THERMON trace heating cables

THERMON self regulating trace heaters cover the complete range of applications from frost protection to high temperature industrial installations.

This leaflet outlines applications in the freezer industry where THERMON trace heating cables can be utilised. These cables together with a complete range of components have been specifically designed for low temperature use in the freezer industry.

The Self Regulating design renders the heater burnout proof particularly at ‘cross-overs’ as the output will vary over its entire length depending on temperature.

The schematic diagram above shows many applications where THERMON heat tracing cables may be used on refrigeration plant. In outdoor installations, particularly in cold climates it is most important to maintain minimum operating temperatures to ensure that refrigerant gases remain as a vapour.

The following application notes describe where the heater cables may be used on refrigeration plant, cool rooms, and commercial freezer cabinets. Thermon will be pleased to provide assistance on the selection of heater cables to suit your application.

All heater cables operate on 240Vac power supply. Low voltage designs are available with TESXL.

Typical refrigeration plant

Liquid receiver
A heater cable may be required in cold climates to maintain refrigerant liquid temperature for optimum system efficiency.

Oil separator
A heater cable may be required to prevent liquid refrigerant returning to the compressor by maintaining it as a vapour.

Suction line accumulator
A heater will assist boil off and ensure that the refrigerant remains as a vapour back to the compressor.

Suitable Heater cables for these applications are FLX, CSR, CCH crankcase heater with strap, or CDH condensate drain heater.
Cool room doors
Warm air entering a cool room will condense and freeze upon contact with a cold surface.
Heater cable installed in the doorway architrave or sliding door seal increases the surface temperature above 0°C and prevents ice forming between frame and door.
Heater cable; THERMON FLX Self Regulating Heater Cable or TESXL Low Voltage Heater Cable

Cool room thresholds
Ice may form at the cool room threshold where warm air enters, condenses, and freezes. This is prevented by running three or four runs of heater cable in floor channels, conduits, or sawn slots directly in the concrete.
Heater cable; THERMON FLX Self Regulating Heater Cable

Compressor crankcase heaters
Compressors may be damaged by the formation of refrigerant liquid in the crankcase particularly after long ‘off’ periods. It may be necessary to heat the crankcase to evaporate the refrigerant trapped in the oil, particularly outdoor installations in cold climates.
Heater cable; THERMON FLX Self Regulating Heater Cable or purpose made crankcase heater for compressors, type CCH complete with strap

Drain lines
The drain line from the drip trays also requires heat tracing to prevent ice formation. The heater may be attached to the underside of the pipe in one straight run, or spiralled if required. On plastic pipes the heater cable should be covered with aluminium foil tape to assist heat dispersion.
The heater cable may also be run inside the pipe provided the connection and end seal are external.
The drain line must be insulated with minimum thickness of 25mm.
Heater cable; THERMON FLX Self Regulating Heater Cable or purpose made Condensate Drain heater for drains, type CDH

Pressure relief ports, or safety vents.
These are mounted in the cool room wall and used to maintain normal atmospheric pressure allowing air to enter or exhaust as required.
They typically comprise a box section with moving vanes which must not become frozen.
Heater cable is spiralled around the box section at approximately 80mm centres and preferably insulated.
Heater cable; THERMON FLX Self Regulating Heater Cable
Fire protection sprinklers
Where these are installed in cool rooms trace heating will be required to prevent freezing on exposed pipe work and fittings. The heater cable rating will depend on the cool room temperature, pipe size, and insulation thickness.
Heater cable; THERMON FLX Self Regulating Heater Cable

Drip trays
Drip trays are required to collect water droplets from the evaporator coils during defrost cycles.
Formation of ice may be prevented by laying a heater cable in the tray, alternatively, attached under the tray. The spiral pitch should be 150-200mm, and the underside of the tray should have a minimum of 25mm insulation.
Heater cable; THERMON FLX Self Regulating Heater Cable

Frost heave prevention
The substrata of freezer floors will withstand cold temperatures for a period of time, however if the ground temperature will eventually drop below freezing. At that point if water is present in the substrata frost heave of the freezer floor will occur. If severe, this will damage the foundation slab with the formation of cracks.
Design and installation guides are available for these applications and Thermon staff is available to assist with the design process
Heater cable; THERMON FLX Self Regulating Heater Cable

Supermarket frozen food cabinets
Wherever warm air is in contact with cold surfaces such as the ‘frost-line’ or rail on open chest freezers then condensation will occur. Similarly with display cabinets, around doors and light fittings.
Trace heaters, or ‘anti-sweat’ heaters successfully overcome these problems.
Heater cable; THERMON FLX Self Regulating Heater Cable or TESXL Low Voltage Heater Cable
Air or water cooled condensers
Where these are installed outdoors in cold climates a trace heater may be required to prevent freeze-up. Insulation should be applied over the heater.
*Heater cable; THERMON FLX* Self Regulating Heater Cable

Fan cowlings
Fan cowlings on evaporator-blowers may ‘ice up’ and cause fan seizure. This may be avoided by spiralling heater cable around the cowling at 50-80mm centres. Aluminium foil tape and insulation over the heater would assist.
*Heater cable; THERMON FLX* Self Regulating Heater Cable

Evaporator bends
Defrost heaters in evaporators may not always extend to the bends, and therefore these may be traced with heater cables to assist the defrost operation.
*Heater cable; THERMON FLX* Self Regulating Heater Cable
Refrigeration Applications
Self-Regulating Heating Cable

**Application: Freeze Protection**

FLX self-regulating heating cables are designed to provide freeze protection for a variety of refrigeration and freezer applications.

These cut to length heater cables are available in power outputs of 16, 33 and 49 watts per meter. Operating voltage is 240 VAC.

The narrow profile of FLX cables provide the flexibility required for freezer door applications.

**Rugged and Reliable . . .**

FLX self-regulating cables are protected by a tinned copper braid to provide grounding and additional mechanical protection for the cable. An optional outer jacket is available if additional mechanical protection is required.

Heat tracing users expect quality products and services from a reputable manufacturer. Thermon exceeds these expectations by operating under the ISO 9001 standard for quality.

**Easy to Design . . .**

FLX are self-regulating, polyolefin insulated cables which vary output in relation to temperature. FLX cables are used primarily for freeze protection of freezer door frames, condensate drains and general freeze protection. FLX’s electrical configuration lends itself to field fabrication of each heat tracing circuit. Field dimensions of the erected piping are not required.

**Easy to Install . . .**

Kits for power connection, end termination and splicing are designed for quick and easy installation.

---

**Self-Regulating Heat Output**

The self-regulating heat output of the cables varies in response to the surrounding temperature. Variations in the ambient temperature are automatically compensated for along the entire length of a heat traced pipe.
Refrigeration Applications
Self-Regulating Heating Cable

Characteristics . . .

- Outer Jacket (Optional)
- Tinned Copper Braid
- Bus Wire
- Radiation Cross-Linked Polyolefin Insulation
- Radiation Cross-Linked Heating Core

Bus wire: nickel-plated copper
Metallic braid: tinned copper
Outer jacket: OJ, polyolefin (optional)
Minimum bend radius @ -15°C: 10 mm
Supply voltage: 240 Vac
Circuit protection: 30 mA ground-fault protection required
Maximum continuous exposure temperature: power-on: 65°C; power-off: 85°C

Nominal Outside Dimension . . .

<table>
<thead>
<tr>
<th></th>
<th>5 or 10-FLX-2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13.0 mm</td>
</tr>
<tr>
<td></td>
<td>6.0 mm</td>
</tr>
<tr>
<td>15-FLX-2</td>
<td>14.5 mm</td>
</tr>
<tr>
<td></td>
<td>6.5 mm</td>
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</tbody>
</table>

Note . . . Dimensions relate to the outer jacket option on the cable. Subtract 1 mm for braided only cables

Certifications/Approvals . . .

<table>
<thead>
<tr>
<th>240 Vac Service Voltage</th>
<th>5-FLX-2</th>
<th>10-FLX-2</th>
<th>15-FLX-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up Temp. °C</td>
<td>-18</td>
<td>-18</td>
<td>-29</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>-40</td>
</tr>
<tr>
<td>Max. Circuit Length m</td>
<td>119.8</td>
<td>68.6</td>
<td>72</td>
</tr>
<tr>
<td>vs. Breaker Size</td>
<td>179.8</td>
<td>103.0</td>
<td>114</td>
</tr>
<tr>
<td>20A</td>
<td>179.8</td>
<td>121.6</td>
<td>131</td>
</tr>
<tr>
<td>30A</td>
<td>182.6</td>
<td>121.6</td>
<td>117</td>
</tr>
<tr>
<td>40A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Certifications/Approvals . . .

[Diagram of heating cable components]
**FreezeTrace CSR**

**Narrow Profile Self-Regulating Cable**

**Product Specifications**

**CSR Self-Regulating Heaters . . .**

- For all freeze protection applications
- Suitable for wet and dry applications
- Flexible for quick installation
- Simple to use
- For use on metallic or plastic surfaces

**Specifications . . .**

- **Bus Wire** .......................................... 16 AWG (1.31mm²)
- **Heating Matrix** ........ Radiation Cross-linked Polyolefin
- **Primary Insulation** ........ dielectric ........ Radiation Cross-linked Polyolefin
- **Metallic Braid** ........................................... Tinned copper
- **Standard Overjacket** ........ Thermoplastic Elastomer
- **Supply Voltage** .................................................... 240 Vac
- **Minimum Bend Radius** ........................................ 32mm
- **Minimum Install Temp.** ...................................... -51ºC
- **Maximum Exposure Temp. Power On** .................... 66ºC
- **Maximum Exposure Temp. Power Off** .................... 85ºC
- **Power Output** ..... 20W/m (6W/ft) @ 10°C @ 240 Vac

**Construction . . .**

1. Bus Wires
2. Variable power heating matrix core
3. Cross-linked polyolefin jacket
4. Tinned copper metallic braid
5. Thermoplastic elastomer overjacket

**Approvals / Certifications . . .**

- **UL** LISTED

**Basic Accessories . . .**

Requires CSR-Term-1-OJ for **Power Connection** and **End-of-Circuit** terminations

**Cross-Section . . .**

- 10.5mm
- 5.5mm

**THERMON . . . The Heat Tracing Specialists®**

30 London Dr. • PO Box 532 • Bayswater, VIC, 3153
Ph: +61 3 9762 6900 • Fax: +61 3 9762 9519
www.thermon.com • thermon@thermon.com.au
CrankCase Heater
240V Self Regulating Cable

Features and Benefits:

Helps extend compressor life by keeping oil at safe operating temperature.

- Helps prevent compressor burn outs.
- Fits compressors up to 5hp with up to 2.3 litres of oil.
- Flexible to -51degC
- No Thermostat required
- Easy to install.
- Can be crossed or overlapped.

CCH is a fast, easy and effective way to extend refrigeration compressor life. It overcomes one of the leading causes of compressor burnout by keeping the crankcase oil warm enough to work effectively. Since it is self regulating, it also keeps oil from becoming too warm while preventing damage to the cable.

CCH incorporates a self regulating polymer core that controls its heat without a thermostat. Over heating is avoided by cutting back heat output at the point the cable touches or overlaps itself or by reacting to changes in ambient temperature. CCH is jacketed with a thermoplastic sheath that resists abrasion and the effects of most chemicals. Each unit is completely self contained meaning less wasted time and materials occur during installation.

Ordering Information:

<table>
<thead>
<tr>
<th>Catalogue Number</th>
<th>Voltage</th>
<th>Power Output @ 10°C</th>
<th>Girth (Wraparound dimension)</th>
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</thead>
<tbody>
<tr>
<td>CCH-2</td>
<td>240V</td>
<td>52 Watts</td>
<td>Up to 2M</td>
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</tbody>
</table>

*Special Lengths can be manufactured upon request

*ALL Electric Heat Tracing requires an Earth Leakage Device fitted to Power Source as per AS/NZS3000:2007
Condensate Drain Heater
240V Self Regulating Cable

Applications...
The Condensate Drain Heater is complete and ready to use for freeze protection on condensate drain lines. Since the cable is self regulating, no controlling thermostat is required.

<table>
<thead>
<tr>
<th>Catalogue</th>
<th>Part Number</th>
<th>Length (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDH-2-1-OJ</td>
<td>651-1020</td>
<td>1</td>
</tr>
<tr>
<td>CDH-2-1.5-OJ</td>
<td>651-1030</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Notes:
*Special Lengths can be manufactured upon request

*ALL Electric Heat Tracing requires an Earth Leakage Device fitted to Power Source as per AS/NZS3000:2007

Construction...
1. Self Regulating SX Overjacketed Cable
2. 3 Core Flex standard 1 metre length.
FLX™ Self-Regulating
Winterization/Freeze Protection
INSTALLATION PROCEDURES

The Heat Tracing Specialists®
**FLX™ Self-Regulating**

Refer to the “FLX Cable Testing Report” for required recording of test data and circuit information.

**Upon Receiving Cable . . .**

1. Upon receiving heating cable, check to make sure the proper type and output have been received. All cables are printed on the outer jacket with part number, voltage rating and watt output.

2. Visually inspect cable for any damage incurred during shipment. The heating cable should be tested to ensure electrical integrity with at least a 500 Vdc megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. IEEE 515.1 recommends that the test voltage for polymer insulated heating cables be 2500 Vdc. Minimum resistance should be 20 megohms. (Record 1 on Cable Testing Report.)

   ![Connect the positive lead of the megger to the cable bus wires and the negative lead to the metallic braid.

   **CAUTION: DO NOT connect power to heating cable while it is on reel or in shipping carton.**

**Before Installing Cable . . .**

1. Be sure all piping and equipment to be traced is completely installed and pressure tested.

2. Surface areas where heat tracing is to be installed must be reasonably clean. Remove dirt, rust and scale with a wire brush and oil and grease films with a suitable solvent.

**INSTALLATION PROCEDURES**

**Typical Heat Tracing Installation . . .**

A complete electric heat tracing system will typically include the following components:

1. Electric heat tracing cable.

2. Power connection kit.

3. Control thermostat (may be remote ambient sensing control.)

4. In-line/T-splice kit (permits two or three cables to be spliced together).

5. Cable end termination.

6. Attachment tape (use on 12" intervals or as required by code or specification).

7. “Electric Heat Tracing” label (peel-and-stick label attaches to insulation vapor barrier on 10’ intervals or as required by code or specification).

8. Thermal insulation and vapor barrier (by others).

The absence of any of these items can cause a system to malfunction or represent a safety hazard.

The National Electric Code and Canadian Electrical Code require ground-fault protection be provided for all electric heat tracing.
FLX™ Self-Regulating

Installation Guidelines for Fire Protection Systems

1. Where above ground water-filled supply pipes, risers, system risers or feed mains pass through open areas, cold rooms, passageways, or other areas exposed to freezing temperatures, the pipe shall be protected against freezing in accordance with NPFA 13, "Standard for the Installation of Sprinkler Systems".

2. Thermon’s FLX Self-Regulating Heating Cables are UL Listed for use on Fire Protection System Piping. This approval states these cables may be used on insulated standpipe and sprinkler system pipe up to and including 6" (15 cm) size, including use on elbows, tees, flanges, hangers and valves, where the minimum ambient temperature is not less than -40°F (-40°C). This application approval includes piping which connects between buildings in unheated areas, piping located in unheated areas or piping through coolers or freezers. As with all heat traced piping systems, thermal insulation is required to ensure the heating system can compensate for heat losses.

3. NFPA 13 states, "it is an unacceptable practice to heat trace and insulate branch lines" of fire protection piping. However, heat tracing and insulation are acceptable means of protecting feed mains, risers and cross mains.

4. In accordance with IEEE 515.1 guidelines, the use of ambient sensing control with low temperature and continuity monitoring as a minimum for all fire protection piping heat tracing systems is required; Thermon recommends the use of an electronic controller with RTD sensing be considered for these applications.

THE NFPA DEFINES THE FOLLOWING:

- **Branch Lines**—The pipes in which the sprinklers are placed, either directly or through risers.
- **Cross Mains**—The pipes supplying the branch lines, either directly or through risers.
- **Feed Mains**—The pipes supplying cross mains, either directly or through risers.
- **Risers**—The vertical supply pipes in a sprinkler system.
1. Refer to Thermon FLX Installation Procedures, FORM CPD0000, for general installation procedures, requirements and guidelines.

2. Upon receiving heating cable, check the cable to make sure the proper type and output have been received. All cables are printed on the outer jacket with part number, voltage rating and watt output.

3. Visually inspect cable for any damage incurred during shipment. The heating cable should be tested to ensure electrical integrity with at least a 500 Vdc megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. IEEE 515.1 recommends that the test voltage for polymer insulated heating cables be 2500 Vdc. Minimum resistance should be 20 megohms. (Record 1 on Cable Testing Report.)
   A. Connect the positive lead of the megger to the cable bus wires.
   B. Connect the negative lead of the megger to the metallic braid.
   C. Energize the megger and record the reading. Readings between 20 megohms and infinity are acceptable. Readings below 20 megohms may mean the electrical insulation has been damaged. Recheck the heating cable for physical damage between the braid and the heating element; small cuts or scuffmarks on the outer jacket will not affect the megger reading unless there was actual penetration through the braid and dielectric insulation jacket.

4. Once the installation is complete, but prior to installation of thermal insulation, recheck the heating cable with at least a 500 Vdc megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. IEEE 515.1 recommends that the test voltage for polymer insulated heating cables be 2500 Vdc. Minimum resistance should be 20 megohms. (Record 2 on Cable Testing Report.)

5. After the thermal insulation is installed, the megohmmeter test should be repeated. Minimum resistance should be 20 megohms. (Record 3 on Cable Testing Report.)

6. After the thermal insulation is installed and power supply is completed, record the panel and circuit breaker information. Ensure all junction boxes, temperature controllers, cable glands, etc. are properly secured. Set the temperature controller (if applicable) to the manual setting and apply rated voltage to the heat tracing circuit(s) for 10 minutes. Record the ambient temperature, measure and record the circuit(s) voltage and current. (Record 4 on Cable Testing Report.)

NOTE: To ensure the heating cable warranty is maintained through installation, the testing outlined on this sheet must be completed on the installed heating cables, and the test results recorded and mailed/faxed to:
Thermon Customer Service
30 London Drive
Bayswater, Victoria, 3153
Fax: 03-9762-9519
FLX™ Cable Testing Report

Customer: ____________________________  Contractor: ____________________________
Address: ____________________________  Address: ____________________________
Phone No: ____________________________  Phone No. ____________________________
Project Reference: ______________________

Record 1: Prior to Installation
  Cable Type: __________________________
  Heater Length: _______________________
  Heater Number: _______________________
  Insulation Resistance M Ohms: ___________
  Tested By: ___________________________  Date: ___________________________
  Witnessed By: _________________________  Date: ___________________________

Record 2: After Installation
  Insulation Resistance M Ohms: ___________
  Tested By: ___________________________  Date: ___________________________
  Witnessed By: _________________________  Date: ___________________________

Record 3: While Pouring Concrete
  Insulation Resistance M Ohms: ___________
  Tested By: ___________________________  Date: ___________________________
  Witnessed By: _________________________  Date: ___________________________

Record 4: Final Commissioning
  Panel Number: _________________________
  Breaker Number: _______________________
  Volts: _______________________________
  Ambient Temperature (deg. F): ____________
  Recorded Amps: _______________________
  Tested By: ___________________________  Date: ___________________________
  Witnessed By: _________________________  Date: ___________________________
Other Products . . .

Thermon offers additional cut-to-length cables or complete turn-key systems for the following applications:

• Hot Water Temperature Maintenance
• Freezer Floor Frost Heave Prevention
• Rail and Rail Switch Heating
• Tank and Hopper Heating
• Instrument Heating Systems
• Control and Monitoring Systems
Installation Instructions

1. Wrap CCH around casing as many times as possible. Can be overlapped without damage to increase coverage.

2. Feed plastic strip into the locking slot in buckle.

3. Tighten cable to secure CCH to the crankcase. Wrap with FT-1H tape for extra surface contact.

4. Connect CCH to power. A 240 Volt supply with 30mA earth leakage protection is mandatory.
Applications:
The SX-TERM-1 BC kit is used for end-of-circuit & power termination of braided Self Regulating Cables.

Components - Kit Part No. - 119-5050
- Power boot TBX-3L
- 8AWG Compression lug
- RTV-2T Sealant
- End cap ET-8

Power Connection:
1. Twist metallic braid back 140mm from the cable end for connection to ground. Remove 115mm of the insulating jacket and semi-conductive matrix between the bus wires, making sure the cable bus wires are not damaged.
2. Apply a generous amount of RTV-2 sealant inside the TBX-3L boot. Push boot over the bus wires so that the boot fully overlaps the primary cable insulation and the bus wires extend through the "legs" of the boot 13-25mm. Metallic braid is not to be run though the boot with the bus wires. Squeeze the boot to work out any air pockets and wipe off excess sealant.

End Termination:
1. Slide braid back 38mm & then cut 18mm off the exposed heater cable.
2. Apply RTV-2 sealant generously to the outside of the ET-8 end cap & onto the end of the cable.
3. Slide the end cap onto the cable with a twisting motion, making sure to work out any air pockets. Wipe off the excess sealant. Pull the braid over the end cap & then crimp together the braid ends with the 8-AWG compression lug supplied.

Caution: Do NOT connect the bus wires together at the end termination. Doing so will result in a direct short and could damage the cable.

ALL Electric Heat Tracing requires an Earth Leakage Device fitted to Power Source
As Per AS/NZS3000:2007
Kit Includes . . .

A. Cable Termination Boot (grey, trouser leg shape)
B. Two-Piece End Termination Cap (one grey and one black)
C. RTV Sealant
D. Installation Instructions

*Glands shown on illustrations are not included in this kit.*

**Power Connection**

1. With a utility knife, remove 125mm of the heating cable overjacket being careful not to cut or damage the metallic braid. *(Glands supplied by others)*

2. Form the heating cable (near the end of the overjacket) into a “U” shape as shown. Near the end of the overjacket open the braid with the tip of a screwdriver and ease the braid to the underside of the “U.”

3. Pull the insulated heating element out through the opening in the braid. When the cable is removed, twist the braid to form a pigtail.

4. Remove 95mm of the inner dielectric insulation with a utility knife being careful not to cut or damage the heating element underneath the insulation. Score each side of the heating cable to remove enough of the black matrix to expose the bus wires. Do not cut or damage the bus wires.

5. Peel the exposed bus wires back from the center matrix and trim away the matrix to leave the bare bus wires.
6. Slide cable termination boot partway over the bus wires and apply RTV sealant to the inside of the boot and to the heating cable where the bus wires meet the matrix and insulation. Slide the boot over the insulation until the bus wires protrude 25mm from the ends of the boot.

DO NOT PASS THE ROUND BRAID THROUGH THE BOOT.

! Caution: Do not energize the heating cable until the end termination has been properly completed. Damage to the cable, electrical shock or fire could result. For Safety and Protection Electric heat tracing requires an earth leakage device fitted to power source.

**End Termination**

1. After determining the location of the end of a heat tracing circuit, cut the cable square to the run of the cable. With a utility knife, remove 25mm of the heating cable overjacket and trim away all of the exposed metallic braid strands with scissors. Do not remove any of the inner primary dielectric insulation.

2. The end termination cap is a two-piece device. Apply a generous coating of RTV sealant to both the cable end (25mm of trimmed cable and 25mm of the overjacket) and the inside of the primary cap (grey boot). With a twisting motion, slide the end cap over the cable until it bottoms out. Place a small amount of RTV in the end of the overcap (black boot) and slide it over the primary cap until it is fully seated.

3. Secure the end termination to the pipe with attachment tape

! Caution:

Do not connect the heating cable bus wires together at the end termination.
Do not use electrical tape, wire nuts or other means to terminate the end of the cable. Damage to the cable, electrical shock or fire could result.
ALL Electric Heat Tracing requires an Earth Leakage Device Fitted to Power as per AS/NZS3000:2007
**Introduction**

A complete electric heat tracing system will typically include the following components:

1. Electric heat tracing cable (self-regulating, power-limiting, parallel constant watt or series resistance).
2. Power connection kit.
3. Control thermostat.
4. In-line/T-splice kit (permits two or three cables to be spliced together).
5. Cable end termination.
6. Attachment tape (use on 12” intervals or as required by code or specification).
7. “Electric Heat Tracing” label (peel-and-stick label attaches to insulation vapor barrier on 10’ intervals or as required by code or specification).
8. Thermal insulation and vapor barrier (by others).

The absence of any of these items can cause a system to malfunction or represent a safety hazard.

**Notes . . .**

1. Ground-fault maintenance equipment protection is required for all heat tracing circuits.
2. Thermostatic control is recommended for all freeze protection and temperature maintenance heat tracing applications.
3. All heat-traced lines must be thermally insulated.

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**Cable Testing**

After a heat tracing circuit has been installed and fabricated and before the thermal insulation is installed, the heating cable should be tested to ensure electrical resistance integrity. The cable should be tested with at least a 500 Vdc megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. It is recommended that the test voltage for polymer-insulated heating cables be 2500 Vdc or 1000 Vdc for MI cable.

After properly terminating the cable, connect the positive lead of the megger to the bus wires and the negative lead to the metallic braid as shown. The minimum acceptable level for the megger reading for any polymer-insulated heat tracing cable is 20 megohms. This test should be repeated after the thermal insulation and weather barrier have been installed.

Connect the positive lead of the megger to the cable bus wires and the negative lead to the metallic braid.
**Thermal Insulation**

The value of properly installed and well-maintained thermal insulation cannot be overemphasized. Without the insulation, the heat loss is generally too high to be offset by a conventional heat tracing system.

Before the thermal insulation is installed on a heat-traced pipe, the tracing circuit should be tested for dielectric insulation resistance. This will ensure that the cable has not been damaged while exposed on the uninsulated pipe.

In addition to piping and in-line equipment such as pumps and valves, all heat sinks must be properly insulated. This includes pipe shoes, hangers, flanges and, in many cases, valve bonnets.

There are many different pipe insulation materials, each of which has advantages in particular applications. Regardless of the type or thickness of insulation used, a protective barrier should be installed. This protects the insulation from moisture intrusion and physical damage and helps ensure the proper performance of the heat tracing system.

**Notes . . .**

- When rigid (noncompressible) materials are used, the inside diameter of the insulation is usually oversized to accommodate the heating cable on the pipe.
- Insulating materials are very susceptible to water absorption, which dramatically increases the heat loss and should be replaced if the materials get wet.

**Final Inspection**

The heating circuit can now be tested for proper operation. This includes measuring and recording the connected voltage, steady-state current draw, length and type of cable, ambient temperature and temperature of the pipe. (See the Inspection Report Form on page 3.)

The complete system (especially the thermal insulation) should now be visually inspected. Additional insulation should be applied snugly around pipe shoes or other heat sinks and sealed from the weather. Expansion joints on high-temperature lines should be examined carefully. There may be exposed insulation where sections fit together or around flanges, valves, pipe hangers or connection kits; these locations should be sealed to prevent ingress of moisture.

“Electric Heat Tracing” caution labels should be applied to the outer surface of the weather barrier at regular intervals of 10 feet (or as required by code or specification). The location of splices and end terminations should also be marked with splice and end termination caution labels.

**Maintenance**

Once the heat tracing system has been installed, an ongoing preventive maintenance program should be implemented using qualified personnel. Support documentation providing general information and an operating history of the specific circuits in the system should be maintained.

The results of the operational testing described above form the testing “base line” or normal range. Subsequent measurements should be recorded periodically and compared to this base-line data to help identify potential malfunctions.
# Inspection Report Form for Electric Heat Tracing (Typical)

<table>
<thead>
<tr>
<th>Location</th>
<th>System</th>
<th>Reference Drawing(s)</th>
</tr>
</thead>
</table>

## CIRCUIT INFORMATION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Connection</td>
<td>Design Voltage</td>
<td>Bkr. Pole(s) No.</td>
</tr>
<tr>
<td>Tee Connection</td>
<td>Ground-Fault Protection (type)</td>
<td></td>
</tr>
<tr>
<td>Splice Connection</td>
<td>Ground-Fault Trip Setting</td>
<td></td>
</tr>
<tr>
<td>Heater Controller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## VISUAL

<table>
<thead>
<tr>
<th>Panel Number</th>
<th>Circuit #</th>
<th>Date</th>
<th>Initial</th>
</tr>
</thead>
</table>

### Thermal Insulation

- Damaged Insulation/Lagging
- Water Seal Good
- Insulation/Lagging Missing
- Presence of Moisture

### Heating System Components

- Enclosures, Boxes Sealed
- Presence of Moisture
- Sign of Corrosion
- Heater Lead Discoloration

### Heating and/or High Limit Controller

- Operating Properly
- Controller Setpoint

## ELECTRICAL

### Dielectric Insulation Resistance Testing

(bypass controller if applicable) Refer to IEEE 515-1997, Section 7.9

<table>
<thead>
<tr>
<th>Test Voltage</th>
<th>Megger Value</th>
</tr>
</thead>
</table>

### Heater Supply Voltage

<table>
<thead>
<tr>
<th>Value at Power Source</th>
<th>Value at Field Connection</th>
</tr>
</thead>
</table>

### Heater Circuit Current Reading

<table>
<thead>
<tr>
<th>Pipe Temperature</th>
<th>Amps Reading at 2-5 min.</th>
<th>Amps Reading After 15 min.</th>
<th>Ground-Fault Current</th>
</tr>
</thead>
</table>

## Comments and Actions

<table>
<thead>
<tr>
<th>Performed by</th>
<th>Company</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved by</td>
<td>Company</td>
<td>Date</td>
</tr>
</tbody>
</table>

*Use this form as an original to make copies*
**Troubleshooting**

The following information is intended to assist in troubleshooting electric heat tracing systems. The primary objective is to provide an enhanced understanding of the elements of a successful heat tracing installation. Of these elements, one of the most important is the **thermal insulation**.

Before calling the heat tracing vendor, make a visual inspection of the installation; perhaps the thermal insulation is wet, damaged or missing. Also consider the possibility that repairs or maintenance of in-line or nearby equipment may have resulted in damage to the heat tracing equipment. These are common causes of tracing problems which are often overlooked. Other possible causes are listed below with their symptoms and remedies.

If an electric heat tracing circuit is suspected to be damaged, a dielectric insulation resistance (megger) test should be performed using a 2500 Vdc megohmmeter for polymer-insulated heating cables or 1000 Vdc for MI cable. Periodic testing with accurate records will establish a “normal” range of operation (refer to the Inspection Report Form on page 3). Dielectric insulation resistance readings which deviate from the normal range can quickly reveal a damaged circuit.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. No heat/no current</td>
<td>A. Loss of power (voltage)</td>
<td>A. Restore power to tracing circuit (check circuit breaker and electrical connections). Poorly made terminations can cause EPD-type breakers to trip unexpectedly</td>
</tr>
<tr>
<td></td>
<td>B. Controller setpoint too low</td>
<td>B. Adjust setpoint</td>
</tr>
<tr>
<td></td>
<td>C. High temperature limit switch activated</td>
<td>C. May require manual reset to re-enable heat tracing circuit</td>
</tr>
<tr>
<td></td>
<td>D. “Open” series heating circuit</td>
<td>D. Repair or replace circuit[^1^]</td>
</tr>
<tr>
<td></td>
<td>E. Controller failure</td>
<td>E. Repair sensor or controller[^2^]</td>
</tr>
<tr>
<td>II. Low system temperature</td>
<td>A. Controller setpoint too low</td>
<td>A. Adjust setpoint</td>
</tr>
<tr>
<td></td>
<td>B. Temperature sensor located too close to heating cable or other heat source; may be accompanied by excessive cycling of control relays/contacts</td>
<td>B. Relocate sensor</td>
</tr>
<tr>
<td></td>
<td>C. Insulation material and/or thickness different than designed</td>
<td>C. Replace insulation; increase insulation thickness (if dry); consider increasing voltage for higher cable output[^3^]</td>
</tr>
<tr>
<td></td>
<td>D. Ambient temperature lower than designed</td>
<td>D. Install higher output heating cable; increase insulation thickness; raise voltage[^3^]</td>
</tr>
<tr>
<td></td>
<td>E. Low voltage (check at power connection point)</td>
<td>E. Adjust voltage to meet design requirements[^3^]</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Remedy</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>III. Low temperature in sections</td>
<td>A. Wet, damaged or missing insulation</td>
<td>A. Repair or replace insulation and jacket</td>
</tr>
<tr>
<td></td>
<td>B. Parallel heating cable; open element or damaged matrix</td>
<td>B. Repair or replace; splice kits are available from cable manufacturer</td>
</tr>
<tr>
<td></td>
<td>C. Heat sinks (valves, pumps, pipe supports, etc.)</td>
<td>C. Insulate heat sinks or increase amount of tracing on heat sinks</td>
</tr>
<tr>
<td></td>
<td>D. Significant changes in elevation along length of the heat-traced pipe</td>
<td>D. Consider dividing heating circuit into separate, independently controlled segments</td>
</tr>
<tr>
<td>IV. High system temperature</td>
<td>A. Controller “on” continuously</td>
<td>A. Adjust setpoint or replace sensor(^2)</td>
</tr>
<tr>
<td></td>
<td>B. Controller failed with contacts closed</td>
<td>B. Replace sensor or controller(^2)</td>
</tr>
<tr>
<td></td>
<td>C. Sensor located on uninsulated pipe or too close to heat sink</td>
<td>C. Relocate sensor to an area representative of conditions along entire pipe length</td>
</tr>
<tr>
<td></td>
<td>D. Backup heating circuit controller “on” continuously</td>
<td>D. Adjust setpoint or replace backup controller</td>
</tr>
<tr>
<td>V. Excessive cycling</td>
<td>A. Temperature sensor located too close to heating cable or other heat source; may be accompanied by low system temperature</td>
<td>A. Relocate sensor</td>
</tr>
<tr>
<td></td>
<td>B. Ambient temperature near controller setpoint</td>
<td>B. Temporarily alter controller setpoint</td>
</tr>
<tr>
<td></td>
<td>C. Connected voltage too high</td>
<td>C. Lower voltage</td>
</tr>
<tr>
<td></td>
<td>D. Heating cable output too high (overdesign)</td>
<td>D. Install lower output heating cable or lower voltage</td>
</tr>
<tr>
<td></td>
<td>E. Controller differential too narrow</td>
<td>E. Widen differential or replace controller to avoid premature contact failure</td>
</tr>
<tr>
<td>VI. Temperature variations from setpoint along pipeline</td>
<td>A. Unanticipated flow patterns or process operating temperatures</td>
<td>A. Redistribute heating circuits to accommodate existing flow patterns; confirm process conditions</td>
</tr>
<tr>
<td></td>
<td>B. Inconsistent cable installation along pipeline</td>
<td>B. Check method of cable installation, especially at heat sinks</td>
</tr>
<tr>
<td></td>
<td>C. Inconsistent cable performance</td>
<td>C. Compare calculated watts/foot [(volts x amps) ÷ length] for the measured pipe temperature with designed cable output for the same temperature; regional damage to parallel cable can cause partial failure</td>
</tr>
</tbody>
</table>

**Notes . . .**

1. Flexible, plastic-jacketed heating cables may be field-spliced; MI cables usually require replacement.
2. Mechanical thermostat sensors cannot be repaired or replaced; RTD or thermocouple sensors can be replaced. Some controllers have replaceable contacts/relays or may require a manual reset if a “trip-off” condition on the heating circuit was detected.
3. The operation of most electric heat tracing cables is dramatically affected by changes in the supply voltage. Before making any changes, consult the cable manufacturer with information on the alternate voltages available. Otherwise, cable failure and/or an electrical safety hazard may result in some situations.
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