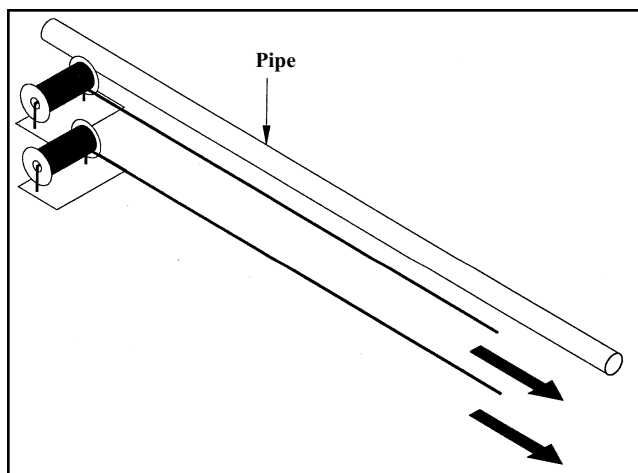


Figure 5.1.2. Multiple cables paid out from two reels

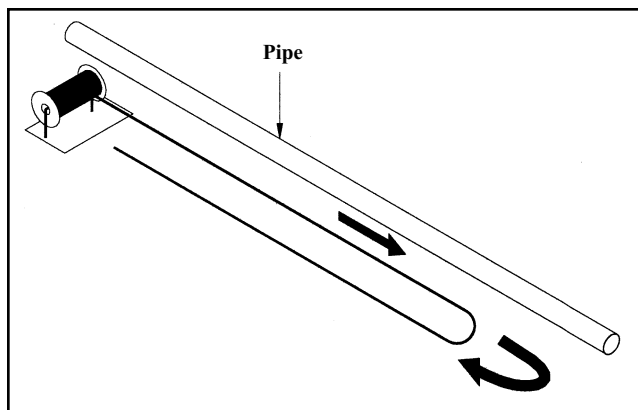


Figure 5.1.3. Multiple cables run paid out from one reel

- If aluminum tape is used, apply it over the entire length of the heating cable after the cable has been secured with fiber glass tape (in accordance with instructions in 5.3).

- Work your way back to the reel.

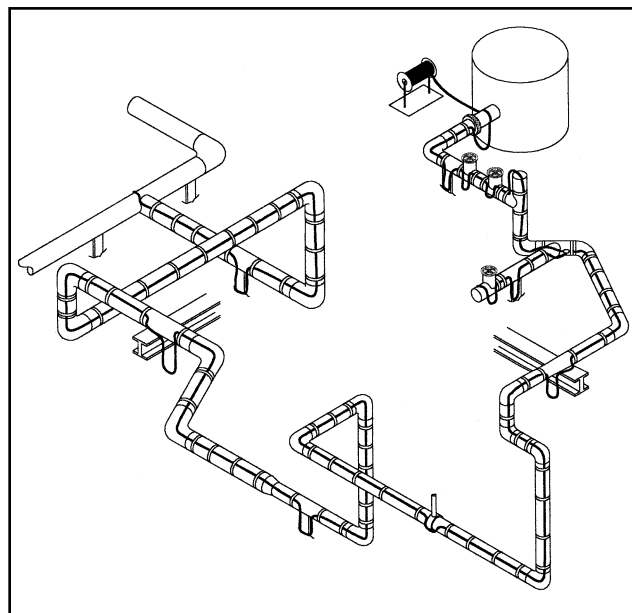


Figure 5.2.1. Attaching the heating cable

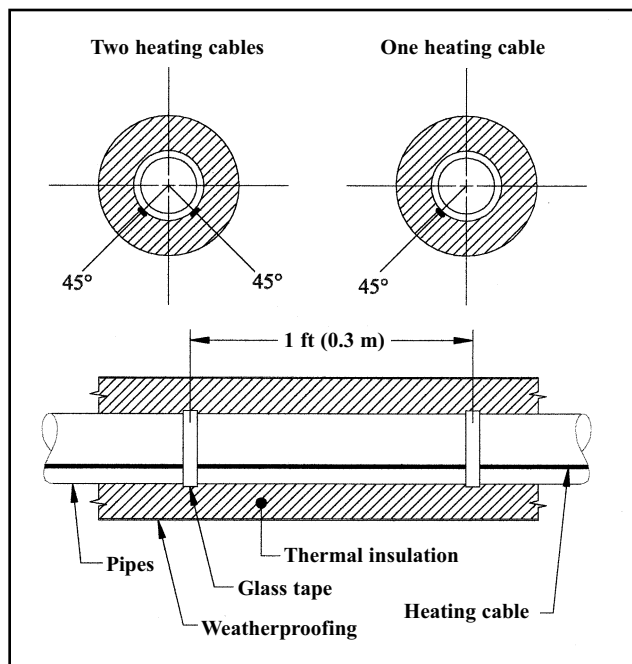


Figure 5.2.1(a). Positioning the heating cable(s)

f) Leave 18 inches of heating cable at the power connection, at all sides of splices and tees, and at the end seal to provide for service loops.

g) Provide extra heating cable allowance for each heat sink (pipe support, valve, flange, instrument) by pulling extra material from the reel and leaving it as a loop taped in front of and behind the heat sink.

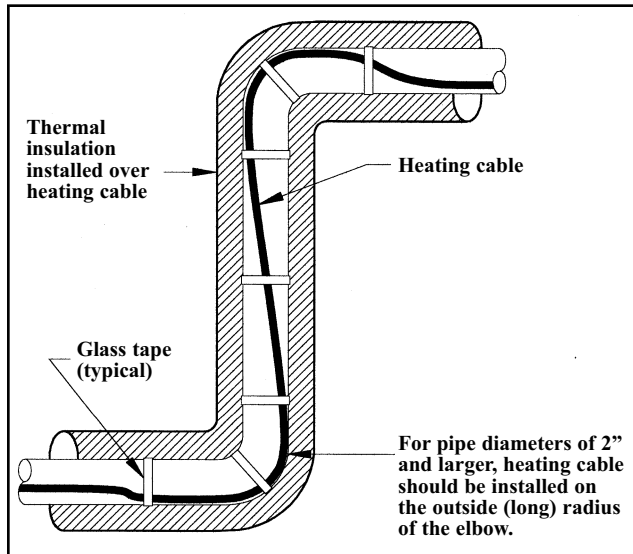


Figure 5.2.1(b). Elbows in pipe diameter greater than 2"

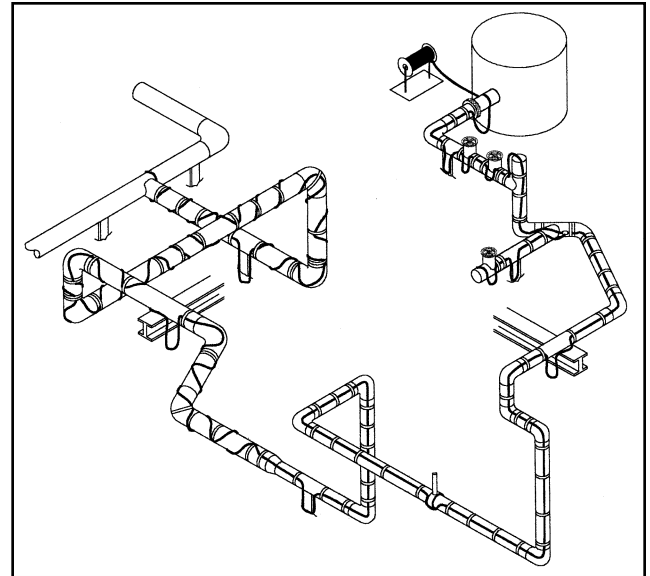


Figure 5.2.2. Spiraling the heating cable

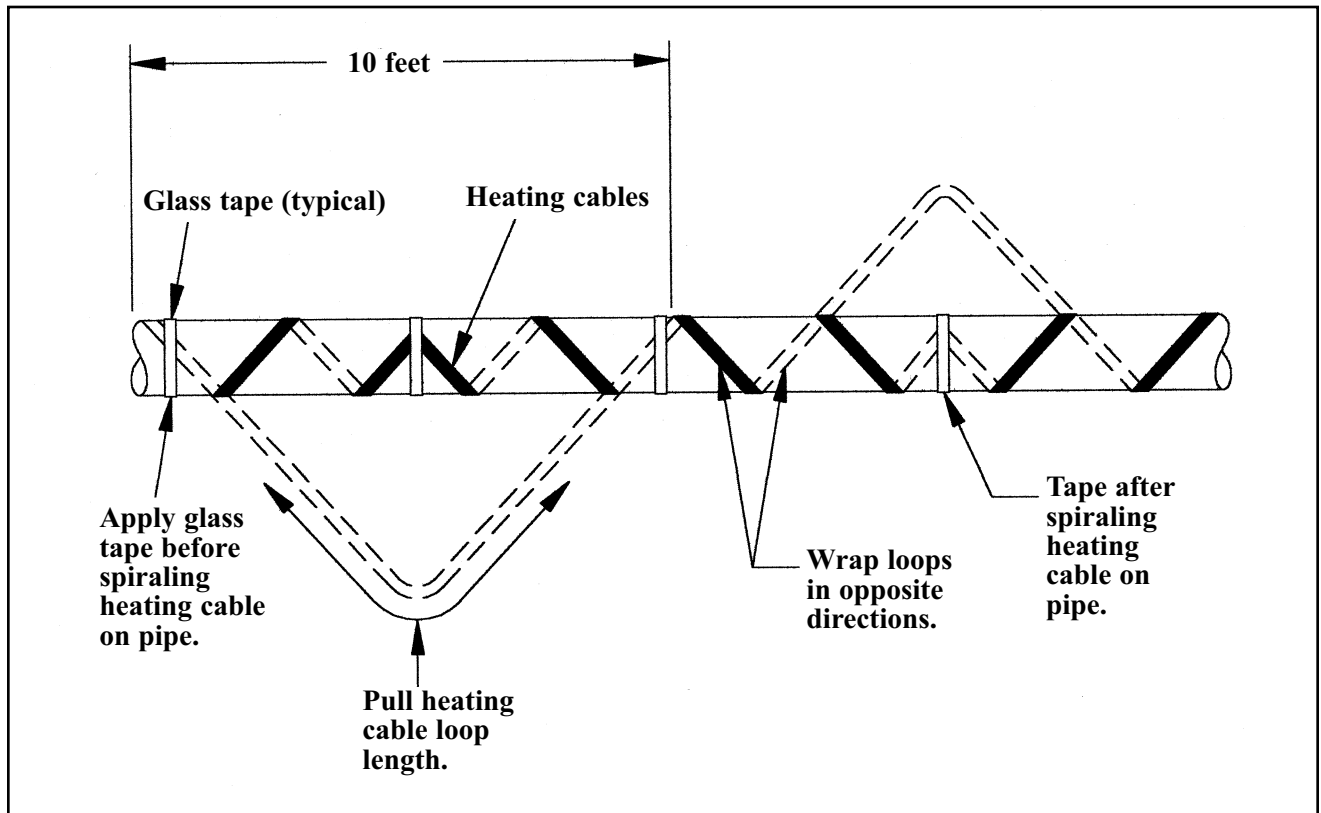


Figure 5.2.2(a). Spiraling the heating cable using loops

Obtain the required loop length from the design drawing or the manufacturer's design guide.

### 5.2.2 Spiraled heat tracing (see Figure 5.2.2 for a general layout)

- a) When the design calls for spiraling, begin by suspending a loop at every 10-foot pipe section as shown in Figure 5.2.2(a). (NOTE: This type of spiraling method is used to facilitate pipe maintenance without breaking the tracing.)
- b) Determine the loop length by obtaining the spiral factor from the drawing and multiplying by ten. For example, if a spiral factor of 1.3 is called for, leave a 13-foot loop of heating cable at every 10-foot section of pipe.
- c) Pull the required amount of heating cable at every 10-foot mark, then attach the heating cable to the pipe and let it hang in a loop.
- d) Grasp the loop in its center and wrap it around the pipe.
- e) Even out the distance between spirals by sliding the wraps along the pipe.

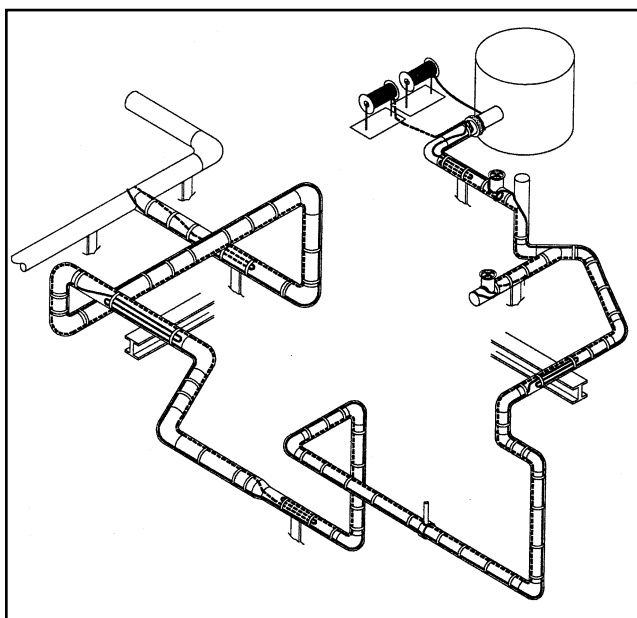


Figure 5.2.3. Double heat-tracing

f) Use glass tape to secure the center of the loop to the pipe.

g) Secure the heating cable flat to the pipe to obtain good contact.

### 5.2.3 Multiple-cable heat tracing

There are two situations where multiple heating cables may be required (see Figure 5.2.3 for a general layout):

- a) Redundant heat tracing is used in situations where a backup is required. Therefore, it is important that every heat sink be traced with both runs of heating cable.
- b) Double or multiple heat tracing is used when single heat tracing alone cannot compensate for larger heat losses. Double heat tracing should have extra heating cable installed only as called out on the design drawing. It is recommended to supply the extra heating cable alternately from both runs in order to balance out both circuit lengths. When heat tracing serviceable equipment such as valves and pressure gauges that may have to be removed later, loops should be left to allow for future access.

## 5.3 Securing the Heating Cable

Heating cable should be secured to piping systems only with tapes and ties intended for the purpose. Self-regulating cables may overlap or touch. For constant wattage cables, follow the manufacturer's instruction on whether to overlap or not.

### 5.3.1 Fiberglass tape

- a) Use general purpose tape for installation of 40°F (50°C) and above.
- b) Use in applications below 266°F (130°C).
- c) Apply at 1-foot intervals.

### 5.3.2 Fiberglass tape (low temperature)

- a) Recommended for low-temperature installation at -40°F (-40°C) and above.
- b) Apply at 1-foot intervals.

### 5.3.3 Aluminum tape

- a) Recommended for heat tracing pump bodies or odd-shaped equipment, or as called out in the design drawing as a heat-transfer aid.
- b) Use in applications below 300°F (150°C).
- c) Install at temperatures above 32°F (0°C).
- d) Tape lengthwise under and/or over the heating cable as required by the design drawing or specification.

### 5.3.4 Non-metallic cable ties

- a) Recommended in applications where the pipe surface prevents proper tape adhesion.
- b) Recommended for temperatures below 180°F (82°C).

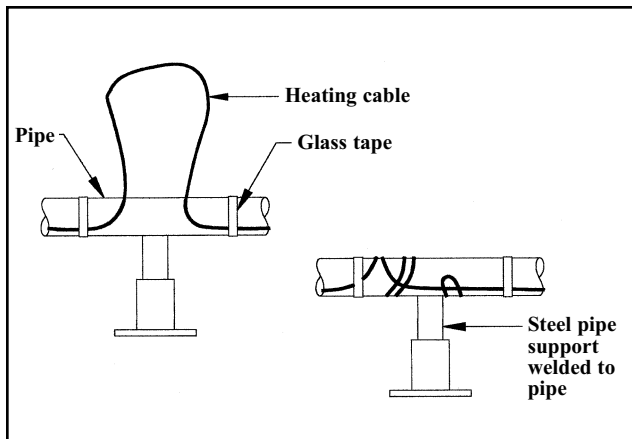


Figure 5.4(a). Welded pipe support (side view) wrapping with self-regulating cable

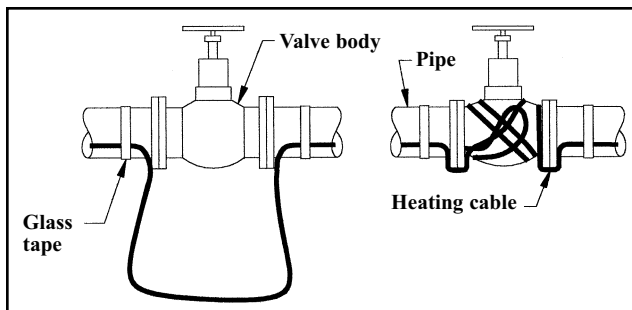


Figure 5.4(c). Valve, wrapping with self-regulating cable

- c) Cable ties should be hand-tightened only!

### 5.3.5 Important

- a) Before taping the heating cable to the pipe, make sure all heat tracing allowances for flanges, valves, supports, and other components have been verified.
- b) Do not use vinyl-based tapes. Some vinyl tapes (electrical or duct tapes) can reduce the operating life of heating cables.

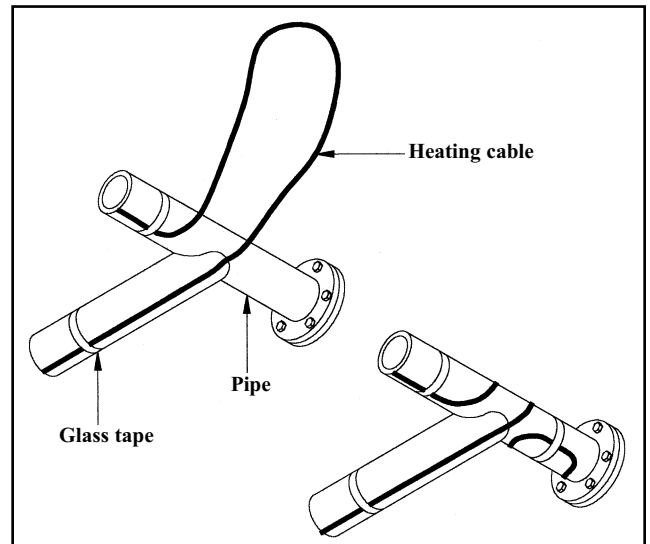


Figure 5.4(b). Dead leg tee, wrapping with constant-wattage cable

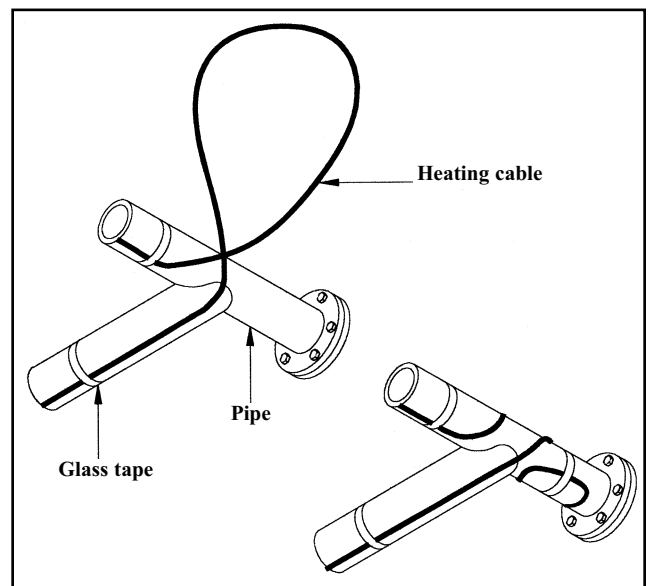


Figure 5.4(d). Dead leg tee, wrapping with self-regulating cable

## 5.4 Wrapping Heat Sinks

Finally, wrap the remaining loops over valves, pipe supports, pumps, and other components.

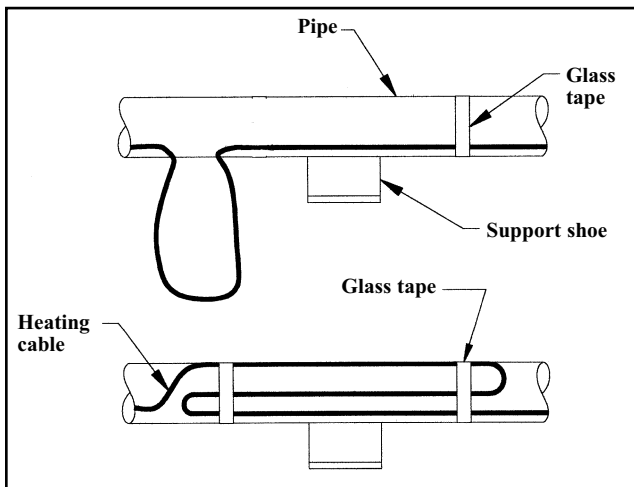


Figure 5.4(e). Welded pipe support shoe (top view)

a) Self-regulating type heating cables are permitted to touch or overlap when wrapping heat sinks, as shown in Figures 5.4(a) through 5.4(d).

b) Some constant-wattage type heating cables will not function if installed so that they touch or overlap. Follow manufacturer's instructions. (See Figures 5.4(e) through 5.4(j).)

## 5.5 Special Cautions

a) Allow extra heating cable allowances for heat sinks, such as pumps and valves, and for service loops at connections. Do not cut the heating cable from the reel until it is attached over the entire length of pipe and all allowances are verified.

b) If the heating cable will be left exposed for some time, protect the ends of the heating cable with plastic bags to prevent water from getting in.

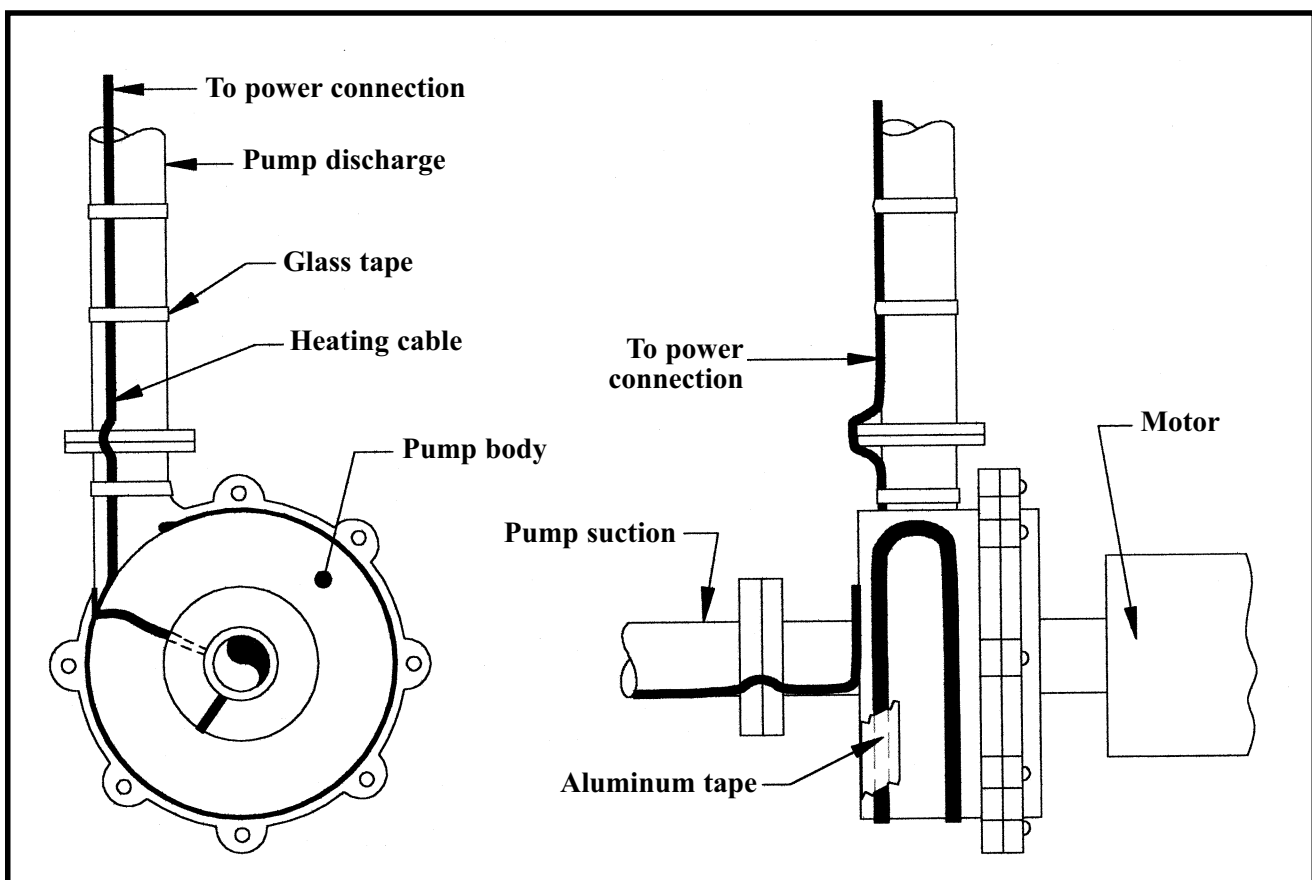


Figure 5.4(f). Split-case centrifugal pump, wrapping with constant-wattage tape

- c) Do not drag the cable over the ground or pull it over sharp edges.
- d) If the cable snags while paying out, stop pulling! Correct the problem before continuing.
- e) Do not walk on the cable or run over it with equipment.
- f) Self-regulating cables may overlap or touch. For constant wattage cables, follow the manufacturer's instructions on whether to overlap or not.

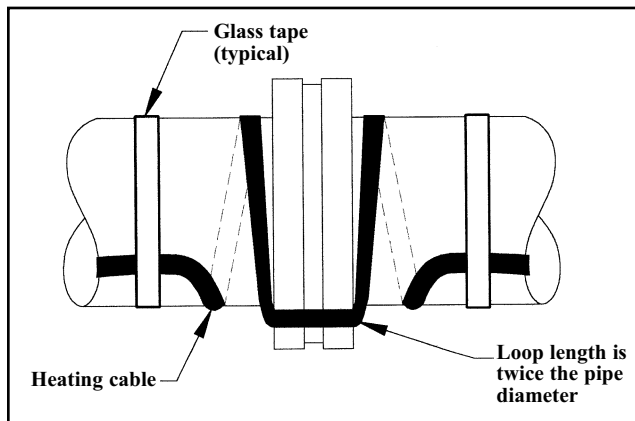


Figure 5.4(g). Pipe flange, wrapping with constant-wattage tape

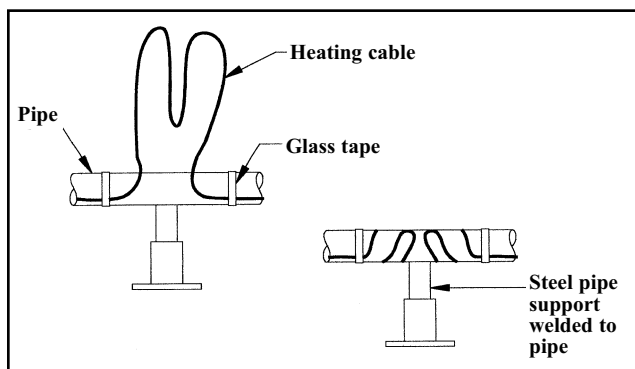


Figure 5.4(i). Welded pipe support (side view) wrapping with constant-wattage tape

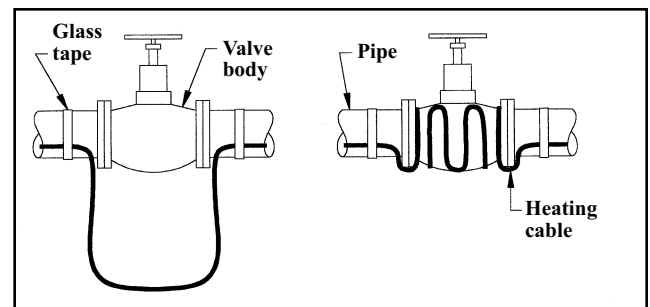


Figure 5.4(h). Valve, wrapping with constant-wattage cable

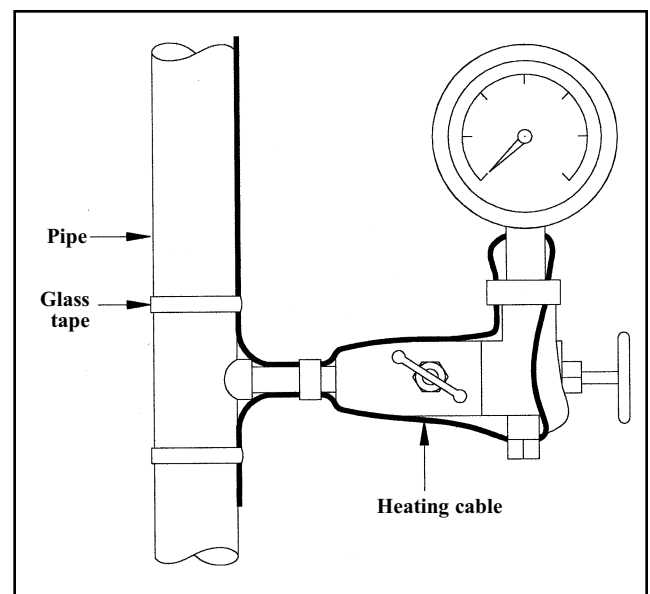


Figure 5.4(j). Pressure gauge

# 6. Heating Cable Connections

Detailed assembly instructions are provided with the connection kits. Read these instructions carefully and install the connection components accordingly.

Each heating cable circuit requires one power connection and at least one end seal. Splices and tees are used as required. Each tee requires one extra end seal (see Figure 6.1). Keep in mind the following points when installing connections:

- a) Before installing connection kits, check the heating cable insulation resistance (refer to Section 12).
- b) Use only manufacturer's recommended connection kits. Using other kits, substitute parts, or vinyl electrical tape will void product approval and product warranty, and can cause electrical arcing or fire.
- c) Be sure the connection kit is the proper one for the heating cable and the application. Part numbers

should be called out on the drawing.

- d) Connection kits use grommets or heat-shrinkable tubing for environmental sealing. Grommets are designed to fit specific heating cables only. Be sure the proper grommets used by checking the installation instructions supplied with the connection kit being installed.
- e) Special adapters may be available for mounting on small pipe sizes. Be sure to use these adapters if needed.
- f) Verify that the proper size pipe for mounting component kits onto the pipe clamp is included with the materials.
- g) Connection kits should be mounted on top of the pipe when practical. Electrical conduit leading to power connection kits should have low-point drains

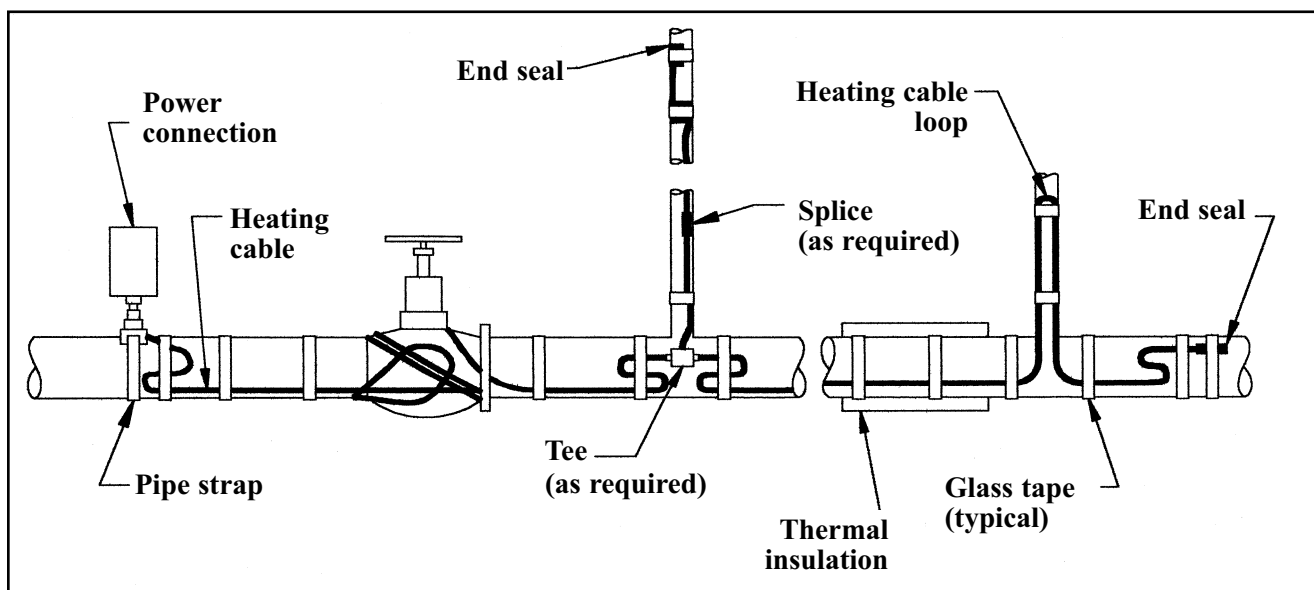


Figure 6.1. Typical system, wrapping with self-regulating tape

installed to avoid condensation entry into the heating system. Mount all heating cable connections above grade level.

h) Follow the recommendations for stripping heating cables included in the installation instructions provided with the connection kits. For self regulating heaters, be sure bus wires are clean and free of conductive core materials before making electrical connections.

# 7. Thermostat Controls

## 7.1 General

The most common type of control system used with industrial heat tracing systems is a thermostat.

- a) Make sure the thermostat being installed is the correct one for the area classification as well as for the weather exposure.
- b) Make sure that the heating cable load is within the rating of the thermostat switch. Check the design drawings for the heating cable load.
- c) The electrical conduit that feeds wiring to the thermostat should have a low-point drain so condensation will not enter the thermostat enclosure.
- d) Make sure that the line voltage being connected to the thermostat is correct. Follow the installation instructions enclosed with the thermostat for proper wiring.

## 7.2 Ambient-Sensing Thermostats

Ambient-sensing thermostats energize the circuit when the ambient temperature drops below the set point.

- a) Mount thermostats above grade level and out of sunlight. Mount the thermostat where it will be exposed to the coldest temperature and the strongest wind.
- b) Be sure to connect the phase wire to the contact that is normally closed below the set point and opens with increasing temperature.

## 7.3 Line-Sensing Thermostats

Line-sensing thermostats sense the pipe temperature by means of a bulb attached to the pipe and connected to the thermostat body via a capillary tube.

- a) Install the sensing bulb on the pipe at a 90-degree angle away from the heating cable so that the heating cable does not thermally interfere with the sensing bulb. Be sure the sensing bulb is firmly attached with aluminum tape to the pipe in order to get good thermal contact between the bulb and the pipe.
- b) The bulb should be located at least 3 feet (1 meter) from any heat sinks, such as valves, pipe supports, and pumps.
- c) Thermostats can be used for temperature control, high-temperature cutout, and high or low alarms. Be sure you use the proper wiring diagram for the control method desired.
- d) Be sure that you have set the control to the proper temperature.
- e) Mount the thermostat on a nearby wall or support, or install a mounting stanchion. To prevent damage, mount the thermostat and the capillary tube where they will be away from foot and equipment traffic.
- f) Seal the insulation where the capillary tube exits the insulation to prevent water entry.

# 8. Thermal Insulation

## 8.1 Pre-Insulation Inspection

After the heating cable is installed, thermal insulation should be installed as soon as possible to minimize potential heating cable damage.

- a) Visually inspect the heating cable for signs of mechanical damage.
- b) Prior to the application of thermal insulation, measure the insulation of the heating cable under normal dry conditions and before the connection of associated wiring or control equipment. The measured value should not be less than 20 Megohms. For heating devices provided with a non-metallic overjacket, perform an insulation resistance test between the metallic covering and ground at 2500 Vdc after 1) installation of the heating device on the pipe/vessel, and 2) installation of the thermal insulation. These tests are used to detect damage to the overjacket during the installation process.
- c) The insulation resistance of the entire branch circuit, after the thermal insulation is complete, should not be less than 10 Megohms measured at 500 Vdc. If required, check the operation of each electric heating cable by applying rated voltage and recording current and pipe temperature at steady-state conditions. Allow time for the current to stabilize, as starting current is sometimes higher than operating current.

## 8.2 Insulation Installation

Make sure that both the pipe and the insulation are dry when a pipe is thermally insulated. Wet insulation is ineffective.

### 8.2.1 Insulation

It is important to use the type and thickness of thermal insulation specified on the design drawing. If another thickness is used, the heating cable type or amount may have to be changed.

- a) Carve the insulation to allow for low-profile components so there is no gap in the insulation closure.
- b) In the standard single-cable installation, rigid insulation may not need to be oversized. This is pipe thermal size and insulation dependent.
- c) Where multiple or redundant heating cables are used, rigid insulation (such as calcium silicate and foam glass) should be oversized by 1/2-inch on pipes and tubing that are 4-inches in diameter or smaller. Larger pipe sizes do not require oversized insulation.

### 8.2.2 Cladding

- a) Weatherproof the thermal insulation. Seal all joints with long life sealing compound. Seal all places where valve stems, conduits, connection enclosures, thermostat capillary tubes, and other components penetrate through the insulation jacketing with a suitable compound to keep water out.
- b) Ensure that the edges of these clearance holes and cable transitions do not rub on the cable and cause mechanical damage.
- c) Metal banding is the preferred method to keep metal jacketing in place. If sheet-metal jacketing is secured with sheet-metal screws, be sure that screws are not long enough to penetrate the thermal insulation and damage the heating cable.
- d) Seal the metal seam with suitable compound.

### **8.3 After Insulation Installation**

Perform the following steps after insulating the pipe:

- a) Mark the insulation.
- b) Test the insulation resistance of each circuit.

#### **8.3.1 Markings**

- a) When the insulation and weatherproofing is complete, attach “Electric Traced” labels on the outside of the insulation as required by NEC Section 427-13.
- b) Place labels at alternate sides about every 10 feet (3 meters). Install these labels where they are visible during normal operations.

#### **8.3.2 Post-installation resistance testing**

After the insulation has been installed, test the insulation resistance circuit to confirm that the heating cable has not been damaged.

# 9. Power Supply and Electrical Protection

## 9.1 Voltage Rating

Ensure that the source voltage corresponds to the heating cable rating and the design drawing

## 9.2 Electrical Loading

Overcurrent devices are sized according to the heating cable type, source voltage, and circuit length to allow start-up at designed ambient temperatures. Project drawings specify the size and type of overcurrent device.

## 9.3 Ground-Fault Protection for Equipment (GFPE)

NEC Sections 427-22 and 427-23 require both grounded braid and GFPE on all equipment. Provide ground-fault protection of equipment (GFPE) for panels which supply electric heat tracing systems. This is not necessary in industrial establishments where there is alarm indication of ground faults, conditions of maintenance and supervision ensure that only qualified persons will service the installed systems, and continued circuit operation is necessary for safe operation of equipment or processes.

# 10. Commissioning

## 10.1 Pre-Commissioning

- a) Visually inspect the pipe, insulation, and connections to the heating cable to make sure that no physical damage has occurred.
- b) Turn off all supply circuit breakers.
- c) Test the Insulation resistance of the system in accordance with the instructions in Section 12.1, to determine whether damage has occurred that may not be readily visible.

## 10.2 Ambient-Sensing Controlled Systems

- a) If the actual ambient temperature is higher than the desired thermostat setting, turn the thermostat setting up high enough to turn on the system, or (with some models) manually set the selector switch to the ON position.
- b) Turn on the main circuit breaker.
- c) Turn on the branch circuit breakers.
- d) After a minimum of five minutes measure the voltage, amperage, ambient temperature, and pipe temperature for each circuit, and record this in the Heater Commissioning Record (*see Annex A*). This information is needed for future maintenance and troubleshooting.
- e) When the system is completely checked out, reset the thermostat to the proper temperature.

## 10.3 Line-Sensing Controlled Systems

- a) Set the temperature to the desired control temperature, or to a setting high enough to turn the circuit on if the pipe temperature is above the control temperature.

- b) Turn on the main circuit breaker.
- c) Turn on the branch circuit breakers.
- d) Allow the system to reach the control point. This may take up to four hours for most circuits. Large, liquid-filled pipes may take longer.
- e) Measure the voltage, amperage, and pipe temperature for each circuit and record this in the Heater Commissioning Record (*see Annex A*). This information is needed for future maintenance and trouble shooting.
- f) When the system is completely checked out, reset the thermostat to the proper temperature.

## 10.4 Backup (Redundant) Systems

Follow the procedure above for the type of control system installed, but commission the systems one at a time. Start up the primary system, qualify it, then shut it down. Then start the backup system, qualify it, and shut it down.

# 11. Preventive Maintenance

## 11.1 Maintenance Procedures

Recommended maintenance for heat tracing systems consists of performing the commissioning testing on a regular basis. Procedures for this testing are described in Section 10.

- a) For systems controlled by line-sensing thermostats, check the system at least twice a year. Systems controlled by ambient-sensing thermostats should be checked before each winter.
- b) If the inspection reveals a low pipe-temperature, or the circuit fails the insulation resistance test, immediately determine the nature of the problem and make the necessary repairs as required. Refer to Section 13 for troubleshooting.

## 11.2 Maintenance Records

Annex A shows a blank cross-out format Heater Commissioning Record that should be filled out during all maintenance and repair work, and kept for future reference.

## 11.3 Repairs

Use only manufacturer recommended cable, terminations, and methods when replacing any damaged cable, connections, thermal insulation, or weather-proofing.

- a) Record all repairs and measurements on the Maintenance Log Record (*see Annex A*).
- b) Retest the system after repairs are made.

## 11.4 Maintenance of Piping and Associated Equipment

- a) De-energize all circuits that may be affected by maintenance.
- b) Protect the heating cable from mechanical or thermal damage during such maintenance work.
- c) The recommended cable installation methods allow for extra cable at all pipe accessories, such as valves, pumps, and pressure gauges, that are likely to incur maintenance work.

## 11.5 Special Cautions

- a) Avoid abusing, cutting, twisting, or tugging the heating cables during piping maintenance. The cable is intended to be re-installed after the equipment is serviced. Therefore, be careful when removing the cable from pipe and equipment.
- b) After maintenance work is done and the cable is re-installed, be sure to test the insulation resistance of the circuit before re-energizing (*see Section 12.1*).

# 12. Heating Cable Testing

Insulation resistance testing is a reliable indicator of the electrical integrity of an electric heat tracing system when all the installation instructions are properly followed.

Insulation resistance testing is recommended at seven stages during the installation process and as part of regularly scheduled maintenance. Accordingly, perform the testing:

1. Before installing the cable
2. Before installing components
3. Before installing the thermal insulation
4. After installing the thermal insulation
5. Prior to initial start-up
6. As part of the regular system inspection
7. After any maintenance or repair work

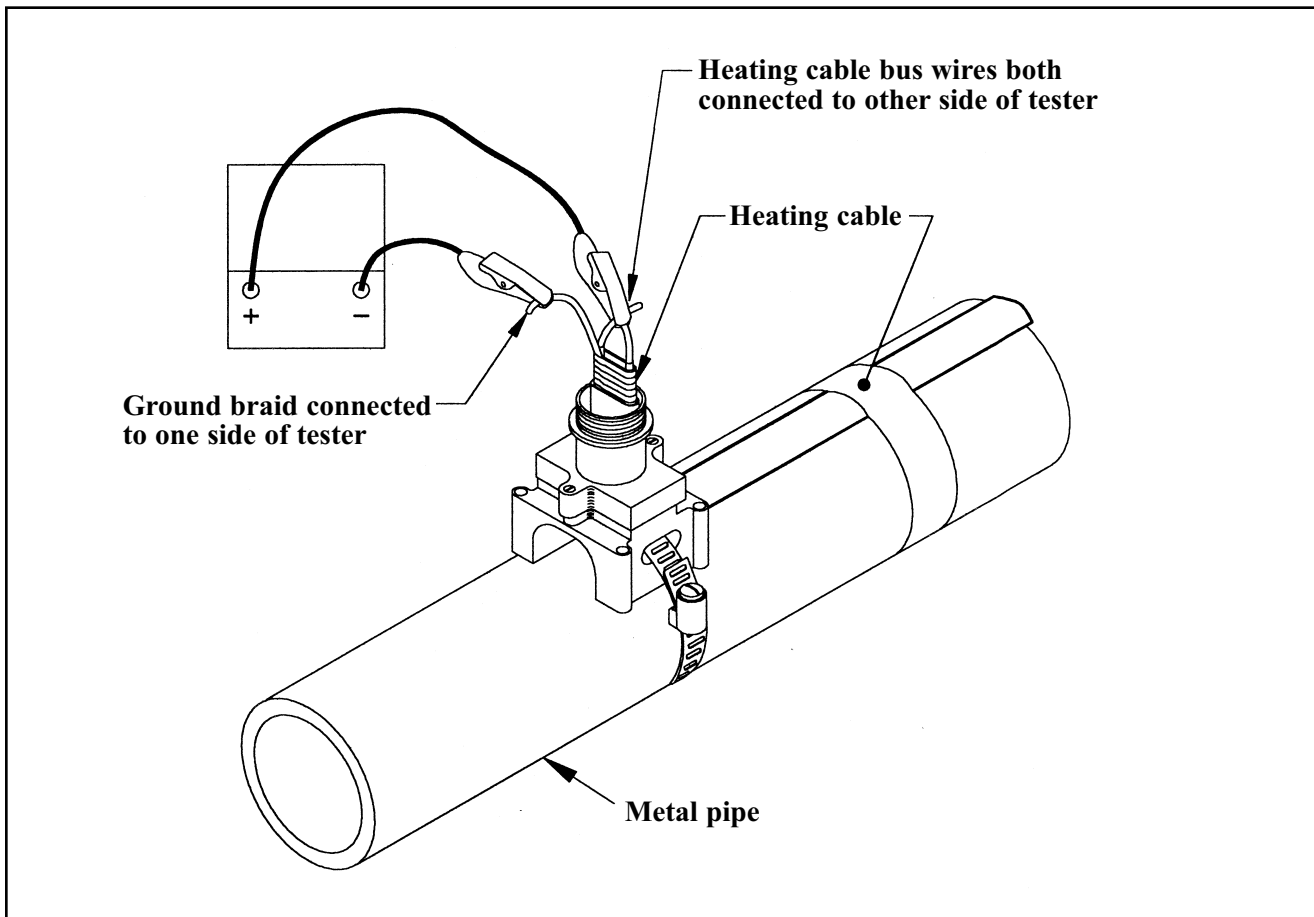


Figure 12.1.2. Insulation resistance testing (braided heating cables)

## 12.1 Insulation Resistance Testing

Insulation resistance testing (insulation resistance testing) should be conducted at three voltages — 500, 1000, 2500 Vdc — as discussed in ANSI/IEEE Standard 141, Section 11.11.9. Significant problems may not be detected if testing is done only at 500 or 1000 volts.

each electric heating cable should be checked by applying rated voltage and recording current and pipe temperature at steady-state conditions. Allow time for the current to stabilize, since the starting current is sometimes higher than the operating current.

### 12.1.1 Heat-tracing cable

The following tests should be performed and documented on a maintenance log record (*see Annex A*).

a) Visually check heating cables and surface heaters for damage incurred during shipping and handling. Perform continuity and insulation tests as a final quality check. Measure insulation resistance from heating device connections to metal covering with a minimum 500 Vdc test voltage. (*NOTE: However, it is strongly recommended that higher test voltages be used. Mineral insulated heating cables should be tested at a maximum of 1000 Vdc, and polymeric insulated heater cables should be tested at 2500 Vdc.*) The measured insulation resistance should not be less than 20 Megohms.

b) Test individual controls to ensure proper calibration. This includes checking for the correct operating temperature range, proper span, and set points.

c) Prefabricated control panels should be completely checked at the manufacturer's shop prior to shipping to verify correct wiring, layout, and function. If such a check by the user is not feasible, obtain documentation from the manufacturer stating that such tests have been performed. After receiving the control panels, a general inspection should again be made with attention to controllers and other devices that may have been damaged in shipping.

### 12.1.2 Branch circuit

After thermal insulation has been installed on pipes and vessels, the insulation resistance of the entire branch circuit should not be less than 10 Megohms measured at 500 Vdc. If required, the operation of

# 13. Typical Troubleshooting Guide for Parallel Circuit Heaters

This guide provides step-by-step assistance in troubleshooting potential heating cable problems; it consists of two parts:

- A series of connected flowcharts
- A numbered series of questions, steps, and corrective actions that correspond to each item on the flowcharts.

## 13.1 Troubleshooting Flowchart (See Figure 13.1)

The symptoms most frequently associated with heat tracing problems are a cold pipe, circuit breaker tripping, and insulation testing failures during commissioning or maintenance testing. These symptoms are analyzed on the flowchart, which the following directions help use:

- a) If the pipe temperature fails to reach the required level, start with Step 1 of the flow chart.
- b) If circuit breaker tripping occurs, or the circuit fails to meet the insulation resistance criteria (insulation resistance test), skip Steps 1 through 22 of the flowchart and go directly to Step 23.

## 13.2 Questions, Steps, and Corrective Actions

### 1. *Design and operating conditions OK?*

Before proceeding further, make sure the “No Flow” condition revealed by operation is not due to a closed valve, failed actuator, damaged pump, or similar condition. Next, verify that the design is correct for the operating conditions. If the system is new and has not previously been checked for functionality, then the design parameters could be suspect. GO TO 19.

### 2. *Insulation dry and continuous?*

Heat tracing cannot compensate for missing or wet insulation. Wet insulation loses its insulating capability. Make sure the insulation is continuous, dry, and weatherproofed. If not, GO TO 20.

### 3. *Pipe temperature confirmed low?*

With a portable temperature probe, record the actual pipe temperature. If the pipe’s actual temperature is not confirmed as being cold, then the monitoring equipment is faulty. GO TO 21.

### 4. *Circuit breaker ON?*

If the circuit breaker has tripped, a fault occurred in the circuit. GO TO 23.

### 5. *Front end voltage OK?*

At the power connection box, record the voltage at the front of the heating cable. If the measured voltage is less than expected, GO TO 22.

### 6. *Far end voltage <85%?*

Record the voltage at the far end of the heating cable. If this value is less than 85% of the value at the front end as recorded in step 5, then the circuit is too long, damaged, or poorly spliced. GO TO 14.

### 7. *Actual power > theoretical power?*

Record the actual circuit amperage at least two minutes after energizing the circuit. Theoretical power is defined as the total circuit length multiplied by the heat loss at the actual pipe temperature plus extras for heat sinks such as valves, pipe supports, and other components. Actual power is defined as the circuit amperage multiplied by the front end voltage recorded in step 5. If the actual power is greater than the theoretical power, the heating cable is operating properly. GO TO 11.

8. *Correct heating cable installed?*

If the actual power is less than the theoretical power, the wrong type of heating cable may be installed. The heating cable catalog number is printed on the cable jacket (see 4.1.1(e) and Figure 4.1.1 (e)).

9. *Proper amount of heating cable installed?*

If the heating cable type is correct, not enough may be installed to cover heat sinks such as valves, pipe supports, and other components. Remove the insulation at all suspect heat sinks and verify installed heating cable footage. If insufficient, GO TO 13.

10. *Check for high-temperature exposure.*

If everything else checks out, the circuit may have been exposed to higher than rated temperatures.

11. *Cable OK; check T-state or design parameters.*

The heating cable is operating properly. Check the set point on the temperature controller and adjust as necessary. Also verify the design parameters; redesign if necessary. END.

12. *Install correct heating cable.*

If an incorrect heating cable was chosen, the system will not maintain its designed temperature. Replace with the correct heating cable type, voltage, and wattage. In a few cases, insufficient wattage can be adjusted by increasing the supply voltage.

13. *Add heating cable where required.*

If insufficient amounts of heating cable were installed at heat sinks, splice in extra heating cable with two splice kits or add a branch with one tee kit and an end termination. END.

14. *Determine actual circuit length with capacitance.*

Braided heating cable lengths can be measured from the power connection. Record the capacitance of the circuit as measured between the bus wires and the braid. Multiply this value by the heating cable capacitance factor to obtain the actual cable length. Base heating cable lengths must be estimated by measuring pipe length and uncovering insulation at heat sinks to determine extra heating cable installed.

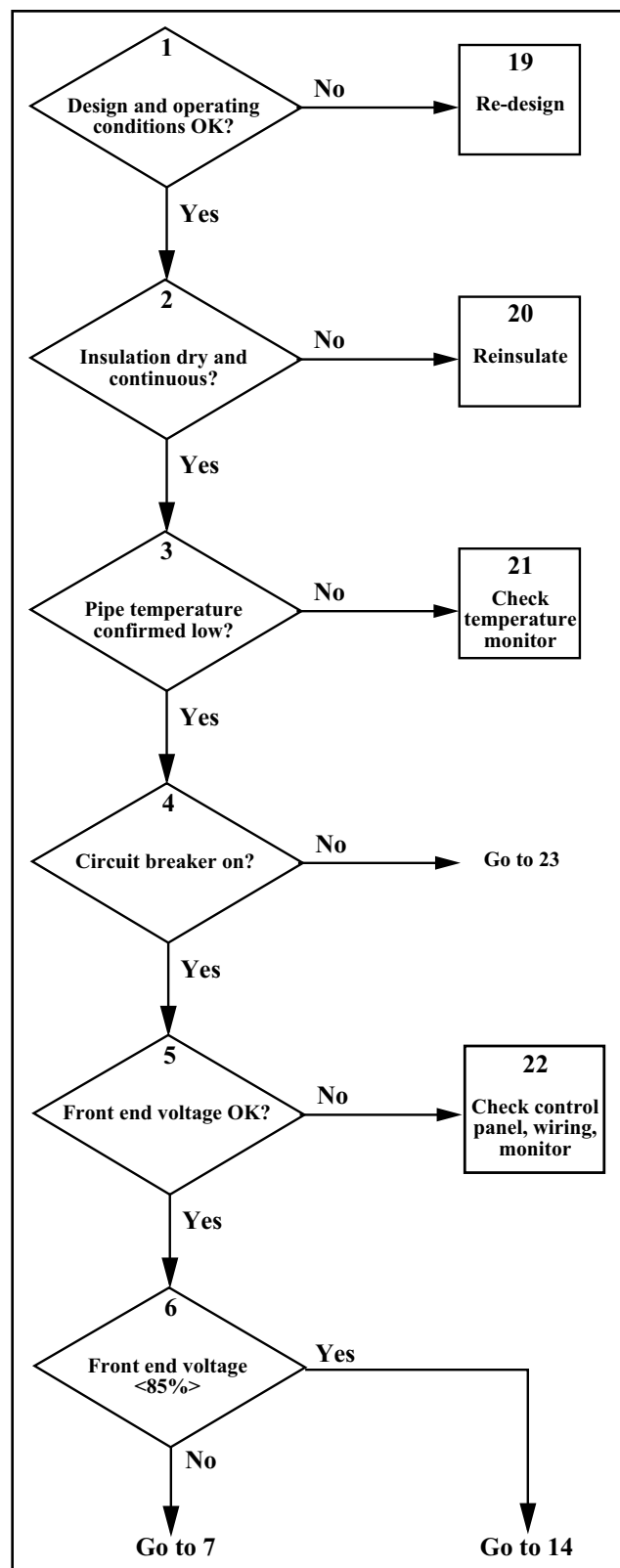


Figure 13.1(a). Troubleshooting flowchart – cold pipe

15. *Circuit length > maximum?*

If the actual heating cable length is greater than the maximum allowed according to the manufacturer's recommendation, GO TO 17.

16. *Split up the circuit or redesign.*

The installed heating cable length is greater than allowed for a given circuit. Split the circuit in two circuits, or redesign the circuit. END.

17. *Obtain working length.*

Record the amperage of the operating section of the circuit and multiply by the voltage recorded in step 5. Divide this total by the watts/length (as provided by manufacturer) to obtain the length of operating heating cable.

18. *Locate damaged area or connection; fix as required.*

Locate the end of the working length of heating cable on the pipe, remove insulation, and repair the cable using approved components. END.

19. *Redesign.*

If the operating temperature, desired maintain temperature, pipe size, insulation type or thickness, or ambient conditions differ from what the system was originally designed for, redesign the circuit using manufacturer's design criteria.

20. *Re-insulate.*

Heating cables cannot overcome lack of insulation.

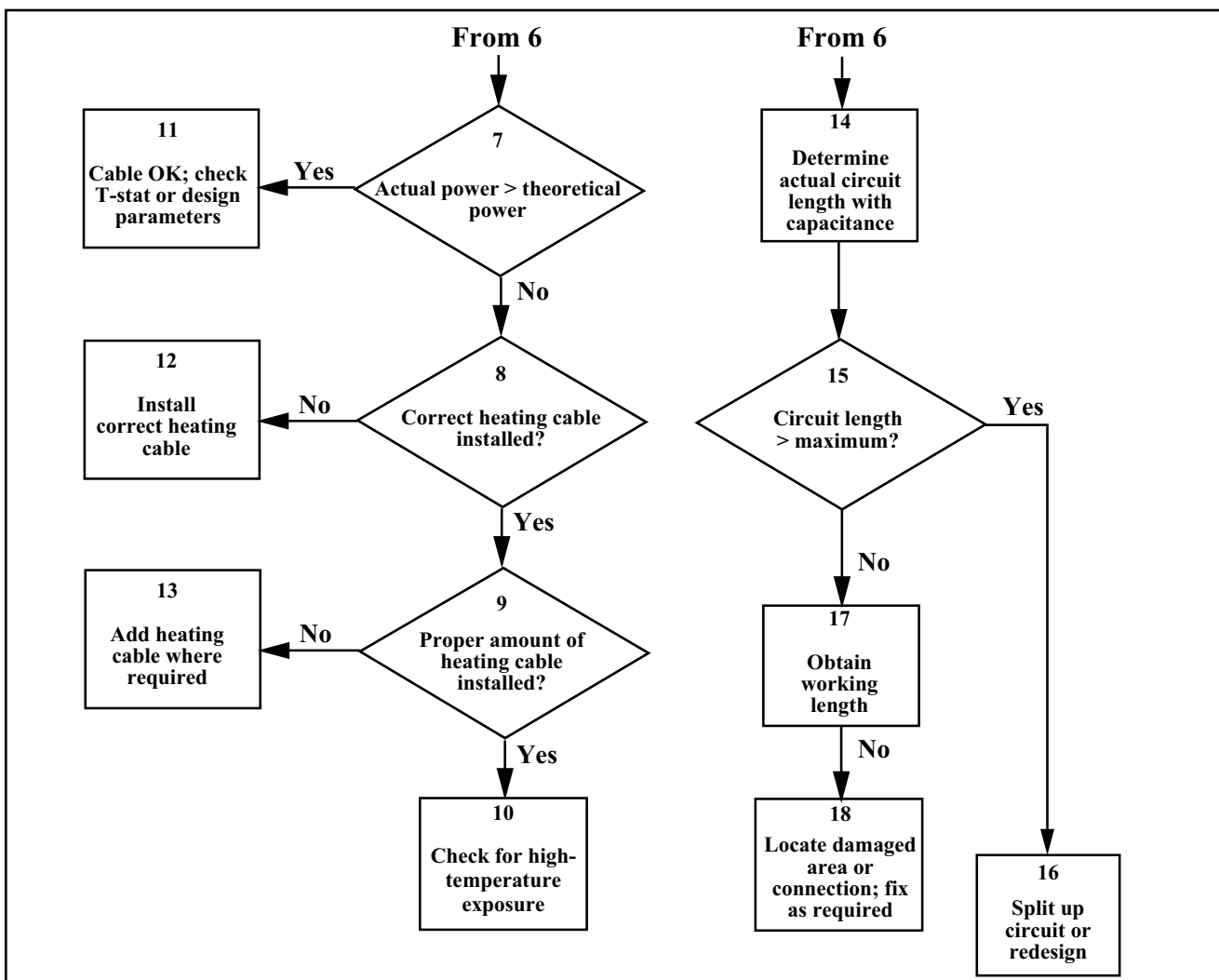


Figure 13.1(a). Troubleshooting flowchart – cold pipe (continued)

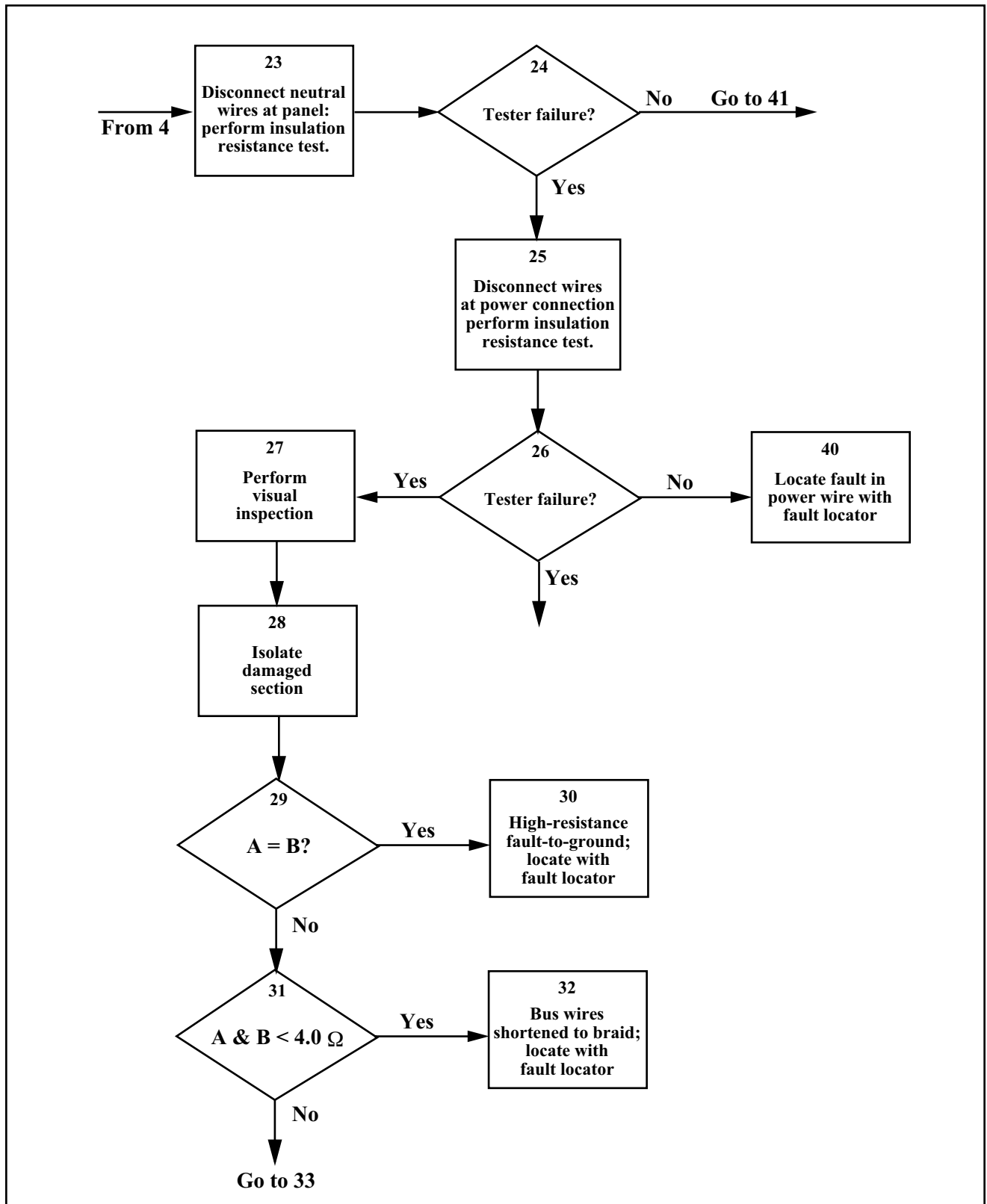


Figure 13.1(b). Troubleshooting flowchart – circuit breaker tripping test failures (continued)

Replace all damaged, missing, or wet insulation. END.

**21. Check temperature monitor.**

The temperature monitoring equipment is faulty or poorly insulated, or may need field calibration. Some RTD (temperature sensor) probes' mounting hardware have been shown to cause a lower than actual recorded pipe temperature. Insulate RTD mounting hardware as necessary. Field calibration is required if the installed probe does not have the same amount of contact with the pipe as when originally calibrated.

**22. Check control panel, wiring, and transformer.**

The control system is not operating correctly. Check for miswired thermostats, a faulty relay or contactor, or an incorrectly programmed control system. Undersized power feed wires can cause a voltage drop to the heating cable. The taps on the transformer may need to be adjusted. END.

**23. Disconnect wires at panel; perform insulation resistance test.**

At panel, disconnect the circuit's power feed wires,

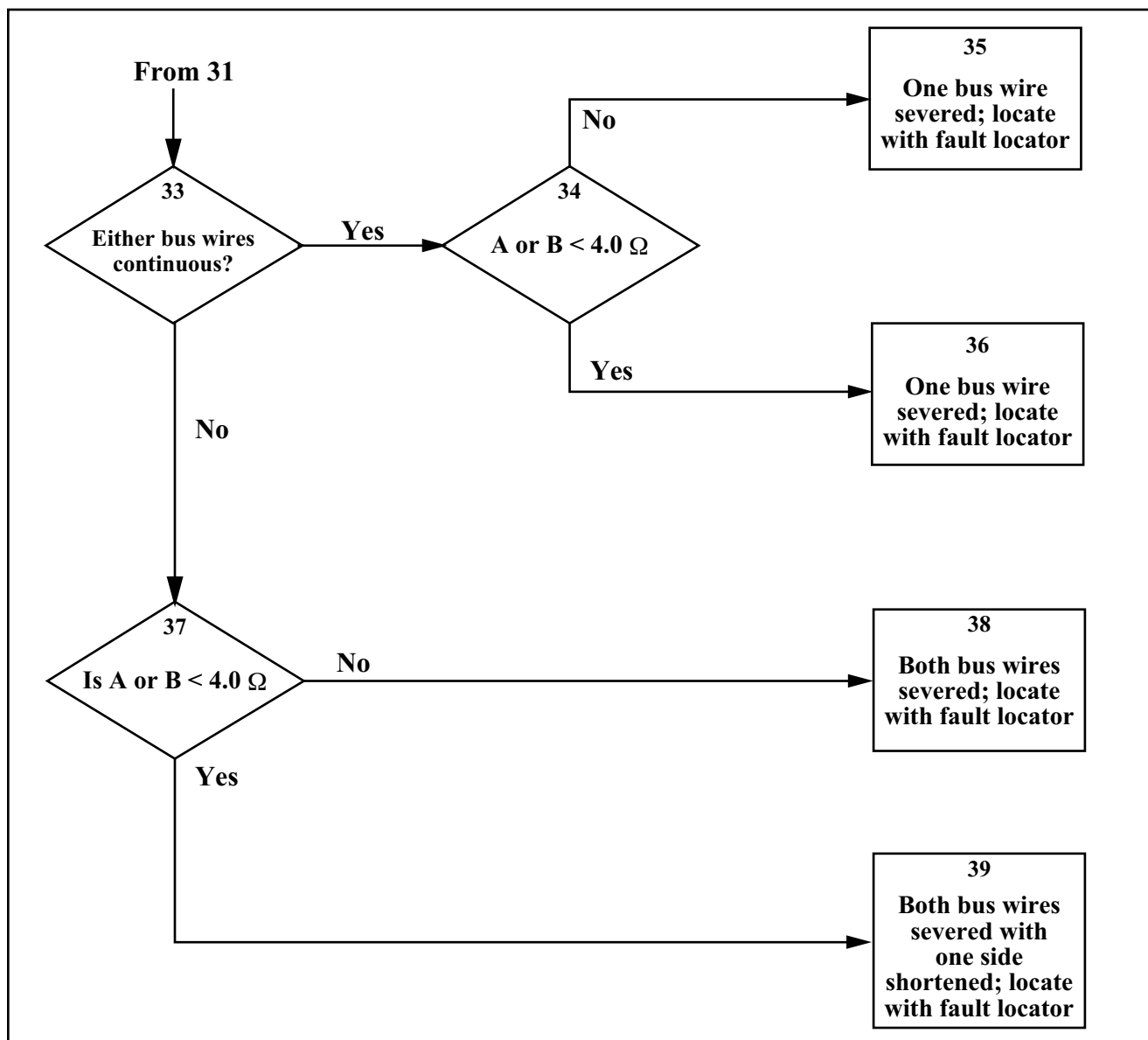


Figure 13.1(b). Troubleshooting flowchart – circuit breaker tripping test failures (continued)

neutral included. Test the circuit from the feed wires to ground as outlined in Section 12.1.

**24. Test failure?**

The circuit is failing this test if the recorded value is below the insulation resistance criteria provided in Section 12.2. If the circuit passes these criteria, GO TO 41.

**25. Disconnect wires at power connection; perform insulation resistance test on the heating cable.**

At the power connection box on the pipe, disconnect the heating cable from the power feed wires, neutral included. Test the circuit from the heating cable to the braid in accordance with Section 12.1.

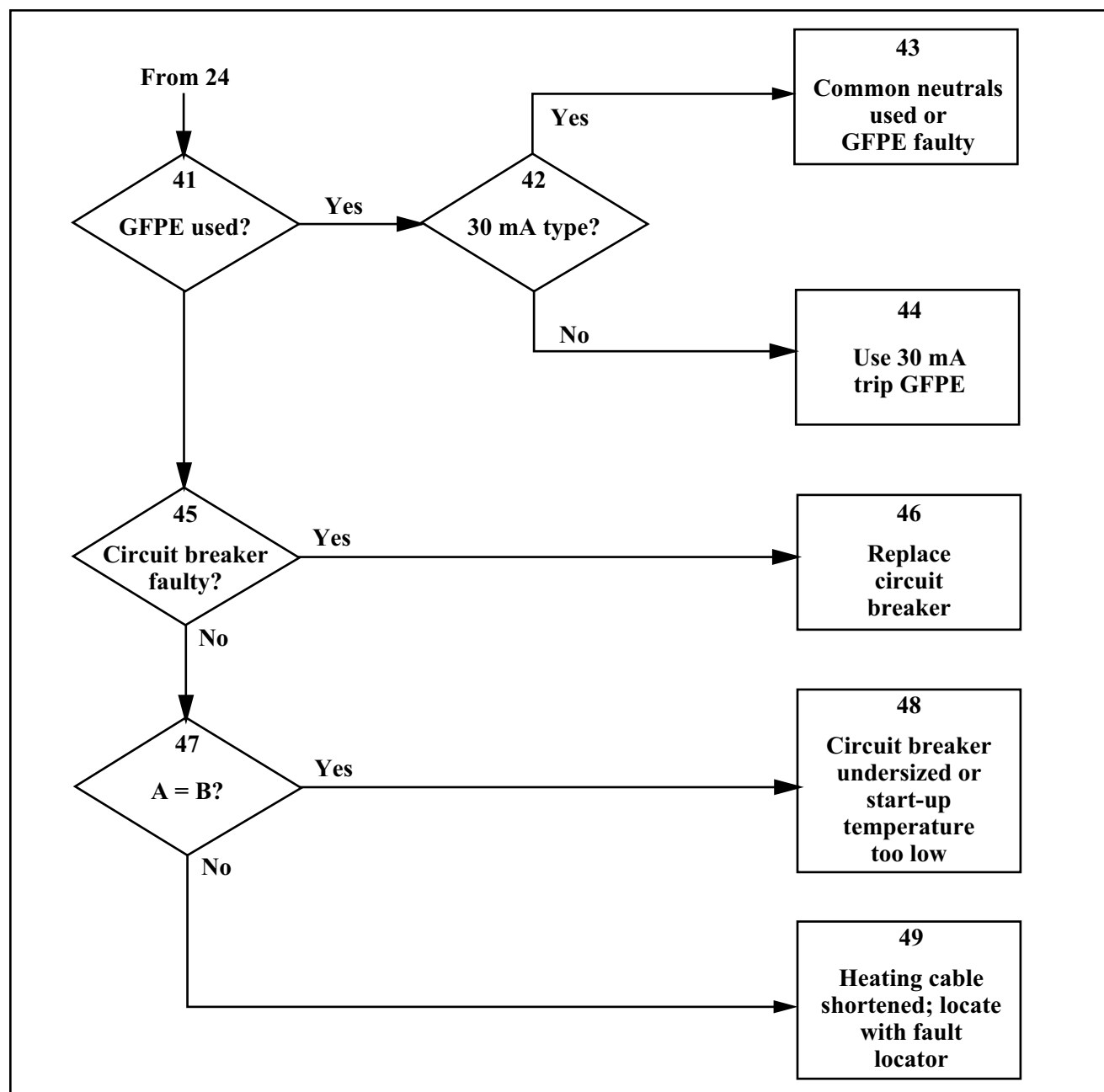


Figure 13.1(b). Troubleshooting flowchart – circuit breaker tripping test failures (continued)

26. *Test failure?*

The heating cable is failing the insulation resistance test if the recorded value is below the insulation resistance criteria provided in Section 12.2. If the circuit passes these criteria, GO TO 40.

27. *Visual inspection.*

On new system installations, inspect all heating cable connections for proper cable preparation and component assembly. On any system, check for heating cable damage around heavily maintained equipment and any section of pipe with damaged or recently repaired insulation.

28. *Isolate damaged section?*

Isolate the damaged section of the heating cable by separating and checking individual lengths between all connections.

29. *A = B?*

Record resistance between the heating cable bus wires at the front end of the heating cable (measurement A), and at the far end (measurement B). If the two values are not equal, GO TO 31.

30. *High resistance fault to ground; locate with fault locator.*

A high impedance fault occurred in the heating cable between the connections. Use the fault locator to locate the fault.

31. *A and B < 4.0 Ohms*

If both A and B are small (less than 4 ohms), a bus-to-bus short is likely. GO TO 32. If not, continue to 33.

32. *Bus wires shorted to braid; locate with fault locator.*

The heating cable bus wires are continuous but shorted together and to the braid. This fault can be located by employing the fault locator, or a time domain reflectometer (TDR). The location can also be approximated by employing the ratio method.

33. *Either bus wire continuous?*

Perform a continuity test to determine if either of the bus wires are continuous throughout the heating cable length. If neither are continuous, GO TO 37.

34. *A or B < 4.0 Ohms*

At least one bus wire was continuous. If either A or B is small (less than 4 ohms), then one bus wire was severed and shorted to the other bus wire; GO TO 37.

35. *One bus wire is severed; locate with fault locator.*

One of the heating cable bus wires is severed and there is a high-resistance fault to the braid. The fault can be located using fault locator or a TDR. The fault location may be approximated using the 1/R method. END.

36. *One bus wire is severed; locate with fault locator.*

One of the bus wires is severed and shorted to the other bus wire. This fault can be located by using fault locator or a TDR. END.

37. *A or B < 4.0 Ohms*

The heating cable has been severed. If either A or B is small (less than 4 ohms), then one of the bus wires is shorted together; GO TO 39. If A and B are large, GO TO 38.

38. *Both bus wires are severed; locate with fault locator or the I/R or capacitance methods.*

The heating cable is severed and both halves have high resistance faults to the braid. This fault may be located by using the fault locator or a TDR. The 1/R method can approximate the fault location. If resistance to ground is 1 Megohm or higher, the capacitance method can also approximate the fault location. END.

39. *Both bus wires are severed with one shorted; locate with fault locator method #5 or capacitance method.*

The heating cable is severed and one half has a bus-to-bus short. This fault can be located by using fault locator special method or a TDR. The I/R method can approximate the fault location. The capacitance method can also approximate the fault location. END.

40. *Locate fault in power wire with fault locator.*

A fault occurred in the power feed wires between the panel and the power connection box. Use fault locator to locate the fault. END.

41. *Ground-fault protection for equipment (GFPE) used?*

Since the circuit has insulation resistance tested fine, something else is wrong. If ground-fault protection equipment is not used, GO TO 45.

42. *30-mA type?*

If the GFPE has a 30-mA trip level, GO TO 43. If a ground-fault circuit-interrupter (GFCI) or other ground-fault device with less than a 30-mA trip level was used, GO TO 44.

43. *Common neutrals used or GFPE faulty.*

The GFPE is faulty or operated incorrectly. Ground-fault protection devices cannot share or swap power wires from different loads. Each device needs a separate set of feed wires to the equipment. The faulty GFPE can be checked with an amperage probe. Replace if necessary. Some GFPE have been shown to nuisance-trip because of capacitance loads induced from long power feed wires or because radios are keyed nearby. END.

44. *Use 30-mA trip ground-fault protection for equipment (GFPE).*

Ground-fault circuit interrupters (GFCIs) or 5-mA trip level devices are personnel protection devices and may be too sensitive for industrial equipment. Heating cable circuits can produce up to 10-mA of leakage under normal conditions. Install 30-mA devices to eliminate nuisance tripping. END.

45. *Circuit breaker faulty?*

If ground-fault protection devices were not used, the breaker may be defective. Record the start-up load. If the circuit's load is less than the breaker size, the breaker needs to be replaced. END.

46. *Replace circuit breaker.*

Replace the defective circuit breaker. If the problem persists, GO TO 47.

47. *A = B?*

If the circuit breaker is operating correctly, it may just be undersized. Check the heating cable resistance at the front end (measurement A) and at the far end (measurement B). If the resistance readings

are equal, the heating cable is OK and the breaker is undersized; GO TO 48. If the resistance readings do not match, an internal short occurred; GO TO 49.

48. *Circuit breaker undersized or start-up temperature too low.*

The heating cable is OK. However, the circuit breaker may be undersized for the application. Breaker size is specified as a function of heating cable length and start-up temperature. Consult manufacturer's literature and replace as required. END.

49. *Heating cable shorted; locate with fault locator or ratio method.*

If an internal short is present and the circuit insulation resistance tested OK, look for wiring problems. Inspect all junction boxes and heating cable components for crossed wires or moisture. The fault can be located with fault locator or approximated with the resistance ratio method. END.

*(These annexes are not a part of the standard)*

# Annex A: Recordkeeping

The forms on the following two pages are used for maintenance and troubleshooting of industrial heat tracing systems:

- Page 35 shows a blank cross-out format Heater Commissioning Record that should be filled out during all maintenance and repair work, and kept for future reference.
- Page 36 shows a blank Maintenance Log Record on which all repairs and measurements should be recorded.

## Heater Commissioning Record

|                                                               |                  |                                           |                               |               |         |         |
|---------------------------------------------------------------|------------------|-------------------------------------------|-------------------------------|---------------|---------|---------|
| Location                                                      | System           | Project number                            | Reference drawing(s)          |               |         |         |
| Heater number                                                 | Line number      | Area classification                       | AIT/T-classification          |               |         |         |
| Panel number                                                  | Location         | Circuit number                            | Circuit Amp/Voltage           |               |         |         |
| Heater manufacturer                                           | Heater model     | Heater wattage unit length/Voltage rating |                               |               |         |         |
| <b>HEATER INFORMATION:</b>                                    |                  |                                           |                               |               |         |         |
| Heater total design length                                    |                  |                                           | Heater total installed length |               |         |         |
| Thermal insulation type                                       |                  |                                           | Thermal insulation thickness  |               |         |         |
| Normal pipe temperature                                       |                  |                                           | Maintain pipe temperature     |               |         |         |
| <b>HEATER TESTING: (data from heater installation record)</b> |                  |                                           |                               |               |         |         |
| Electrical resistance (continuity) test in ohms (see NOTE)    |                  |                                           |                               |               |         |         |
| Electrical insulation resistance test in megohms              |                  |                                           |                               |               |         |         |
| Overjacket insulation resistance test in megohms              |                  |                                           |                               |               |         |         |
| Test ambient temperature                                      |                  |                                           |                               |               |         |         |
| <b>PERFORMANCE DATA:</b>                                      | <b>Volts ac</b>  |                                           | <b>Current in Amperes</b>     |               |         |         |
|                                                               | Panel            | Field                                     | 1 phase                       | 3 phase       |         |         |
|                                                               |                  |                                           | Line                          | A phase       | B phase | C phase |
| Startup                                                       |                  |                                           |                               |               |         |         |
| After 10 minutes                                              |                  |                                           |                               |               |         |         |
| After 4 hours                                                 |                  |                                           |                               |               |         |         |
| Ambient temperature at time of test                           |                  |                                           |                               |               |         |         |
| Pipe temperature at beginning of test                         |                  |                                           |                               | After 4 hours |         |         |
| Calculated watts per unit length (Volt x Amp/Length)          |                  |                                           | After 4 hours                 |               |         |         |
| <b>TEMPERATURE CONTROL: type</b>                              |                  |                                           |                               |               |         |         |
| Heating controller                                            | Ambient sensing  | Pipe sensing                              | Temperature set point         |               |         |         |
| High-Limit controller                                         | Type             | Location                                  | Temperature set point         |               |         |         |
| Heating controls calibrated                                   |                  |                                           |                               |               |         |         |
| Heating controls operation verified                           |                  |                                           |                               |               |         |         |
| <b>ALARMS/MONITORING: type</b>                                |                  |                                           |                               |               |         |         |
| Temperature                                                   | High setting     | Low setting                               | Operation verified            |               |         |         |
| Heater current                                                | High setting     | Low setting                               | Operation verified            |               |         |         |
| Ground-Fault current                                          |                  | Setting                                   | Operation verified            |               |         |         |
| Loss of voltage                                               |                  |                                           | Operation verified            |               |         |         |
| Other                                                         |                  |                                           | Operation verified            |               |         |         |
| <b>GROUND-FAULT PROTECTION: type</b>                          |                  |                                           |                               |               |         |         |
| Setting                                                       | Measured current |                                           | Tested for operation          |               |         |         |
| Performed by                                                  | Company          |                                           | Date                          |               |         |         |
| Witnessed by                                                  | Company          |                                           | Date                          |               |         |         |
| Accepted by                                                   | Company          |                                           | Date                          |               |         |         |
| Approved by                                                   | Company          |                                           | Date                          |               |         |         |

**NOTE**—Continuity of self-limiting cable only used for short or open circuit.

## Maintenance Log Record

|                                                                 |             |                                               |  |      |                  |  |
|-----------------------------------------------------------------|-------------|-----------------------------------------------|--|------|------------------|--|
| Location                                                        | System      | Reference Drawing(s)                          |  |      |                  |  |
| <b>CIRCUIT INFORMATION</b>                                      |             |                                               |  |      |                  |  |
| Heater cat. no.                                                 |             | Circuit length                                |  |      | Bkr. panel no.   |  |
| Power connection                                                |             | Design voltage                                |  |      | Bkr. pole(s) no. |  |
| Tee connection                                                  |             | Ground-Fault protection (type)                |  |      |                  |  |
| Splice connection                                               |             | Ground-Fault trip setting                     |  |      |                  |  |
| Heating controller                                              |             |                                               |  |      |                  |  |
| <b>VISUAL</b>                                                   |             |                                               |  |      |                  |  |
| Panel number                                                    | Circuit No. |                                               |  |      |                  |  |
|                                                                 | Date        |                                               |  |      |                  |  |
|                                                                 | Initial     |                                               |  |      |                  |  |
| <b>Thermal insulation</b>                                       |             |                                               |  |      |                  |  |
| Damaged insulation/lagging                                      |             |                                               |  |      |                  |  |
| Water seal good                                                 |             |                                               |  |      |                  |  |
| Insulation/lagging missing                                      |             |                                               |  |      |                  |  |
| Presence of moisture                                            |             |                                               |  |      |                  |  |
| <b>Heating system components</b>                                |             |                                               |  |      |                  |  |
| Enclosures, boxes sealed                                        |             |                                               |  |      |                  |  |
| Presence of moisture                                            |             |                                               |  |      |                  |  |
| Signs of corrosion                                              |             |                                               |  |      |                  |  |
| Heater lead discoloration                                       |             |                                               |  |      |                  |  |
| <b>Heating and/or high-limit controller</b>                     |             |                                               |  |      |                  |  |
| Operating properly                                              |             |                                               |  |      |                  |  |
| Controller set point                                            |             |                                               |  |      |                  |  |
| <b>ELECTRICAL</b>                                               |             |                                               |  |      |                  |  |
| Insulation resistance testing (bypass controller if applicable) |             | (Refer to IEEE Std 515-1997, 6.6.1 and 6.6.2) |  |      |                  |  |
| Test voltage                                                    |             |                                               |  |      |                  |  |
| Megger value                                                    |             |                                               |  |      |                  |  |
| <b>Heater supply voltage</b>                                    |             |                                               |  |      |                  |  |
| Value at power source                                           |             |                                               |  |      |                  |  |
| Value at field connection                                       |             |                                               |  |      |                  |  |
| <b>Heater circuit current reading</b>                           |             |                                               |  |      |                  |  |
| Amp reading at 2 to 5 min                                       |             |                                               |  |      |                  |  |
| Amp reading after 15 min                                        |             |                                               |  |      |                  |  |
| Ground Fault current                                            |             |                                               |  |      |                  |  |
| Comments and actions:                                           |             |                                               |  |      |                  |  |
| Performed by                                                    |             | Company                                       |  | Date |                  |  |
| Approved by                                                     |             | Company                                       |  | Date |                  |  |

# Annex B: Reference Standards

This publication, when used in conjunction with the National Electrical Code and manufacturers' literature, provides sufficient information to install and maintaining industrial heat tracing systems. The following publications may also provide useful information:

The Institute of Electrical and Electronics Engineers, Inc.  
445 Hoes Lane  
P.O. Box 1331  
Piscataway, NJ 08855  
(908) 981-0060  
(908) 981-9667 Fax

IEEE 515-1997, *Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications*

ANSI/IEEE 515.1-1995, *Recommended Practice for the Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Commercial Applications*

ANSI/IEEE 141-1993, *Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book)*

## **Other National Electrical Installation Standards™ published by NECA:**

National Electrical Contractors Association  
3 Bethesda Metro Center, Suite 1100  
Bethesda, MD 20814  
(301) 215-4504 tel  
(301) 215-4500 fax  
[www.neca-neis.org](http://www.neca-neis.org)

NECA 1-2000, *Practices for Good Workmanship in Electrical Contracting* (ANSI)

NECA 100-1999, *Symbols for Electrical Construction Drawings* (ANSI)

NECA 101-2000, *Standard for Installing Steel Tube (Rigid, IMC, EMT)*

NECA/AA 104-2000, *Recommended Practice for Installing Aluminum Building Wire and Cable* (ANSI)

NECA/FOA 301-1997, *Standard for Installing and Testing Fiber Optic Cables*

NECA 400-1998, *Recommended Practice for Installing and Maintaining Switchboards* (ANSI)

NECA 402-2000, *Recommended Practice for Installing and Maintaining Motor Control Centers* (ANSI)

NECA/EGSA 404-2000, *Recommended Practice for Installing Generator Sets* (ANSI)

NECA/IESNA 500-1998, *Recommended Practice for Installing Indoor Commercial Lighting Systems* (ANSI)

NECA/IESNA 501-2000, *Recommended Practice for Installing Exterior Lighting* (ANSI)

NECA/IESNA 502-1999, *Recommended Practice for Installing Industrial Lighting Systems* (ANSI)



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Bethesda, MD 20814  
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**Standards & Safety**  
**Index: NECA 202**  
**10K/7-01**

