Design Guide and Installation Details for Self-Regulating Heating Cable
Self-Regulating Heating Cables

The RSCC 2700 self-regulating heating cable is available with either a tinned copper or stainless steel overshield. Factory Mutual approved for use in Class I, Division 2, Groups B, C, and D; Class II, Division 2, Group G; Class III, Division 2 areas. It is rated for T5 per NEC. Meets or exceeds requirements of IEEE Electrical Resistance Heat Tracing Specifications. The RSCC 2300 self-regulating heating element is available with either a tinned copper or stainless steel overshield. Factory Mutual approved for use in Class I, Division 2, Groups B, C, and D; Class II, Division 2, Group G; Class III, Division 2 areas. It is rated for T3 per NEC and meets or exceeds requirements of IEEE Electrical Resistance Heat Tracing Specifications.

Use of Ground Fault Protective Devices

Caution . . . N.E.C. CODE 1996 STATES IN ARTICLE 427-22: ‘Ground-fault protection of equipment shall be provided for each branch circuits supplying electric heating equipment.’

<table>
<thead>
<tr>
<th>Watts/ft.</th>
<th>Service</th>
<th>Electrical Class</th>
<th>Overshield Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1 = 120 VAC</td>
<td>1 = Ordinary and Div. 2</td>
<td>C = Tinned Copper</td>
</tr>
<tr>
<td>1.0</td>
<td>2 = 240 VAC</td>
<td>3 = Ordinary and Div. 2 with Monitor Wires</td>
<td>S = Stainless Steel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Voltage (Volts)</th>
<th>120</th>
<th>240</th>
<th>120</th>
<th>240</th>
<th>120</th>
<th>240</th>
<th>120</th>
<th>240</th>
<th>120</th>
<th>240</th>
<th>120</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Circuit Length (Feet)</td>
<td>330</td>
<td>660</td>
<td>270</td>
<td>540</td>
<td>210</td>
<td>420</td>
<td>180</td>
<td>360</td>
<td>240</td>
<td>480</td>
<td>180</td>
<td>280</td>
</tr>
<tr>
<td>Thermal Rating at 50°F [Watts/ft.]</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Maintain (Deg. F)</td>
</tr>
<tr>
<td>Maximum Exposure (Deg. F)</td>
</tr>
</tbody>
</table>

Visit Us At: www.rscc-heattrace.com
Introduction

Principle of Operation
RSCC self-regulating heating cables regulate their heat output in response to changes in temperature. The highly engineered conductive core increases its heat output when the temperature falls and decreases its heat output when the temperature rises.

To help protect against impact and mechanical abuse, these heating cables have a metallic overshield. These heating cables are Factory Mutual approved for use in hazardous areas.

This design guide was compiled to offer a simplified systematic approach for designing pipe heat tracing systems utilizing the RSCC self-regulating heating cables.

The following step-by-step procedures will enable you to determine the length of heating cable required to efficiently heat trace pipes, valves and flanges.

Alternate Voltages
RSCC 240 VAC self-regulating heating cables can be operated at alternative voltages. The chart below compares heating cable power output with product rating.

Power Adjustment Factor

<table>
<thead>
<tr>
<th>Part No.</th>
<th>208 Volts</th>
<th>277 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2703-2</td>
<td>.75</td>
<td>1.28</td>
</tr>
<tr>
<td>2705-2</td>
<td>.86</td>
<td>1.16</td>
</tr>
<tr>
<td>2708-2</td>
<td>.91</td>
<td>1.10</td>
</tr>
<tr>
<td>2710-2</td>
<td>.93</td>
<td>1.08</td>
</tr>
<tr>
<td>2305-2</td>
<td>.78</td>
<td>1.25</td>
</tr>
<tr>
<td>2310-2</td>
<td>.86</td>
<td>1.16</td>
</tr>
<tr>
<td>2315-2</td>
<td>.92</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Example:
Thermal output of 2705-2 5 Watts/Ft. at 50°F, powered at 208 VAC = 5 Watts/Ft. x .86 = 4.3 Watts/Ft.
To determine the pitch and amount of RSCC self-regulating heating cable required to heat trace a pipe, you’ll need to know the pipe temperature to be maintained, minimum ambient temperature, pipe size and insulation type and thickness.

Calculating Heat Loss
1. First determine temperature difference (ΔT) between temperature to be maintained (Tm) and minimum ambient temperature (Ta).
   \[ ΔT = T_m - T_a \]
2. Select insulation K factor from Table 1 (Ki) and divide by .021 to determine conductivity ratio (Rk).
   \[ R_k = \frac{K_i}{.021} \]
3. Determine heat loss from Table 2A (Qa) by selecting pipe size and insulation thickness. If piping is indoors multiply (Qa) by 0.9.
4. Calculate heat loss from pipe (Qp) by multiplying ΔT by Rk and Qa.
   \[ Q_p = ΔT \times R_k \times Q_a \]

Determine Heater Power Output
From Graph I (page 3) select the heater with the power output (Qh) which meets or exceeds the heat loss (Qp) from the pipe. For non-metal pipe multiply the power output Qh from the chart by 0.7 before selecting the heater.

In some circumstances it may be desired to use a heater with less power output per foot of heater than the calculated heat loss per foot of pipe. In these cases, the heater can be spiralled onto the pipe to achieve the required power output per foot of pipe. A developed power ratio and heater pitch will need to be determined.

Calculate Developed Power Ratio
To calculate developed power ratio (Rd) divide heat loss from pipe (Qp) by heater power output (Qh).
   \[ R_d = \frac{Q_p}{Q_h} \]

Determine Heater Pitch
To determine the required pitch (P), select value from Tables 3A and 3B for calculated value of (Rd) and pipe size.

Calculate Required Heater Length
To determine required heater length (Lh), multiply length of pipe (LP) by (Rd).
   \[ L_h = L_p \times R_d \]

Table 2A — Heat Loss (Qa) from Insulated Pipe (Watts/Foot-°F).

<table>
<thead>
<tr>
<th>Pipe Size (IPS)</th>
<th>Pipe O.D. (Inches)</th>
<th>1/2&quot;</th>
<th>1&quot;</th>
<th>1-1/2&quot;</th>
<th>2&quot;</th>
<th>2-1/2&quot;</th>
<th>3&quot;</th>
<th>4&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>0.840</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3/4</td>
<td>1.050</td>
<td>0.06</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1.315</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>1.900</td>
<td>0.09</td>
<td>0.06</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2.375</td>
<td>0.11</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2-1/2</td>
<td>2.875</td>
<td>0.13</td>
<td>0.08</td>
<td>0.06</td>
<td>0.05</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3.500</td>
<td>0.16</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3-1/2</td>
<td>4.000</td>
<td>0.18</td>
<td>0.10</td>
<td>0.07</td>
<td>0.05</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4.500</td>
<td>0.20</td>
<td>0.11</td>
<td>0.08</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>6</td>
<td>6.625</td>
<td>0.28</td>
<td>0.15</td>
<td>0.11</td>
<td>0.09</td>
<td>0.07</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>8</td>
<td>8.625</td>
<td>0.35</td>
<td>0.19</td>
<td>0.13</td>
<td>0.10</td>
<td>0.09</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td>10</td>
<td>10.750</td>
<td>0.44</td>
<td>0.23</td>
<td>0.16</td>
<td>0.13</td>
<td>0.10</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>12</td>
<td>12.750</td>
<td>0.51</td>
<td>0.27</td>
<td>0.19</td>
<td>0.14</td>
<td>0.12</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>14</td>
<td>14.000</td>
<td>0.56</td>
<td>0.29</td>
<td>0.20</td>
<td>0.16</td>
<td>0.13</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>16</td>
<td>16.000</td>
<td>0.64</td>
<td>0.33</td>
<td>0.23</td>
<td>0.18</td>
<td>0.15</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>18</td>
<td>18.000</td>
<td>0.71</td>
<td>0.37</td>
<td>0.25</td>
<td>0.20</td>
<td>0.16</td>
<td>0.14</td>
<td>0.11</td>
</tr>
<tr>
<td>20</td>
<td>20.000</td>
<td>0.79</td>
<td>0.41</td>
<td>0.28</td>
<td>0.21</td>
<td>0.18</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>24</td>
<td>24.000</td>
<td>0.94</td>
<td>0.48</td>
<td>0.33</td>
<td>0.25</td>
<td>0.21</td>
<td>0.18</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Values given above are heat loss for metal pipe in units of Watts/Foot of pipe per °F temperature difference from pipe to ambient temperature fiberglass insulation.
Example: (2700 Heater)

\[ T_a = -20^\circ F \]
\[ T_m = 40^\circ F \]

Insulation — Calcium Silicate
Pipe Material — Metal
Insulation Thickness — 2"
Length of Pipe — 100’

Step I

\[ \Delta T = T_m - T_a = 40 - (-20) = 60 \]

Step II

\[ R_k = \frac{K}{.021} = \frac{.031}{.021} = 1.48 \]

Step III

\[ Q_a \text{ from Table 2A for 6 IPS pipe and 2” thick insulation is .09.} \]

Step IV

\[ Q_p = T \times R_k \times Q_a = 60 \times 1.48 \times .09. = 8.0 \]

Step V From Graph 1, at 40°F the 2708 heater produces \( Q_i \) of 8.5 watts per foot. Select the 2708 heater for this application.

Alternate Heater by Spiralling

Assume that for the above example you wish to use a 2705 heater.

The \( Q_i \), from Graph 1, at 40°F for the 2705 heater is 5.5 watt per foot.

Step VI

\[ R_p = Q_i \div Q_h = 8.0 \div 5.5 = 1.46 \]

Step VII The pitch, \( P \), in inches from Table 3A for 6 IPS and \( R_p = 1.46 \) is 14 inches.

Step VIII

\[ L_h = L_p \times R_p = 100’ \times 1.46 = 146’ \text{ cable length required.} \]
Heat Tracing Valves

To determine the amount of RSCC self-regulating heating cable required to heat trace a valve, you’ll need to know the pipe temperature to be maintained, minimum ambient temperature, valve size and insulation type and thickness.

Calculating Heat Loss
1. First determine temperature difference (\( \Delta T \)) between temperature to be maintained (\( T_m \)) and minimum ambient temperature (\( T_a \)). 
   \[ \Delta T = T_m - T_a \]

2. Select insulation K factor from Table 1 (\( K \)) and divide by .021 to determine conductivity ratio (\( R_k \)). 
   \[ R_k = K \div .021 \]

3. Determine heat loss from Table 2B (\( Q_b \)) by selecting valve size and insulation thickness. If valve is indoors multiply (\( Q_b \)) by 0.9.

4. Calculate heat loss from pipe (\( Q_v \)) by multiplying \( \Delta T \) by \( R_i \) and \( Q_i \). 
   \[ Q_v = \Delta T \times R_i \times Q_i \]

Determine Heater Power Output
From Graph I determine heater power output for pipe temperature to be maintained (\( Q_h \)). If valve is nonmetal multiply value of \( Q_h \) from graph by 0.7.

Calculate Developed Power Ratio
To calculate developed power ratio (\( R_p \)) divide heat loss from valve (\( Q_v \)) by heater power output (\( Q_h \)). 
   \[ R_p = Q_v \div Q_h \]

Example: (2708 Heater)
- \( T_a = -20^\circ \text{F} \)
- \( T_m = 40^\circ \text{F} \)
- Insulation — Calcium Silicate
- Valve Size — 6 IPS
- Insulation Thickness — 2"
- Number of Valves — 2

Step I \( \Delta T = T_m - T_a \)
   \[ \Delta T = 40 - (-20) \]
   \[ \Delta T = 60 \]

Step II \( R_k = K \div .021 \)
   \[ R_k = .031 \div .021 \]
   \[ R_k = 1.48 \]

Step III \( Q_b \) from Table 2B for 6" valve and 2" thick insulation is .31.

Step IV \( Q_v = \Delta T \times R_i \times Q_i \)
   \[ Q_v = 60 \times 1.48 \times .31 \]
   \[ Q_v = 27.5 \]

Step V \( Q_h \) from Graph 1 for 40°F required temperature is 8.5.

Step VI \( R_p = Q_v \div Q_h \)
   \[ R_p = 27.5 \div 8.5 \]
   \[ R_p = 3.24 \text{ feet per heater valve} \]

Step VII \( L_h = N_i \times R_p \)
   \[ L_h = 2 \times 3.24 \]
   \[ L_h = 6.5' \]

Visit Us At: www.rscc-heattrace.com
To determine the amount of RSCC self-regulating heating cable required to heat trace an insulated pipe flange, fitting or hanger, simply find the size on the vertical axis, read across to the appropriate device, then read down to the horizontal axis to determine the amount of cable required per 10°F temperature difference. Multiply the temperature difference by this value and divide by ten to get the inches of cable to use per device. Hanger sizing is determined by the width of the hanger.

**Example: for 60°F temperature difference:**

(2) 10" flanges (4" heater per 10 degrees difference); \(2 \times 4 \times 60/10 = 48.0"\)

(1) 10" fitting (4" heater per 10 degrees difference); \(1 \times 4 \times 60/10 = 24.0"\)

(4) 7" wide hangers (4" heater per 10 degrees difference); \(4 \times 4 \times 60/10 = 96"\)

Total 168"

Total Allowance Required = 14.0'

Pipe flanges, fittings and hangers act as heat sink devices in a heat trace system. Allowances must be made for these devices to maintain a consistent and operational system.

For pipe flanges and fittings under two inches in size use four inches of heater per device. For hangers under two inches in size use six inches of heater per device.
Positioning and Attachment of Heating Element

Note:
1. If ratio of heater footage to pipe is greater than 1.5 — use two parallel heaters or select higher wattage heater. If ratio is less than 1.0 — use one parallel heater.
2. When installing the heater on non-metal pipe secure the heater to the pipe with aluminum tape. Refer to pitch chart on isometric drawings for proper pitch length.

Visit Us At: www.rscc-heattrace.com

Spiral Installation of Heating Element

Note:
1. If ratio of heater footage to pipe is greater than 1.5 — use two parallel heaters or select higher wattage heater. If ratio is less than 1.0 — use one parallel heater.
2. When installing the heater on non-metal pipe secure the heater to the pipe with aluminum tape. Refer to pitch chart on isometric drawings for proper pitch length.

*Glass Tape P/N 1528-01017, 1528-01019
Power Connection Kit Mounting Detail
Ordinary and Hazardous Areas

Connection Kits
P/N 1548-40000
(2700 Family)
P/N 1548-41000
(2300 Family)

Note:
1. For more specific details and full materials list refer to installation instruction sheet packed with connection kit

Heating Element Termination
and Heating Element Tee Splice

End Seal Kit
P/N 1548-50300

*Glass Tape or Cable Ties (typical)
Heat Shrinkable Tubing over Crimped Splice Barrels
P/N 1548-50211

Pipe

*Glass Tape P/N 1528-01017, 1528-01019
Thermostat Sensor Positioning and Attachment on Tanks

Positioning and Attachment of Thermostat Sensor on Pipe

Visit Us At: www.rscc-heattrace.com
Note:
This detail is shown as an illustration of a method of taking advantage of the shape of a piping configuration to attain good pipe contact. To simply trace the inside radius of the corner would not be considered correct. Although a tee-splice might also be used to trace the third leg of the tee. The objective of this detail is to emphasize that it is advisable to get more heater on any area where the thermal insulation might not be fitted as well as on straight pipe. This method is intended to be used on other fittings besides tees.

*Glass Tape P/N 1528-01017, 1528-01019
Heat Tracing of Fittings
Valves and Process Equipment

Notes:
1. Exact configuration may vary per valve type.
2. For removable valve bodies leave a loop of tracing of the proper length when tracing the pipe.
3. See installation chart for correct amount of tracing per valve size.
4. Take care to keep the flat side of the heater in as good physical contact with the valve body as possible.
5. Fully insulate and weather protect.

*Glass Tape P/N 1528-01017, 1528-01019
Notes:
1. See National Electrical Code paragraph 427-12(E).
2. Fully insulate and weatherproof (if outdoors).

Note:
- Heater must be pulled thru flexible conduit to avoid splicing — if necessary to splice heater a junction box will be required.

*Glass Tape or Cable Ties (typical)

Notes:
- Use fiberglass or aluminum tape to hold tracer in place on pump body.
- Fully insulate and weather protect.

Visit Us At: www.rscc-heattrace.com
Heat Tracing Around Pipe Supports

Note:
All forms of rigid pipe supports directly in contact with the pipe surface act as a heat sink. Heat tracing should be doubled over at these points and the supports should be insulated as much as practicable to limit heat loss.

*Glass Tape P/N 1528-01017, 1528-01019

Visit Us At: www.rscc-heattrace.com
Note: Fully insulate and weather protect pipe support if outdoors.

* Glass Tape P/N 1528-01017, 1528-01019

Visit Us At: www.rscc-heattrace.com
Heat Tracing of Line Mounted Instruments

Connection Kits
P/N 1548-40000
(2700 Family)
P/N 1548-41000
(2300 Family)

*Glass Tape P/N 1528-01017, 1528-01019
Connection Kits
P/N 1548-40000
(2700 Family)
P/N 1548-41000
(2300 Family)

*Glass Tape or Cable Ties (typical)

Note:
Treat turbine flow meter as a valve of the same pipe diameter. Leave a loop of material the same as for a valve.
*Glass Tape or Cable Ties (typical)

End Seal
P/N 1548-40300

Steel Strap or Cable Ties

Power Connection Kits
P/N 1548-40000
P/N 1548-41000

Notes:
1. Fully insulate and weatherproof.
2. Exact configuration may vary.
3. Refer to installation isometrics for proper tracer type and amount.
4. Where the heater is applied in the region designated as "Bell Area" aluminum tape should be used to aid heat transfer because of the excessively irregular surface.

*Glass Tape P/N 1528-01017, 1528-01019

Visit Us At: www.rscc-heattrace.com
Heaters Wired Directly to Thermostat

Design Guide and Installation Details for Self-Regulating Heating Cable

Note:
Article 427-56(B) of the National Electrical Code states that:
"temperature controlled switching devices which do not have an "off" position shall not be required to open all ungrounded conductors and shall not be permitted to serve as the disconnecting means".

Visit Us At: www.rscc-heattrace.com
Heaters Wired with 3 Pole Contactor

Note:
Article 427-56(B) of the National Electrical Code states that:
"Temperature controlled switching devices which do not have an "off" position shall not be required to open all ungrounded conductors and shall not be permitted to serve as the disconnecting means".

Additional heaters may be added to any circuit provided the total load does not exceed contact rating.

Visit Us At: www.rscc-heattrace.com