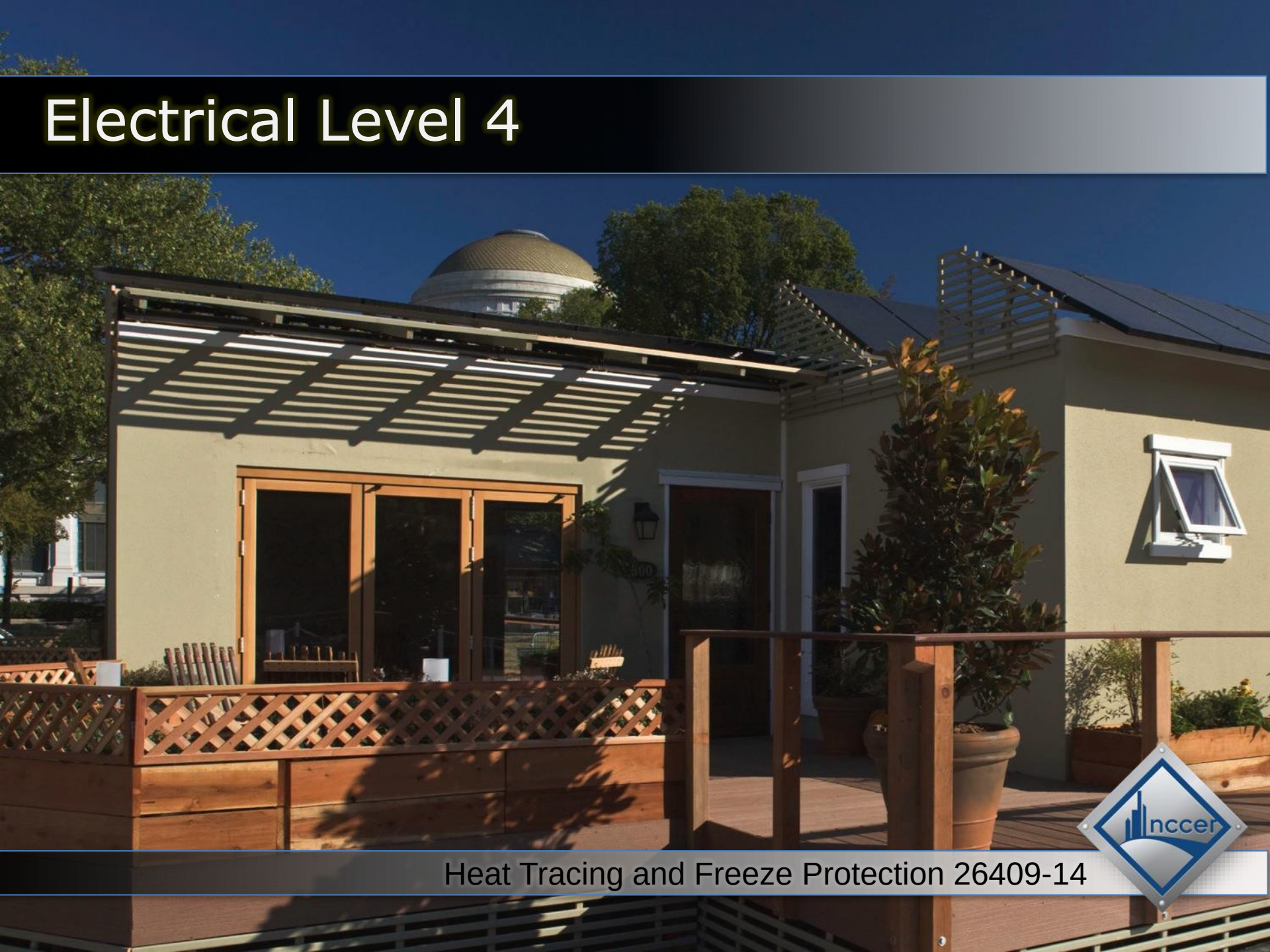
Electrical Level 4



Heat Tracing and Freeze Protection 26409-14

Objectives

When trainees have completed this lesson, they should be able to do the following:

1. Identify and describe the purpose of electric heat tracing equipment used with pipelines and vessels.
2. Select, size, and install electric heat tracing equipment on selected pipelines and vessels in accordance with the manufacturer's instructions and *National Electrical Code*® (*NEC*®) requirements.
3. Identify and describe the purpose of electric heating equipment used with roof, gutter, and downspout de-icing systems.
4. Select, size, and install selected roof, gutter, and downspout de-icing systems in accordance with the manufacturer's instructions and *NEC*® requirements.
5. Identify and describe the purpose of electric heating equipment used with snow-melting and anti-icing systems.

Objectives and Performance Task

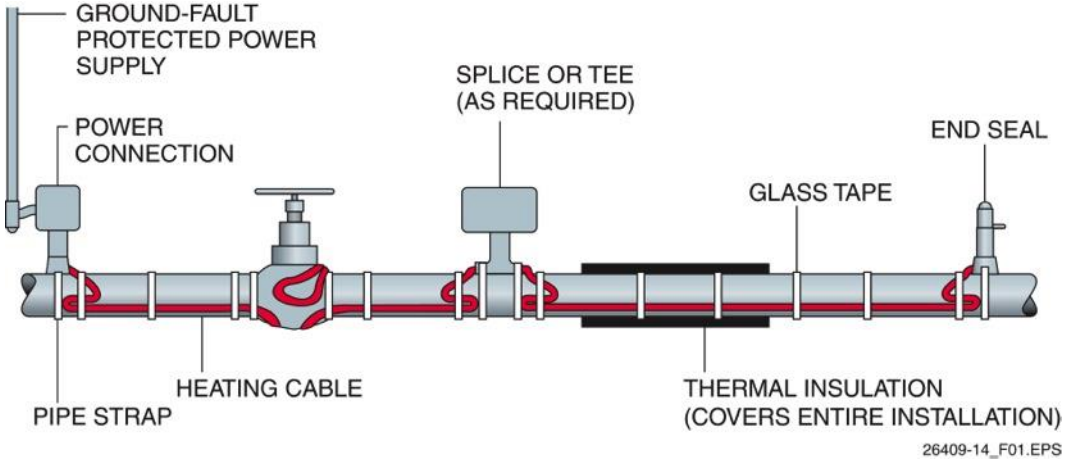
6. Select, size, and install selected snow-melting and anti-icing systems in accordance with the manufacturer's instructions and *NEC*® requirements.
7. Identify and describe the purpose of electric heat tracing equipment used with domestic hot-water temperature maintenance systems.
8. Select, size, and install selected electric heat traced domestic hot-water systems in accordance with the manufacturer's instructions and *NEC*® requirements.
9. Identify and describe the purpose of electric floor heating/warming systems.
10. Select, size, and install selected electric floor heating/warming systems in accordance with the manufacturer's instructions and *NEC*® requirements.

Performance Task

Prepare and connect heat tracing cable in a power connection box or splice box.

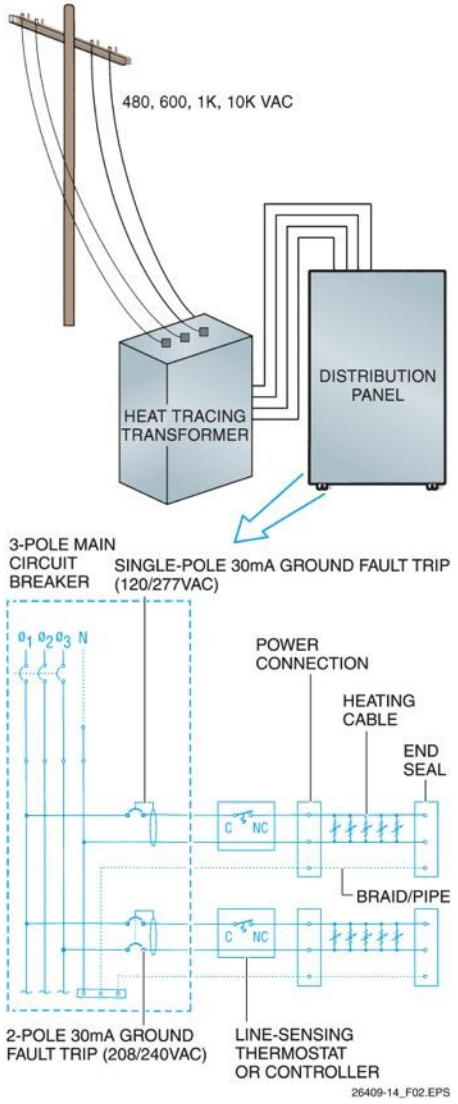
Introduction; Pipeline Electric Heat Tracing Applications; Pipeline Electric Heat Tracing Systems

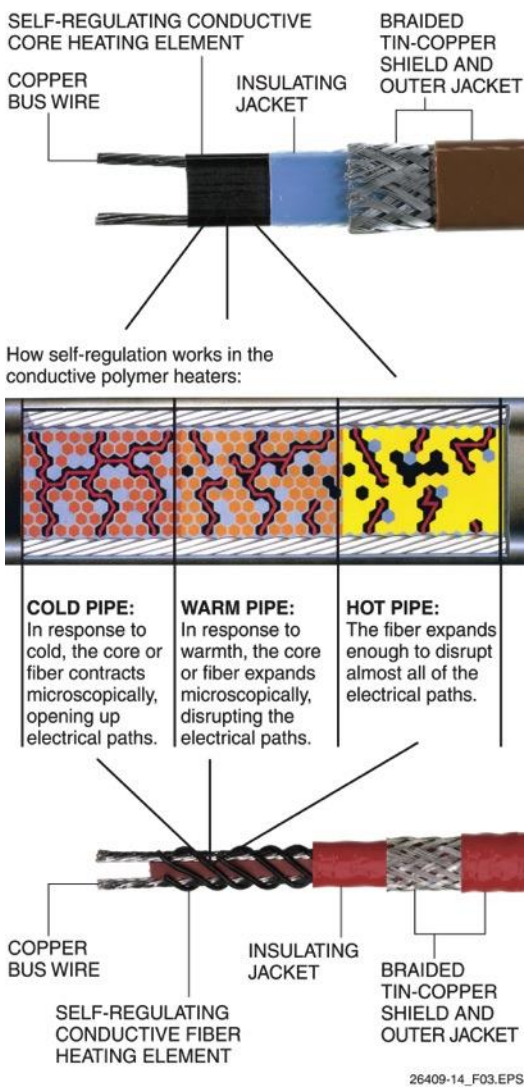
- Pipeline heat tracing systems can provide either freeze control or temperature maintenance. Temperature maintenance can be used to control fluid characteristics and prevent condensation.
- A basic pipeline heat tracing system consists of a power distribution system, electrical heating cables, and interface components.



Heat Tracing System Power Distribution

- In the system shown here, three-phase utility power is stepped down to provide 120V/277VAC using a dedicated transformer for the heat tracing system.
- The branch circuit breakers apply voltage to the power connection boxes of one or more heat tracing circuits.



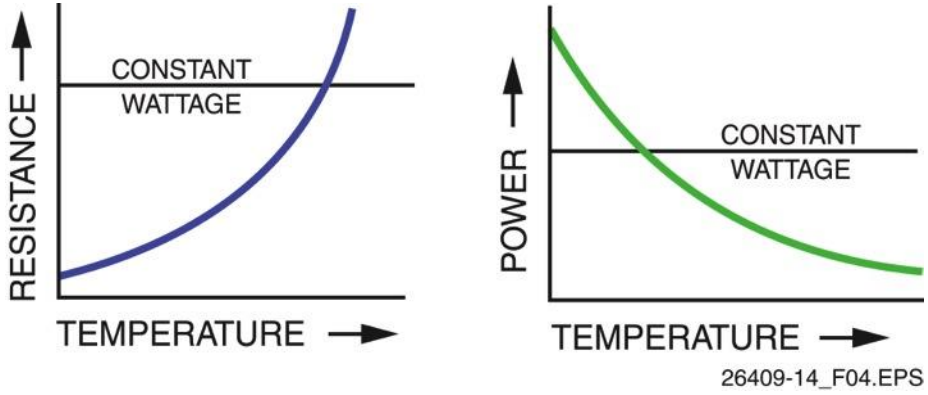


Typical Construction of Self-Regulating Heat Tracing Cables

Self-regulating heat tracing cable adjusts its heating output in response to temperature changes in the surrounding air.

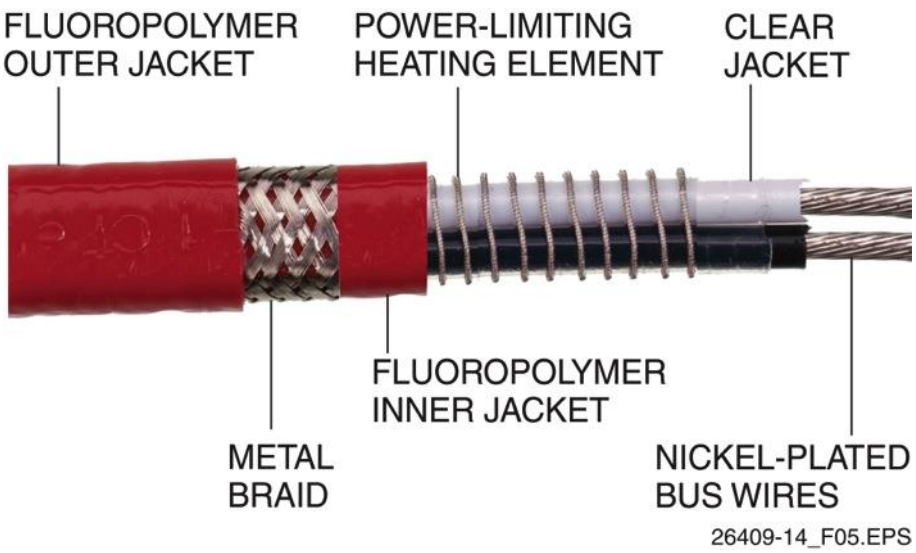
Resistance and Power Versus Temperature for Self-Regulating Heat Tracing Cable

- As the temperature increases, the conductive core expands, increasing the electrical resistance and reducing the current flow. The result is a lower heat output.
- The parallel resistance of self-regulating cable allows it to be overlapped without overheating and to be cut to length in the field.

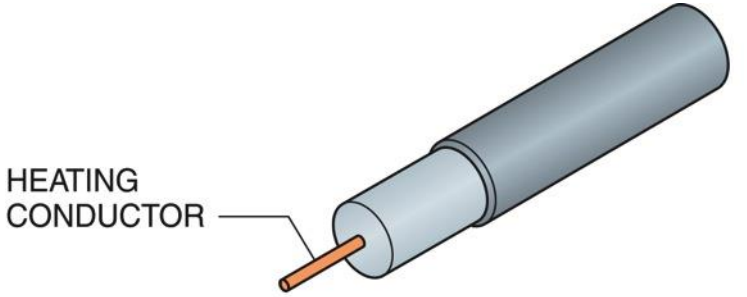


Construction of a Power-Limiting Heating Cable

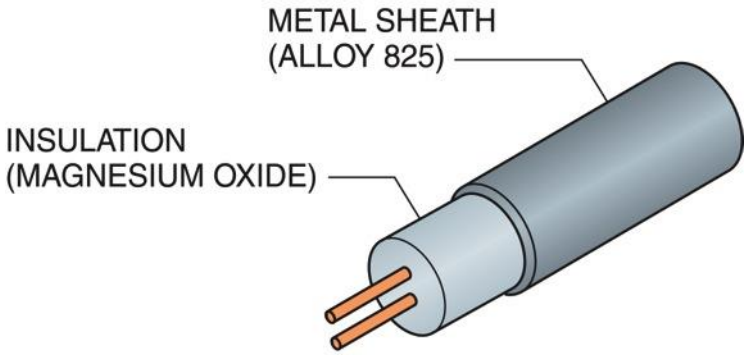
- Power-limiting cable is used for process temperature maintenance on metal pipes requiring a high power output and/or high temperature exposure.
- It is connected alternately between the two bus wires every 2' to 3' feet along the cable length. The distance between the two contact points forms a heating zone.



Construction of Mineral-Insulated Cables



SINGLE-CONDUCTOR CABLE



DUAL-CONDUCTOR CABLE

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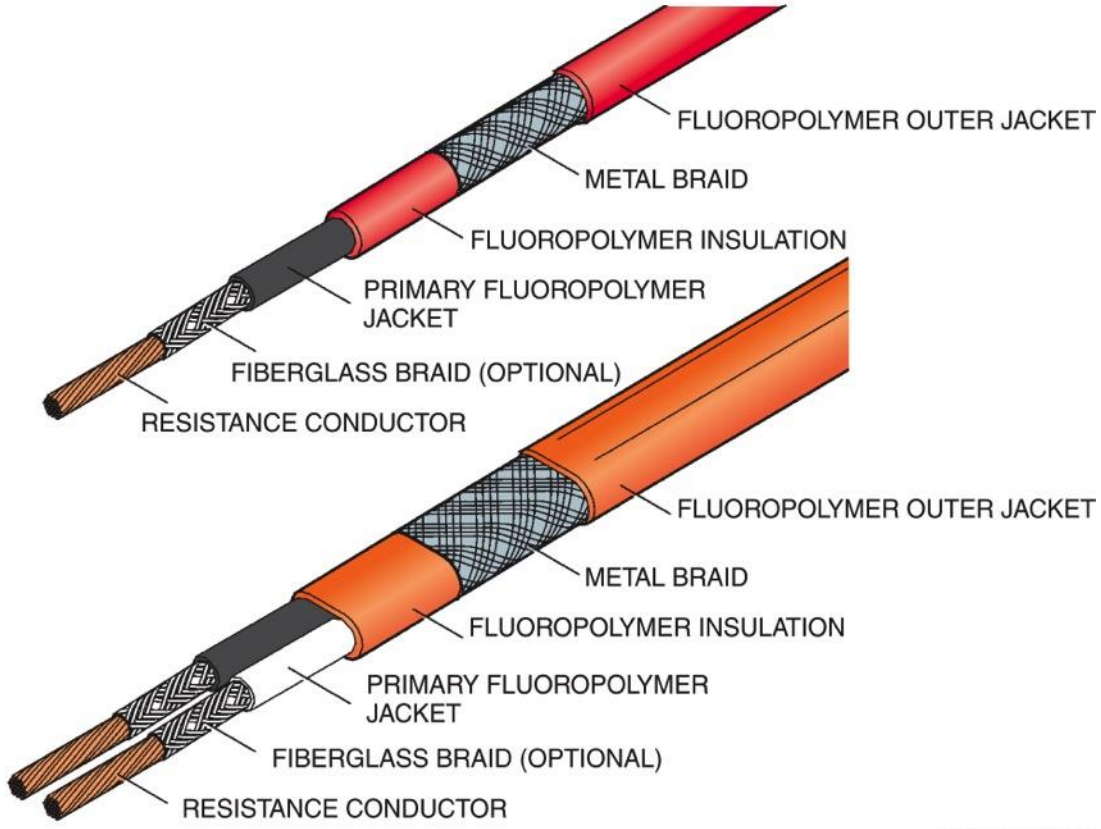
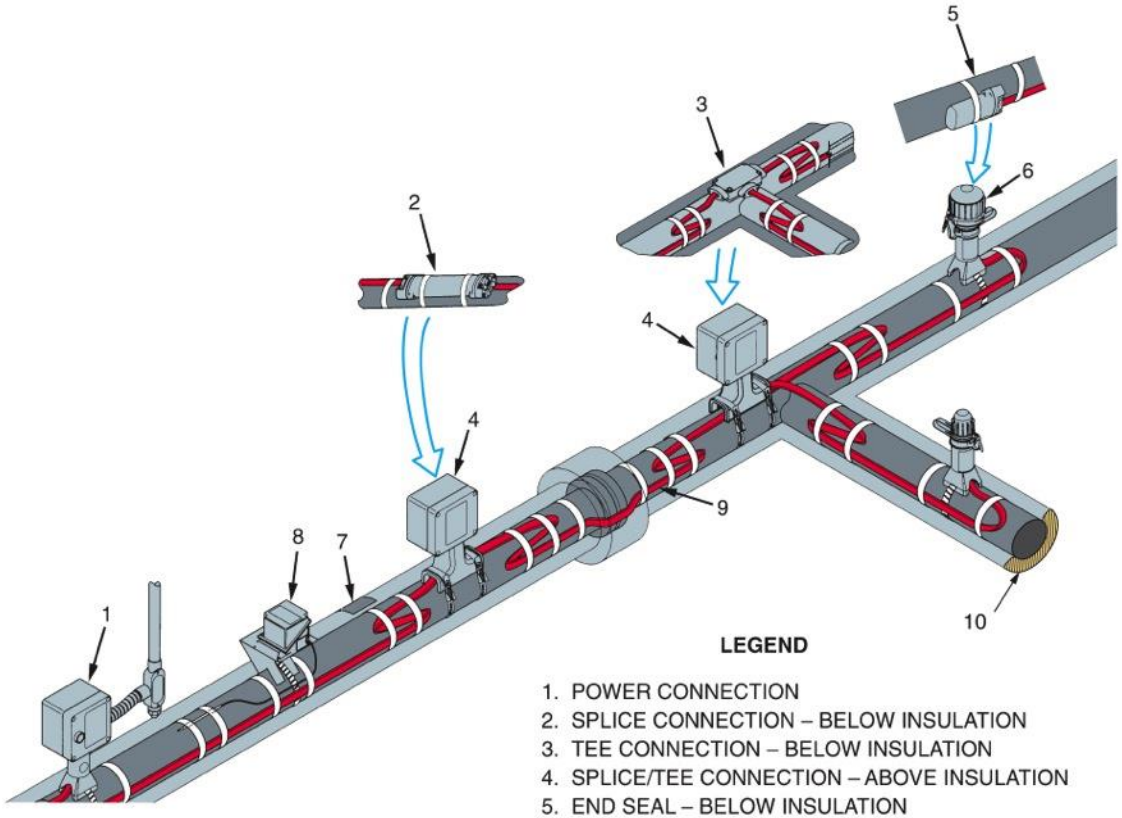
- Mineral-insulated (MI) cables are a type of constant-wattage, series resistance heating cable.
- MI cables are used to trace long pipelines where the temperature or power output of self-regulating or power-limiting cables would be inadequate.

Construction of a Series Resistance Heating Cable



Self-Regulating/Power-Limiting Heating System



LEGEND

1. POWER CONNECTION
2. SPLICE CONNECTION – BELOW INSULATION
3. TEE CONNECTION – BELOW INSULATION
4. SPLICE/TEE CONNECTION – ABOVE INSULATION
5. END SEAL – BELOW INSULATION
6. END SEAL – ABOVE INSULATION
7. ATTACHMENT TAPE, LABELS
8. THERMOSTAT
9. SELF-REGULATING CABLE
10. INSULATION

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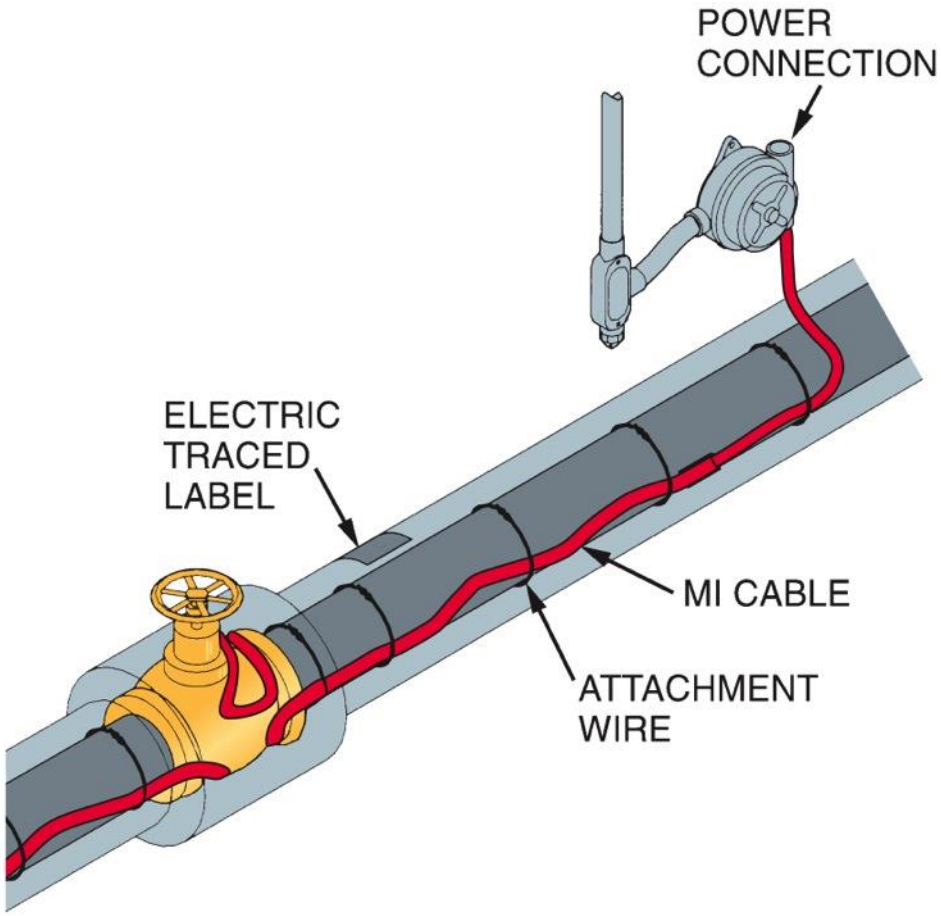
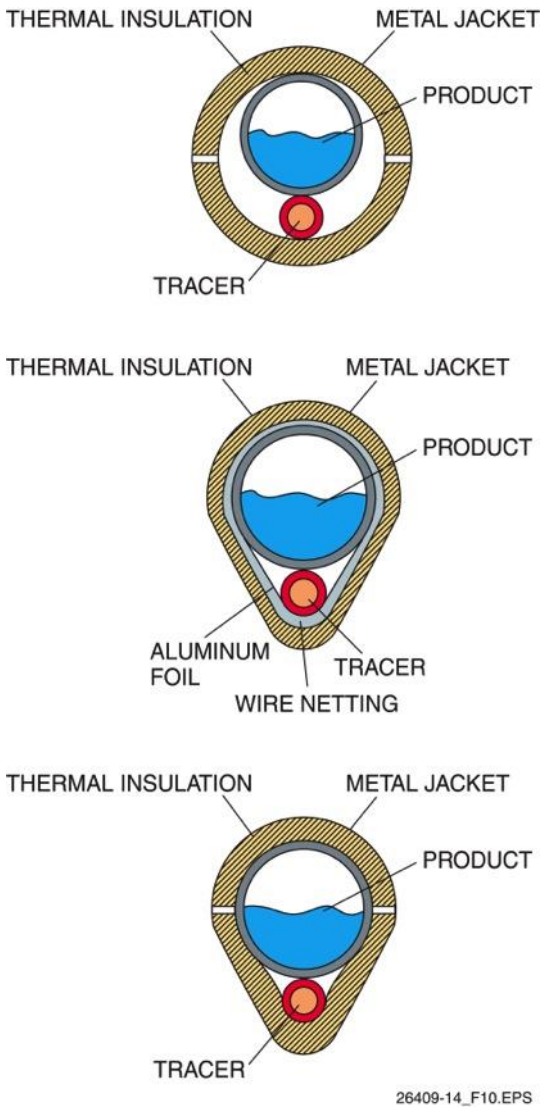
Mineral-Insulated Cable System





Heat Tracer/Insulation Configurations

- To prevent heat loss, heat-traced pipe may be insulated. The heat tracing cables are installed under the insulation and the insulation is jacketed for weather protection.
- Heat tracing insulation is selected based on its thermal and mechanical properties as well as chemical compatibility, and moisture or fire resistance.

Ambient-Sensing Thermostat Used to Control Heat Tracing Circuits

- There are five types of heat tracing temperature controls: self-regulating, ambient-sensing, proportional ambient-sensing, line-sensing, and dead-leg. The method selected depends on the application and how critical temperature maintenance is to the process.
- Ambient-sensing control uses a thermostat to respond to changes in the surrounding air temperature.

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Typical Line-Sensing Thermostat Used to Control Heat Tracing Circuits

- Ambient-sensing control uses a thermostat to respond to changes in the pipe temperature and requires a separate control for each heating circuit.
- Line-sensing controls are used in narrow temperature maintenance applications and provide the highest degree of control using the least amount of energy.

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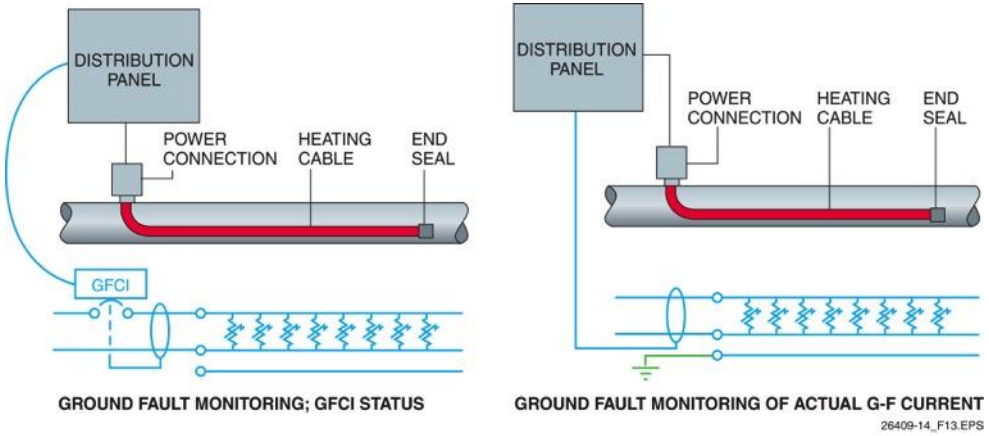
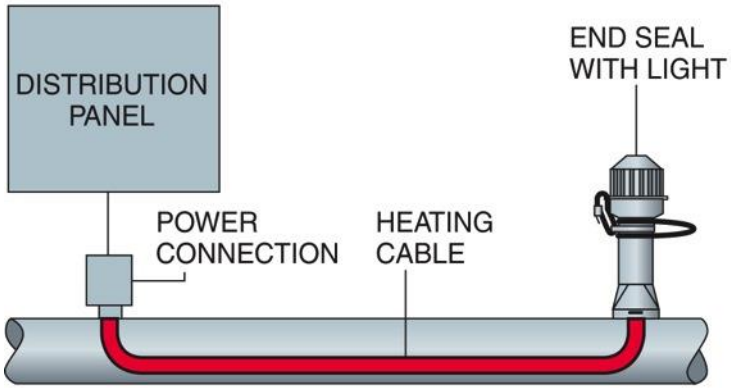
Simplified Heat Tracing Circuit with Ground Fault Monitoring

- A ground fault monitoring system monitors the current leakage from the heating cable, power wiring, and components using ground fault circuit breakers and/or current-sensing devices.
- The ground fault circuit breakers in heat tracing systems trip at 30mA and do not provide the personnel protection of a GFCI, which trips at 5mA.

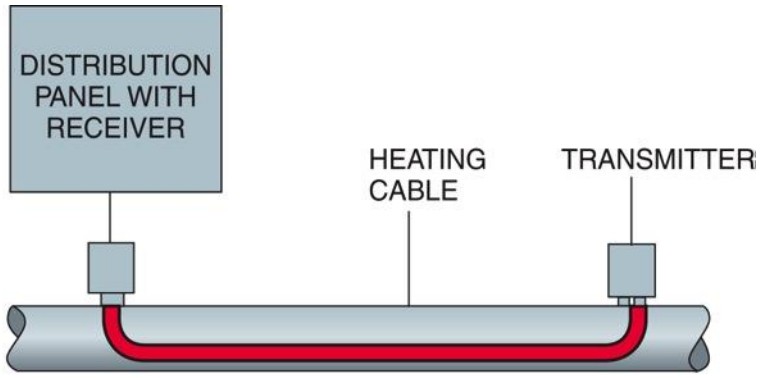


Simplified Heat Tracing Circuit with End-of-Circuit Continuity Monitoring

- Continuity monitoring verifies that voltage is present at the end termination of a heat tracing cable run.
- Some circuits use an LED at the end of the run to provide continuous monitoring when the circuit is energized.



CONTINUITY MONITORING WITH END-OF-CIRCUIT LIGHT



CONTINUITY MONITORING WITH END-OF-CIRCUIT TRANSMITTER

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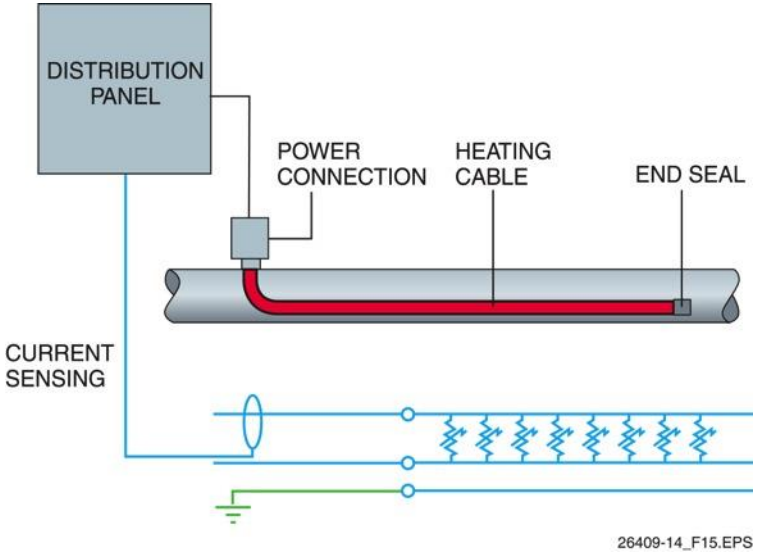
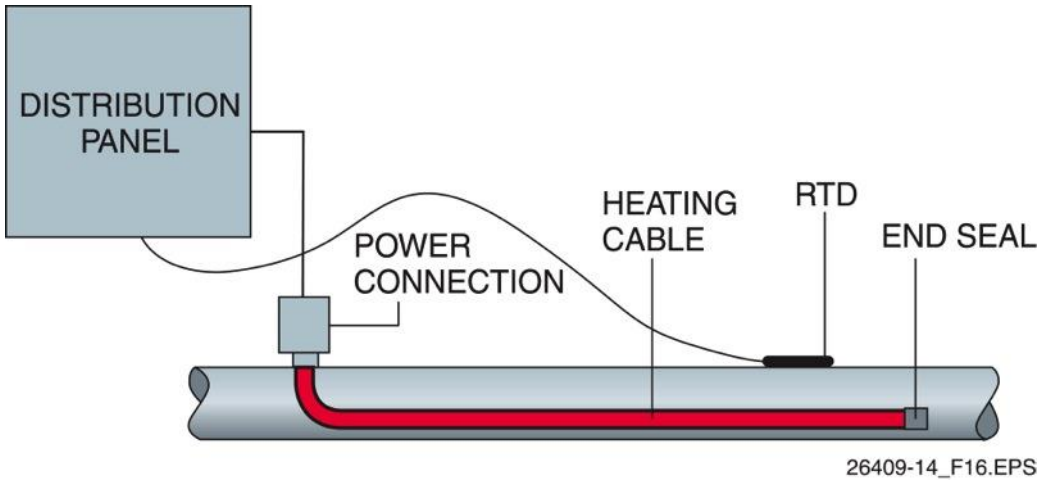
Simplified Heat Tracing Circuit with Current Monitoring

- Current monitoring uses a special controller or relay to signal when the circuit current is too high or too low.
- The alarm will signal if there is a loss of power or open/damaged heating cable bus or branch circuit wiring.

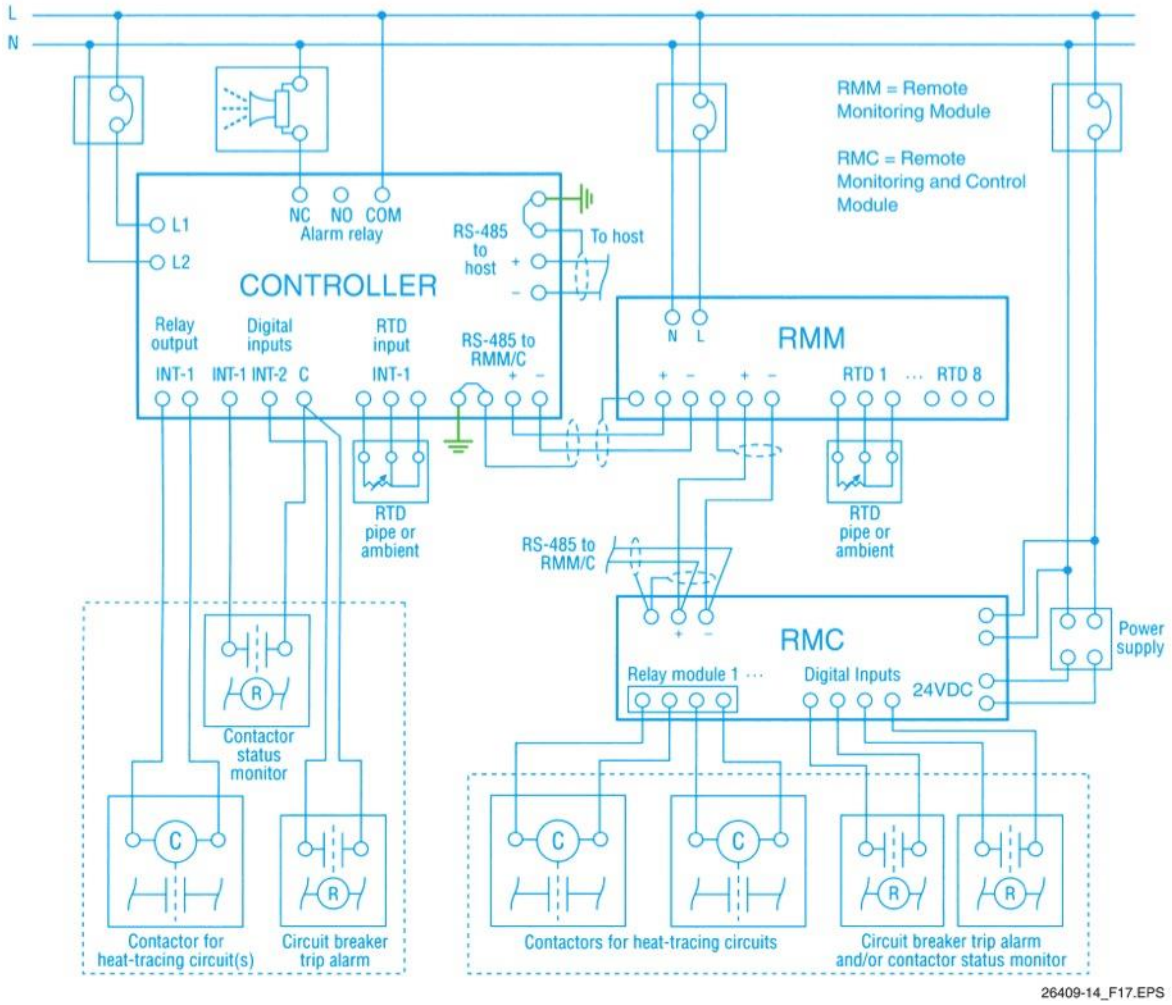


Simplified Heat Tracing Circuit with Temperature Monitoring

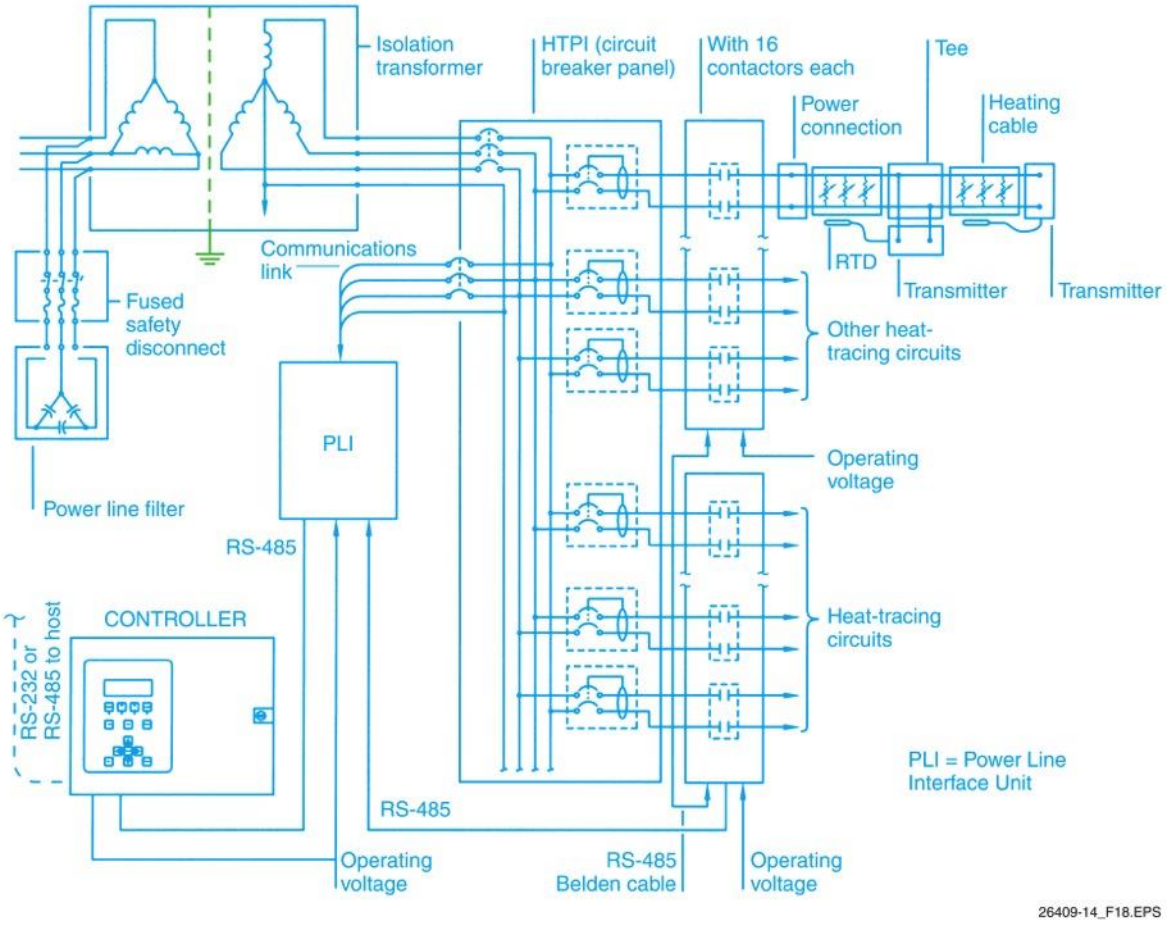
- Temperature monitoring continuously measures the pipe temperature using a digital controller connected to a resistance temperature detector (RTD).
- The controller generates an alarm if the measured temperature is outside of the high/low temperature limits.



Typical Heat Tracing System Circuit Configuration



Heat Tracing System Using Power Line Carrier Technology



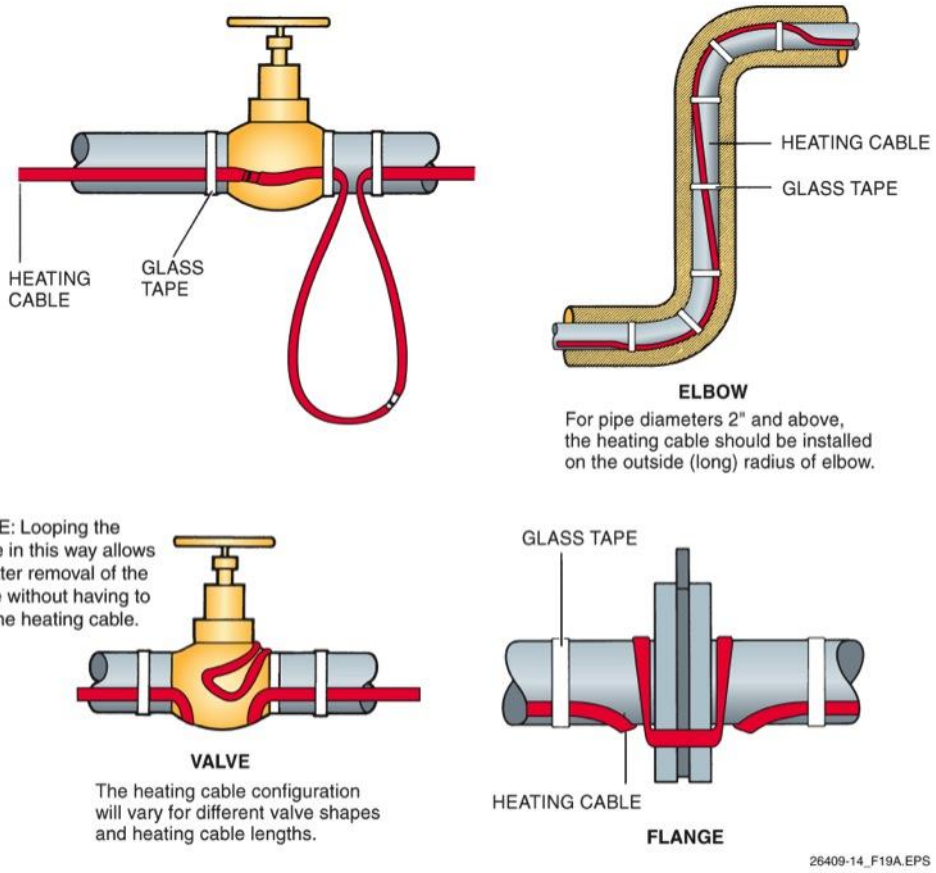
Equipment Selection and Installation for Pipe Heat Tracing Systems

Heating Cable	Supply (VAC)	Startup Temperature	Circuit Breaker Size Maximum Circuit Length			Maximum Amp/Foot
			15A	20A	30A	
5XL1-CR or -CT	120	40°F	165	220	250	0.072
		0°F	110	145	220	0.108
8XL1-CR or -CT	120	40°F	120	160	190	0.100
		0°F	85	115	170	0.139
5XL2-CR or -CT	208/277	40°F	285	380	450	0.042
		0°F	190	255	385	0.042

Typical Lengths of Additional Cable Required to Heat Trace Pipeline Components

Pipe Size (Inches)	Screw Valves	Flange Valves	Butterfly Valves	Pipe Supports	Pipe Elbows	Pipe Flange
1	6"	6"	6"	6"	3"	3"
2	6"	1"	6"	1'	6"	6"
3	1"	2'	1'	1'	6"	6"
4	2'	3'	1'	1'	9"	6'
6	3'	4'	1'	2'	9"	1'
8	4'	5'	2'	2'	9"	1'
10	5'	7'	2'	3'	1'	1'
12	7'	8'	2'	3'	1'	1'
14	8'	10'	3'	4'	1'	2'

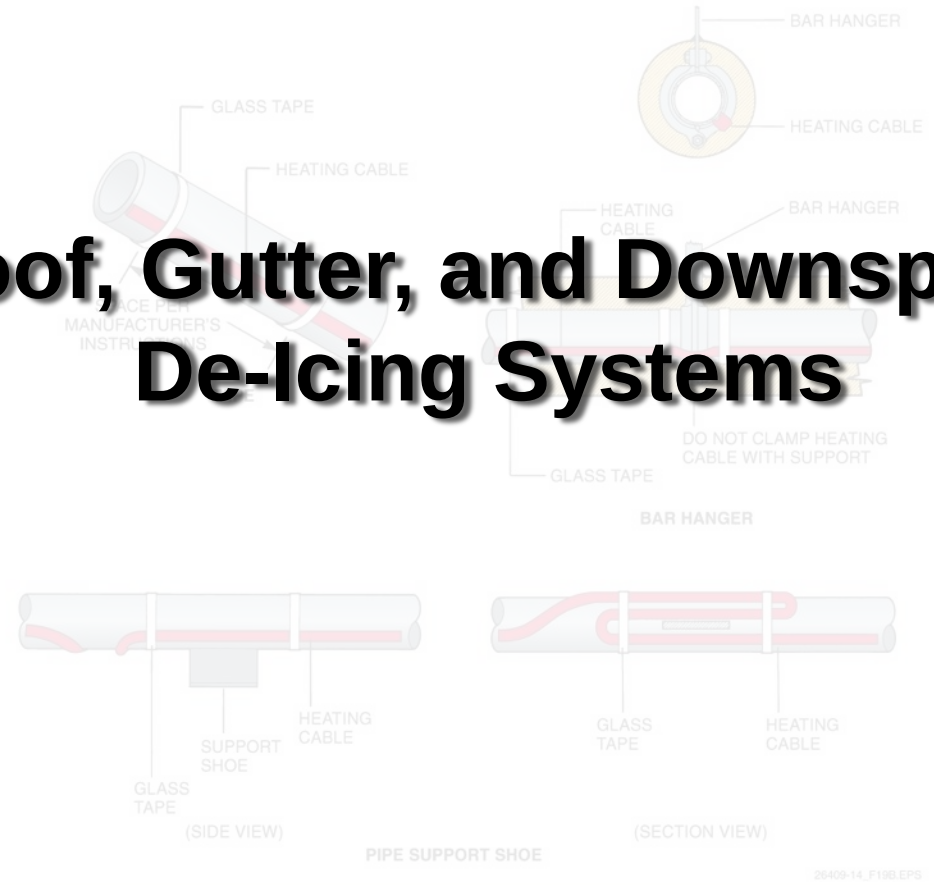
Installing a Heating Cable on Common Pipeline Components



Next Session…

Installing a Heating Cable on Common Pipeline Components

Roof, Gutter, and Downspout De-Icing Systems



Roof, Gutter, and Downspout De-Icing Systems

- Roof, gutter, and downspout de-icing systems are used to prevent the formation of ice dams and icicles that present a safety hazard and can result in leaks.
- These systems provide a continuous heated path for melting snow and ice.

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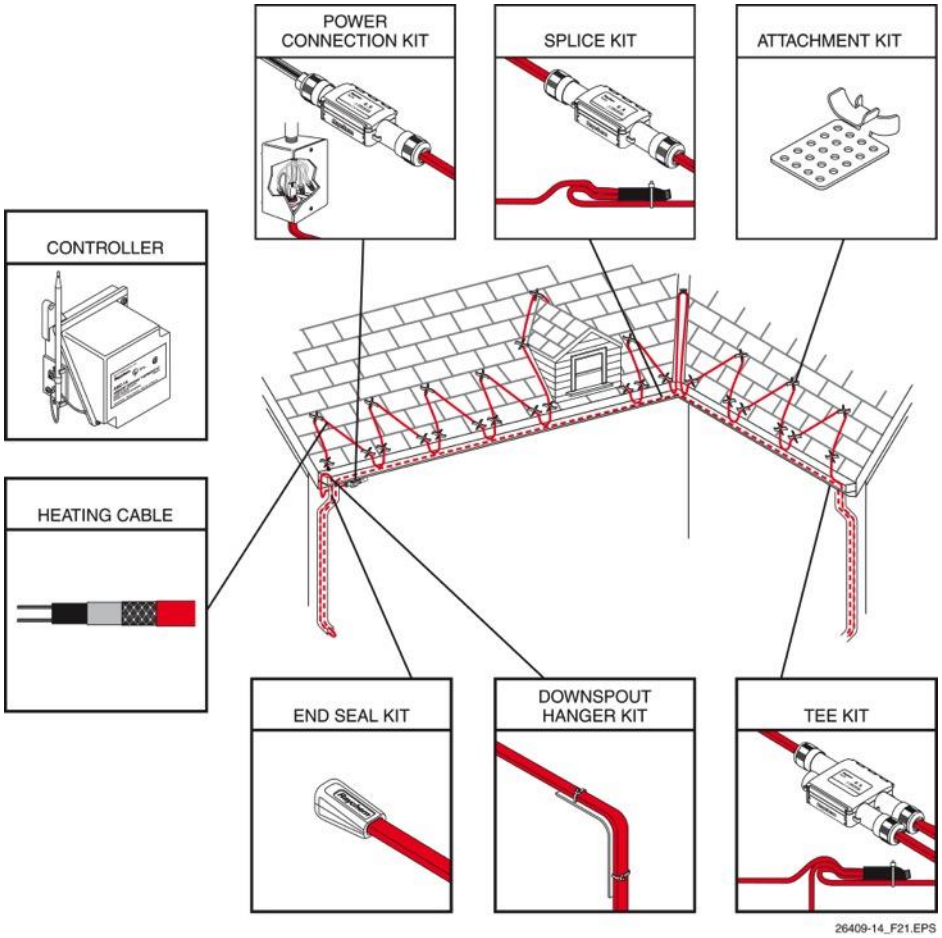
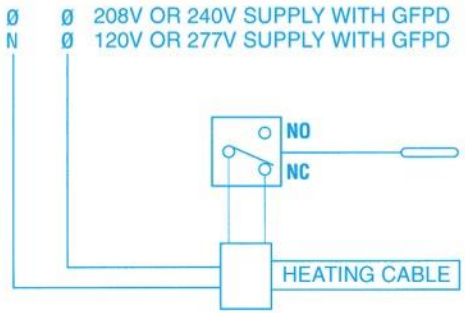
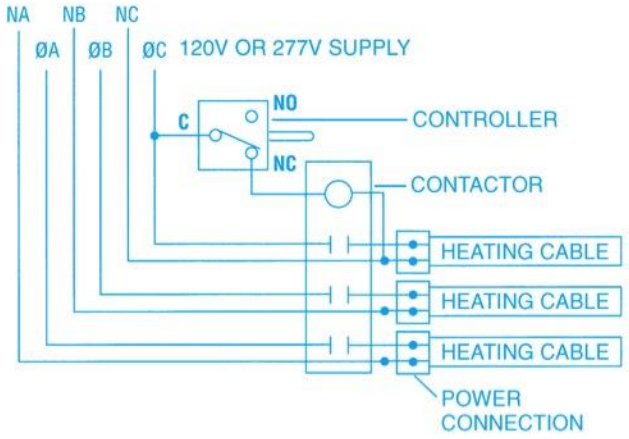
Components of a Typical Roof, Gutter, and Downspout De-Icing System



Typical Wiring for Single and Multiple Circuit Roof, Gutter, and Downspout De-Icing Systems



TYPICAL CONTROL WIRING – SINGLE CIRCUIT



TYPICAL CONTROL WIRING – MULTIPLE CIRCUITS

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Component Selection and Installation for Roof, Gutter, and Downspout De-Icing Systems

- Prior to installation, survey the roof construction and layout, then choose the cable attachment method and temperature control. Next, determine the number of circuits required and select the system components and accessories.
- When installing the heating cable, start at the end seal and work backwards.

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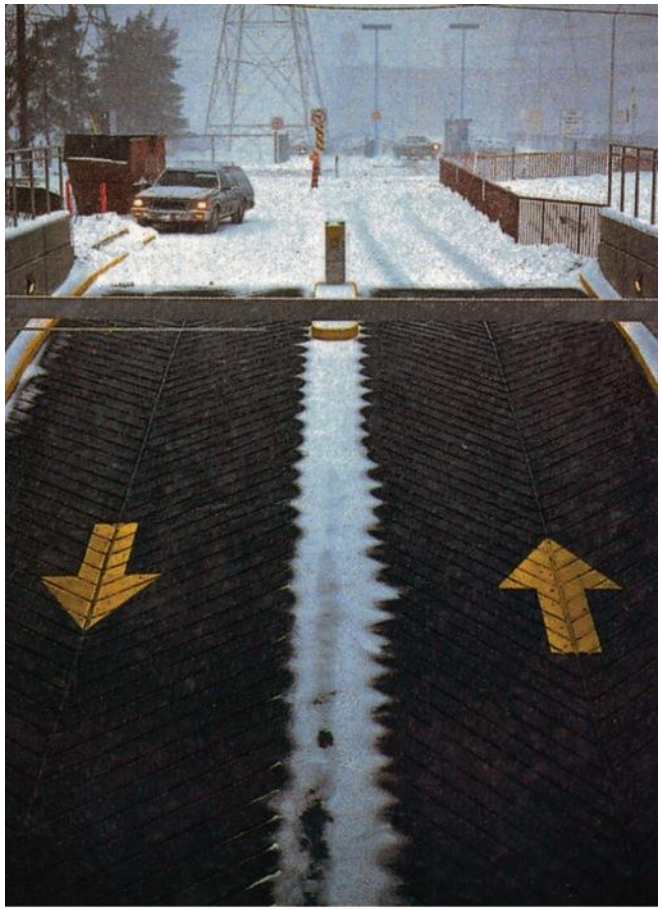
Snow-Melting and Anti-Icing Systems

- Snow-melting and anti-icing systems are used to prevent the buildup of snow and ice on walking surfaces and roadways.
- Three methods of control are used: manual control, ambient thermostat control, and automatic snow control.



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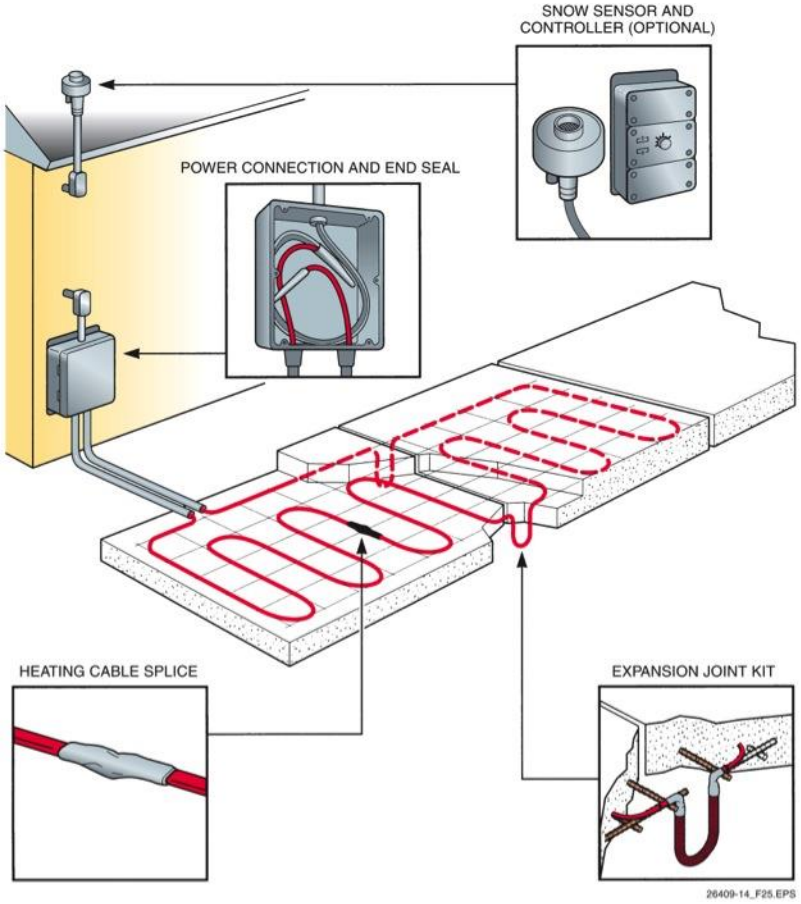
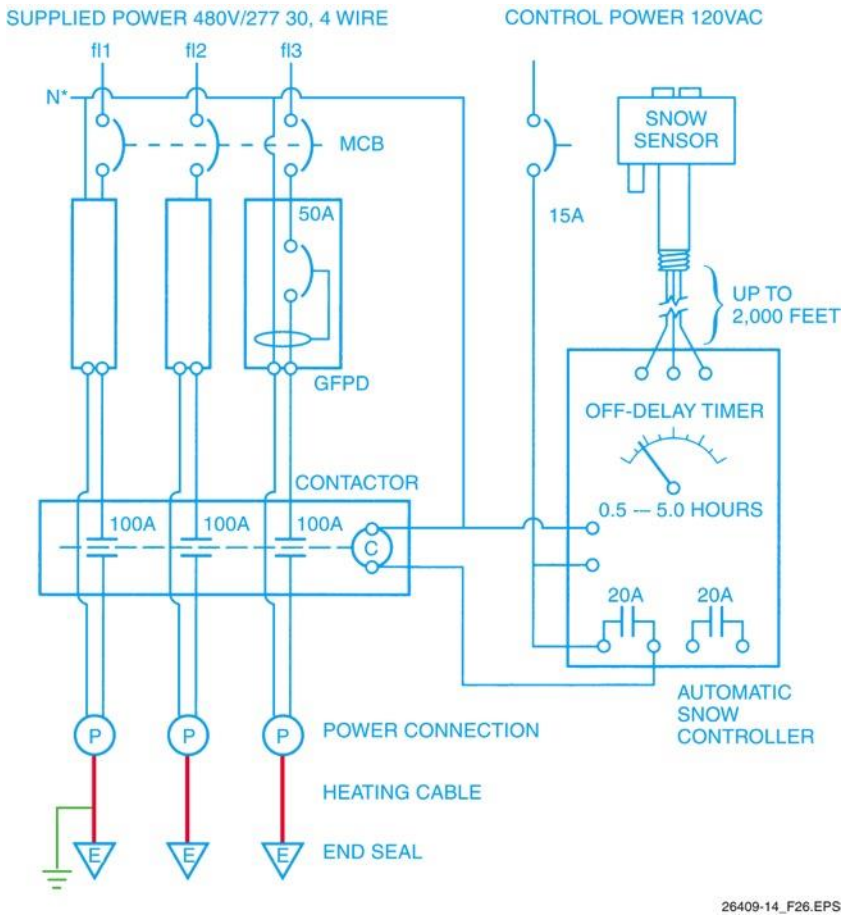
Components of a Typical Snow-Melting and Anti-Icing System



Typical Wiring for a Snow-Melting and Anti-Icing System Controlled by an Automatic Snow Controller

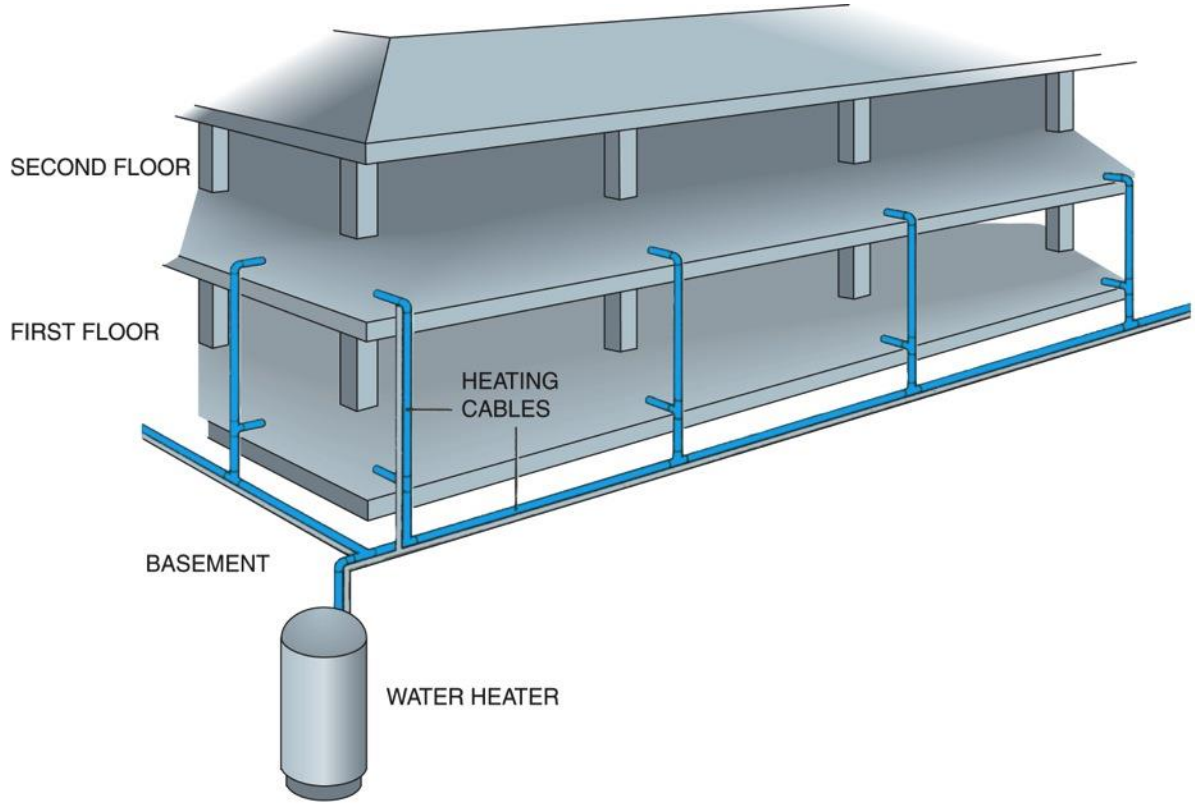


Next Session…

Domestic Hot-Water Temperature Maintenance Systems; Component Selection and Installation for Domestic Hot-Water Temperature Maintenance Systems

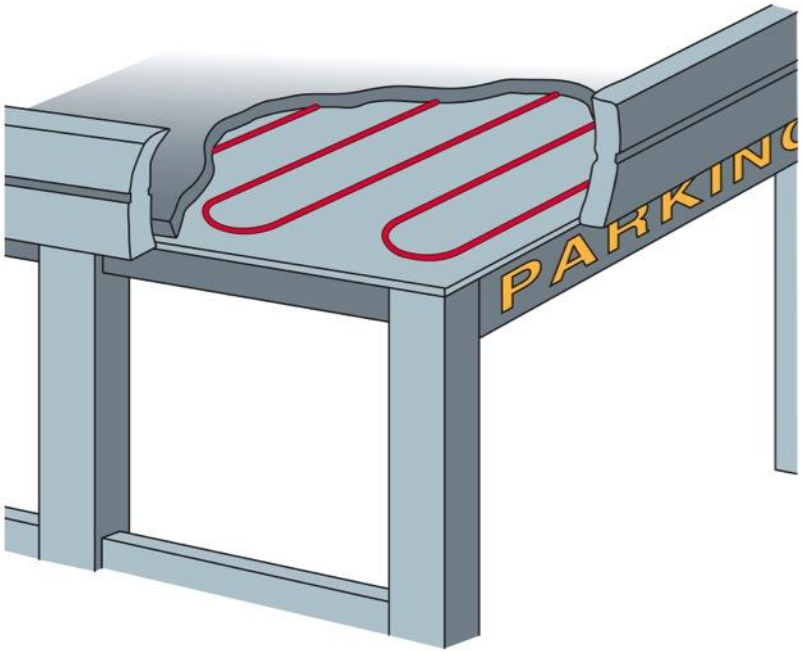
9.0.0 – 10.2.0

Domestic Hot-Water Temperature Maintenance Systems; Component Selection and Installation for Domestic Hot-Water Temperature Maintenance Systems



Floor Heating and Warming Systems; Component Selection and Installation for Floor Heating Systems

- Radiant floor heating systems warm a floor mass, which then heats the space. Radiant floor heating provides a more uniform room temperature than other heating types.
- Both heating mats and self-regulating/series resistance cable are available. Cable can be embedded in mortar/concrete, run on an exposed bottom surface, or through conduit.



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Next Session…

Typical Electric Floor Heating Mat Installation

26409-14_F30.EPS

Wrap Up

Performance Task

This session will conclude with trainees preparing and connecting heat tracing cable in a power connection or splice box.

Wrap Up

3-2-1

3 – Write 3 important things learned during class

2 – Write 2 questions you have about the material

1 – Write 1 thought you had about the material

Next Session…

MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.