SPECIFYING OMEGALUX® HEAT CABLE

For PipingSystems

MADE IN USA

HEAT LOSS CALCULATIONS

CALCULATING HEAT LOSSES FROM INSULATED METAL PIPES

STEP 1. OBTAIN NECESSARY INFORMATION

A. Desired pipe maintenance temperature in °F (T_M).

B. Minimum expected ambient temperature in °F (T_A).

C. Size of pipe, nominal.

D. Data on thermal insulation.
1. Insulation material
2. Thickness in inches
3. Inside diameter of insulation in inches. For soft insulation, ID of insulation is same as OD of pipe. For hard insulation, use one size larger. Also, use one size larger for all spiraled installations. Use Chart 1 (page 39)

E. Maximum expected wind velocity, if over 20 mph.

STEP 2. DETERMINE HEAT LOSSES PER FOOT OF PIPE

A. Calculate maximum temperature differential. $\Delta T = T_M - T_A$

B. Use Chart 1 to determine heat loss rate in watts per foot of pipe per °F temperature differential. Enter chart with insulation ID and insulation thickness. The chart value includes a 10% safety factor.

C. Multiply maximum temperature differential from Step 2A by heat loss rate from Step B, to determine heat losses per foot of pipe. Q = (ΔT)(Heat loss rate per °F)

D. Adjust for K factor if necessary. Chart 1(page 39) is based on fiberglass insulation with K = 0.25 at 50°F maintenance temperature. For other materials or other maintenance temperatures, adjust Q by the ratio of your insulation K factor to 0.25 as shown in parenthesis under your K value. See Chart 2 (page 39).

Adjust Q = (Q) [($K/0.25$) or adjustment factor from chart 2]

Use the adjusted Q value in future calculations.

E. Adjust for wind velocity if necessary. Chart 1 is based on 20 mph maximum wind velocity. Add 5% additional safety margin for each 5 mph over 20. Use the adjusted Q value in future calculations. Do not however, add more than 15% regardless of wind speed.

F. Adjust for indoor installation. Multiply Q by 0.9 if installation is indoors.

SYSTEM SPECIFICATION

To specify which heat tracing product to use, an analysis of the parameters of the products must be done. This will determine the suitability of the product for the application.

1. Determine the suitability of the cable based on the maintenance and maximum intermittent exposure temperatures. See cable specifications.

2. Select the cable with a suitable jacket material.

Sheath Material	Self Reg.	Constant Wattage	Mineral Insulated
Basic:			
Thermoplastic Rubber (TPR)	x	—	—
PVC	—	x	—
Fluoropolymer	—	x	—
Thermoplastic			
Copper	—	—	x
Incoloy	—	—	x
Optional:			
Tinned Copper Braid	x	x	—
TPR Overbraid	x	—	—
Fluoropolymer			—
Overbraid	x	x	—
Polyethylene Coating	—	—	x

3. Choose the heat output rating of the cable which will make up heat loss calculated in Step 2.

- **Choose any heating cable which will make up heat output rating which equals or exceeds the calculated heat loss. For SPF, SRC and SRM /E self-regulating heat trace cables, consult heat output (Watts/ft) vs. maintenance temperature graphs.**
- **If mineral insulated heating cable is to be used, consult Applications Engineering.**
- **If the calculated heat loss per foot exceeds the heat output rating of the desired heating cable, there are a number of possible solutions These are:**
  - Choose a different type of heater.
  - Use more insulation
  - Switch to an insulation with a lower “k” factor.
  - Use two or more parallel runs of cable on the pipe where the sum of the cables’ heat output equals or exceeds the calculated heat loss.
  - Spiral wrap the cable. Consult wrapping factor Chart 3 (page 40). Consider also the minimum radius given in the specifications for the type of cable to be used.

4. Determine the number of feet of heating cable required.

Pipe–
- For a straight run of cable, it is equal to the length of pipe.
- For parallel runs of cable, it is the number of runs times the pipe length.
- For spiral wrapped runs, it is the feet of cable per foot of pipe times the pipe length.

Flanges —
- For each pair of flanges, provide an extra amount of cable equal to twice the diameter of the flanges.

Valves —
- Consult chart 4 on page 41 for valve allowances.

Pipe Hangers —
- Allow 3 times the pipe diameter for each hanger.

Variation Allowance —
- Extra cable should be provided for possible differences between piping drawings and the actual installation. Allow extra heating cable of: 1% for up to 1"diameter pipes

  2% for pipes larger than 1" but less than 4" in diameter

  3-5% for pipes larger than 4"

Other fittings —
- Consult OMEGALUX®

Total length of heating cable required is the sum of the above. Be sure not to exceed maximum circuit lengths for the cable.

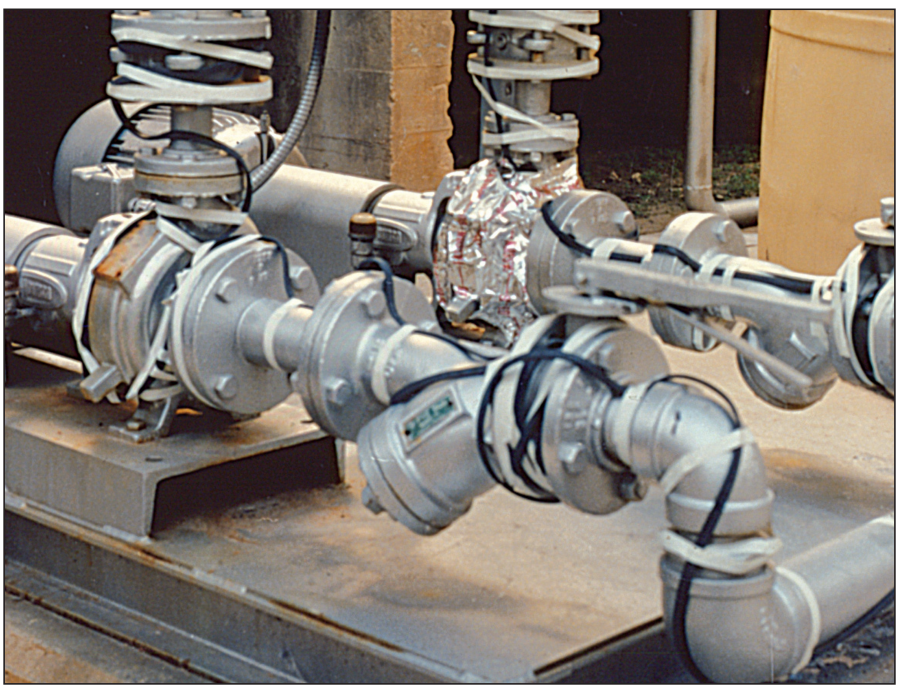
5. Choose heater voltage based on the voltages available at the installation site. For longer runs of heating cable, it is beneficial to use the highest possible voltage. If available voltages are different than the rated voltage of the cable, the heat output will be affected.

6. Consider the electrical design parameters of the installation. Consult Article 427 of National Electric Code for additional details on electrical installation. This section is intended to provide general guidelines related to the electrical design of pipe tracing systems. The information provided is intended to be used in conjunction with the OMEGALUX® heat cable installation instructions. Each application must use OMEGALUX® installation kits for electrical termination to be approved by U.L., F.M., etc. For information on installation kits such as for power termination, splices, tees, etc., consult pages 49 through 51, RTES, RTST, RTPC and RTEC.

In addition to termination, each heating cable installation must have some form of overcurrent protection such as circuit breakers or fusing. The rating of these devices should be 125% of the total current load. For constant output heating cables such as constant wattage or mineral insulated*, the total load can be calculated using the formula:

$$\text{Total current Load (Amps)} = \frac{\text{Cable length(feet) x Watt/ft (at operating conditions)}}{\text{Operating Voltage}}$$

For OMEGALUX® self-regulating heating cable, the total current load is calculated differently. When power is applied to a self-regulating heating cable, a brief current load surge is experienced. This surge is generally termed inrush current. The value of the inrush current is dependent on the temperature at which the cable is energized.



To calculate the current load, use the equation:

$$\text{Total current Load (Amps} = \text{inrush current x cable length (ft)}$$

For self-regulating cable, refer to SRL, SRM for inrush current values.

When selecting circuit breakers as the overcurrent protection device for installations utilizing self-regulating heating cable, it is recommended that the "thermal" trip type units be selected instead of the "magnetic" trip type. This will minimize possibility of nuisance tripping when the cable must be energized at lower than normal temperatures.

A ground fault interrupter (GFI) device may be placed in the circuit as additional protection. This will reduce the risk of shock or electrical arcing due to physical abuse of the cable. OMEGALUX® recommends that the GFI be rated for a 30 milliamp trip. Since a ground path is required for proper operation of a GFI, the cable should have the metal overbraid (with or without any overcoat) option ar a metallic sheath. GFI devices are strongly recommended for installations in hazardous areas.

7. Consider the control scheme. A wide range of control schemes exist in pipe tracing. Some of the more popular techniques and applications will be discussed here but are by no means limited to these.

SPECIFYING OMEGALUX® HEAT CABLE

For Piping Systems (continued)

Control can be based on two different areas, the temperature of the pipe or the temperature of the surrounding area. The latter of the two, ambient sensing, is normally recommended for freeze protection applications. Pipe sensing is widely used in applications ranging from freeze protection to process temperature maintenance.

Good control of the temperature of a pipeline is very dependent on the placement of the sensing element. Ambient sensing elements should be placed where the lowest ambient temperature is expected. Pipe sensing element should not be located within five feet of a beginning, end, splice, or any disruption of the thermal insulation. The pipe sensing element should be located at a point along the pipe most representative of the entire piping system.

When specifying a temperature controller, the total load of the heating cable system to be controlled cannot exceed the amperage rating of the controller.

If the amperage rating of the controller is exceeded, an auxiliary contractor will be required to control power to the heating cable system.

OMEGALUX® has a wide variety of controls available for almost any pipe tracing system.

8. Specify the heating cable product –

- ✓ For self regulating heat cable refer to pages 43 to 47.
- ✓ For constant wattage heat cable, refer to page 48, 54 and 55.
- ✓ For mineral insulated heating cable, refer to OMEGALUX® mineral insulated heating cable in this section.

Third Party Approvals

Approval Cable:	SRF	SRL3	SRL5	SRL8	SRL10	SRM3	SRM5	SRM8	SRM10	CWM4	CWM8	CWM12
UL listed for ordinary areas	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
FM approval for ordinary areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	*	✓	*
FM approval for hazardous areas, Class I, Div. II, Groups B, C, D (gases, vapors)		✓	✓	✓	✓	✓	✓	*	✓	*	✓	*
FM approval for hazardous areas, Class II, Div. II, Group G (combustible dust)		✓	✓	✓	✓	✓	✓	*	✓	*	✓	*
FM approval for hazardous areas, Class III, Div. II, (easily ignitable fibers & fillings)		✓	✓	✓	✓	✓	✓	*	✓	*	✓	*
CSA certified for ordinary areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	

*Approval Pending.

CHART 1. **Heat Losses From Insulated Metal Pipes Watts Per Foot of Pipe Per °F Temperature Differential (For up to 20 mph wind speed)**

Pipe Size (Nom.)	Insulation I.D.	INSULATION THICKNESS (IN.)							
		½	¾	1	1½	2	2½	3	4
½	0.840	0.054	0.041	0.035	0.028	0.024	0.022	0.020	0.018
¾	1.050	0.063	0.048	0.040	0.031	0.027	0.024	0.022	0.020
1	1.315	0.075	0.055	0.046	0.036	0.030	0.027	0.025	0.022
1¼	1.660	0.090	0.066	0.053	0.041	0.034	0.030	0.028	0.024
1½	1.990	0.104	0.075	0.061	0.046	0.038	0.034	0.030	0.026
2	2.875	0.120	0.086	0.069	0.052	0.043	0.037	0.033	0.029
2½	2.875	0.141	0.101	0.080	0.059	0.048	0.042	0.037	0.032
3	3.500	0.168	0.118	0.093	0.068	0.055	0.048	0.042	0.035
3½	4.000	0.189	0.133	0.104	0.075	0.061	0.052	0.046	0.038
4	4.500	0.210	0.147	0.115	0.083	0.066	0.056	0.050	0.041
—	5.000	0.231	0.161	0.125	0.090	0.072	0.061	0.054	0.044
5	5.563	0.255	0.177	0.137	0.098	0.078	0.066	0.058	0.047
6	6.625	0.300	0.207	0.160	0.113	0.089	0.075	0.065	0.053
—	7.625	0.342	0.235	0.181	0.127	0.100	0.084	0.073	0.059
8	8.625	0.385	0.263	0.202	0.141	0.111	0.092	0.080	0.064
—	9.625	0.427	0.291	0.224	0.156	0.121	0.101	0.087	0.070
10	10.750	0.474	0.323	0.247	0.171	0.133	0.110	0.095	0.076
12	12.750	0.559	0.379	0.290	0.200	0.155	0.128	0.109	0.087
14	14.000	0.612	0.415	0.316	0.217	0.168	0.138	0.118	0.093
16	16.000	0.696	0.471	0.358	0.246	0.189	0.155	0.133	0.104
18	18.000	0.781	0.527	0.401	0.274	0.210	0.172	0.147	0.115
20	20.000	0.865	0.584	0.443	0.302	0.231	0.189	0.161	0.125
24	24.000	1.034	0.696	0.527	0.358	0.274	0.223	0.189	0.147

Values in Table 1 are based on the formula below, plus a 10% Safety margin.
The k factor of .25 for fiberglass at 50°F is assumed.

$$\text{Watts/ft of pipe} = \frac{2\pi K\,(\Delta T)}{(Z)\ \ln\left(\frac{D_O}{D_1}\right)}$$

k= Thermal Conductivity (BTU•IN/HR•SQ FT•°F)

D_O= Outside Diameter of Insulation (IN)

D_1= Inside Diameter of Insulation (IN)

ΔT = Temperature Differential (°F)

Z = 40.944 BTU • IN/W • HR • FT

CHART 2. Thermal Conductivity (K) of Typical Pipe Insulation Materials BTU • In/Hr • Sq Ft • °F

INSULATION TYPE		Pipe Maintenance Temperature							
		0°F	50°F	100°F	150°F	200°F	300°F	400°F	500°F
Fiberglass or Mineral Fiber Based on ASTM C-547	k value	0.23	0.25	0.27	0.30	0.32	0.37	0.41	0.45
	Adjustment factor	(.92)	(1.00)	(1.08)	(1.20)	(1.28)	(1.48)	(1.64)	(1.80)
Calcium Silicate* Based on ASTM C-533	k value	0.35	0.37	0.40	0.43	0.45	0.50	0.55	0.60
	Adjustment factor	(1.40)	(1.48)	(1.60)	(1.72)	(1.80)	(2.00)	(2.20)	(2.40)
Foamed Glass* Based on ASTM C-552	k value	0.38	0.40	0.43	0.47	0.51	0.60	0.70	0.81
	Adjustment factor	(1.52)	(1.60)	(1.72)	(1.88)	(2.04)	(2.40)	(2.80)	(3.24)
Foamed Glass* Based on ASTM C-591	k value	0.18	0.17	0.18	0.21	0.25	—	—	—
	Adjustment factor	(.72)	(.68)	(.72)	(.84)	(1.00)	—	—	—

**For rigid insulation, one size larger than pipe is recommended, up through 8" Use same size insulation on 10" pipe and larger.*

SPECIFYING OMEGALUX® HEAT CABLE

For Piping Systems (continued)

EXAMPLE FOR OUTDOOR INSTALLATIONS

Maintain a 1½″ pipe at 100°F to keep a process fluid flowing. Use 2″ thick fiberglass insulation. Minimum expected ambient temperature is 0°F Maximum expected wind velocity is 35 mph.

HEAT LOSS CALCULATIONS

STEP 1

A. T_M = 100°F
B. T_A = 0°F
C. 1½" Nominal
D. (1) Fiberglass, which is soft
(2) 2" thick
(3) 1.900"
(4) K= 0.27, from chart 2 (page 39)

E. 35 mph wind

STEP 2

A. T = 100°F - 0°F
= 100°F

B. 0.038 watts/FT•°F

C. Q = (100°F)(0.038 watts/FT•°F) = 3.80 watts/FT

D. Adjusted K = 1.08 from Chart 2
Adjusted Q = (3.80 x 1.08) = 4.10 watts/FT

E. Add 15% additional for 35 mph wind (4.10 x 1.15) = 4.72 watts/FT

F. Outdoors

SYSTEM SPECIFICATIONS (as discussed on page 36)

STEP 1

In our example, the maintenance temperature is 100°F and the maximum intermittent exposure temperature is 150°F so any cable is suitable based on these parameters.

STEP 2

Based on the chemical environment we could use self-regulating with fluoropolymer overbraid option, or constant Wattage with the basic fluoropolymer sheath or fluoropolymer with overbraid option, or mineral insulated cable with any of the basic sheath materials.

STEP 3

There are a number of different solutions to our sample application. Let's look at each type of heat tracing products individually.

CHART 3 WRAPPING FACTOR (Feet of Cable per Foot of Pipe) Pitch (Ins)

Pipe Size	2	3	4	5	6	7	8	9	10	11	12	14	16	18	24	30	36	42
½	1.90	1.47	1.29	1.19	1.14	1.10	1.08	1.06	—	—	—	—	—	—	—	—	—	—
¾	2.19	1.64	1.40	1.27	1.19	1.14	1.11	1.09	1.07	1.06	—	—	—	—	—	—	—	—
1	2.57	1.87	1.55	1.38	1.27	1.21	1.16	1.13	1.11	1.09	1.07	—	—	—	—	—	—	—
1¼	3.07	2.18	1.76	1.53	1.39	1.30	1.24	1.19	1.16	1.13	1.11	1.08	1.06	—	—	—	—	—
1½	3.43	2.41	1.92	1.65	1.48	1.37	1.29	1.24	1.20	1.16	1.14	1.10	1.08	1.06	—	—	—	—
2	4.15	2.86	2.25	1.90	1.67	1.52	1.42	1.34	1.28	1.24	1.20	1.15	1.12	1.10	1.05	—	—	—
2½	4.91	3.36	2.61	2.17	1.89	1.70	1.56	1.46	1.39	1.33	1.28	1.21	1.17	1.13	1.08	1.05	—	—
3	5.88	3.99	3.06	2.52	2.17	1.93	1.76	1.63	1.53	1.45	1.39	1.30	1.23	1.19	1.11	1.07	1.05	—
4	7.43	5.01	3.82	3.11	2.65	2.33	2.09	1.92	1.78	1.67	1.58	1.45	1.36	1.29	1.17	1.11	1.08	1.06
5	9.09	6.10	4.63	3.75	3.17	2.77	2.47	2.24	2.06	1.92	1.81	1.63	1.51	1.42	1.25	1.17	1.12	1.09
6	10.75	7.20	5.44	4.40	3.70	3.22	2.86	2.58	2.36	2.19	2.04	1.83	1.67	1.55	1.34	1.23	1.16	1.12
8	13.88	9.28	6.99	5.63	4.72	4.08	3.60	3.23	2.94	2.71	2.51	2.22	2.00	1.83	1.53	1.36	1.26	1.20
10	17.20	11.49	8.65	6.94	5.81	5.01	4.41	3.95	3.58	3.28	3.03	2.65	2.37	2.15	1.75	1.52	1.38	1.29
12	20.34	13.58	10.21	8.19	6.85	5.89	5.18	4.62	4.18	3.83	3.53	3.07	2.73	2.40	1.97	1.68	1.51	1.39
14	22.30	14.89	11.18	8.97	7.49	6.44	5.66	5.05	4.57	4.17	3.85	3.34	2.96	2.67	2.11	1.79	1.59	1.46
16	25.44	16.98	12.75	10.22	8.53	7.33	6.43	5.74	5.18	4.73	4.35	3.77	3.33	3.00	2.34	1.97	1.73	1.57
18	28.58	19.07	14.31	11.47	9.57	8.22	7.21	6.42	5.80	5.29	4.86	4.20	3.71	3.33	2.58	2.15	1.88	1.69
20	31.71	21.16	15.88	12.72	10.61	9.11	7.99	7.11	6.42	5.85	5.38	4.64	4.09	3.66	2.82	2.34	2.03	1.81
24	37.99	25.34	19.02	15.22	12.70	10.90	9.55	8.50	7.66	6.98	6.41	5.52	4.85	4.34	3.32	2.72	2.33	2.07

To determine the wrapping factor, divide the calculated heat loss by the heat output of the cable. Locate the value that is equal to or the next highest in the row for the pipe size in your application. The value at the top of the column is the pitch or spacing from center to center of the cable along the pipe.

Self regulating—we could use the 8 Watt per foot cable since its output at 100°F is 5 Watts per foot.

Constant wattage— we could use the 8 Watt per foot constant wattage cable.

We could also change the insulation, its thickness, etc. and try a different rating.

STEP 4

Pipe - 115 ft
Flanges - Approx. 1 ft

Valves - 1 ft

Variation Allowance:
115' x 0.02 =2 ft
Total Length of Heat Cable Req'd. = 119 ft

STEP 5

If we use a 240 Volt power source,

CHART 4
LENGTH ALLOWANCES FOR VALVES*

Pipe Size	Butterfly Valves (Feet)	Globe or Gate Valves (Feet)
½	1	1
¾	1	1
1	1	1
1½	1	1
2	1	2
2½	1	2
3	1	2
4	2	3
5	2	4
6	2	5
8	3	5
10	3	6
12	4	6
14	4	8
16	5	8
18	5	10
20	5	10
24	5	10

*This table assumes that the valve is covered by the same type and thickness of insulation on the pipe and all cracks are sealed.

we could use the following:

A. 8 Watt per foot self regulating, or

B. 8 Watt per foot constant wattage, or

C. MI cable**

STEP 6

DETERMINE TOTAL CURRENT LOAD

In our sample problem, the total current load for the constant wattage cable is:

$$\frac{119 \text{ ft x } 8 \text{ W/ft}}{240 \text{ Volts}} = 3.97 \text{ Amps,}$$

In our example using 8 Watts per foot, 240 Volt self-regulating heating cable, the current load, based on a minimum 50°F start-up temperature, would be (.08 Amps per foot) x (119 ft) = (9.52 Amps)

STEP 7

Refer to (page 36) for complete discussion of the control scheme.

STEP 8

SPECIFY THE HEAT CABLE PRODUCT

SELF-REGULATING: In our example, we would specify 119 ft of SRL 8-2CT heating cable.

CONSTANT WATTAGE: In our example, we would specify 119 ft of CWM 8-2 or CWM 8-2CT heating cable.

SPECIFYING OMEGALUX® HEAT CABLE

PLASTIC PIPE TRACING DESIGN

OMEGALUX® SRL self-regulating heating cables are well suited for use on plastic pipes. The self-regulating characteristic maintains the maximum temperature of the cable to acceptable limits for use on plastic pipe. However, careful attention should be taken when designing the heat tracing system not to exceed the maximum allowable pipe temperature for the plastic pipe being used. This maximum temperature rating may vary with the operating pressure of the pipe. Consult the manufacturers data for the pipe being used to obtain maximum ratings.

When using SRL self-regulating heating cable on plastic pipe, the output of the cable is affected due to the poor heat transfer characteristics of the pipe. When designing a system for use on plastic pipe, use the graphs below for the adjusted cable output vs. temperature. Note that the use of aluminum tape improves the heat transfer from the cable to the pipe. This improves the efficiency of the system. Appropriate graphs for the cable output with the use of aluminum tape on plastic pipes are also shown below.

Example:
If the pipeline described in the example on page 38 is assumed to be plastic pipe, then the following figures must be used to select the rating of RL heating cable to be used. From Step 2 on page 36, we know that 4.72 watts/ft. is required to make up for heat losses. If the cable is applied to the pipe **without** using aluminum tape, then from Figure B-1, the heat output required is found to be greater than what a single straight run of any of the heating cable shown could produce. Consult Step 3 on page 36 for recommendations in this case.

If aluminum tape is applied **under or over the cable,** then from Figure B-2 it can be seen that 10 Watt per foot SRL heating cable can be used. In this case, if aluminum tape was applied **under and over** the cable, 10 Watt per foot SRL heating cable would still be required.

Note: *These graphs are for cable installed on plastic pipe only.*

FIGURE B-1

SRL Heating Cable on Plastic Pipe without Aluminum Tape, Cable Output vs. Temperature

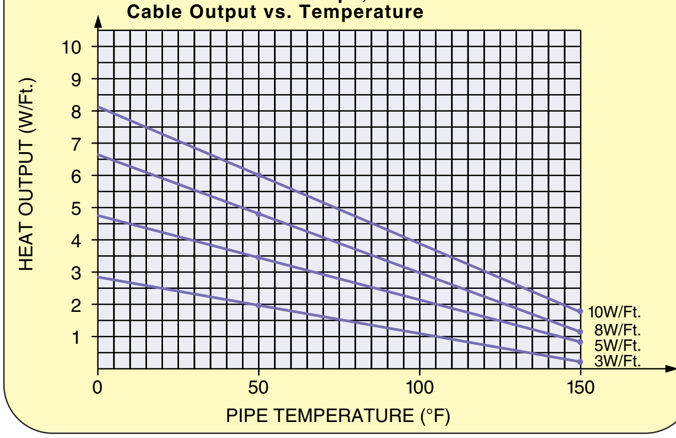


FIGURE B-2

SRL Heating Cable on Plastic Pipe with Aluminum Tape Installed on the Pipe Under or Over the Cable, Cable Output vs. Temperature

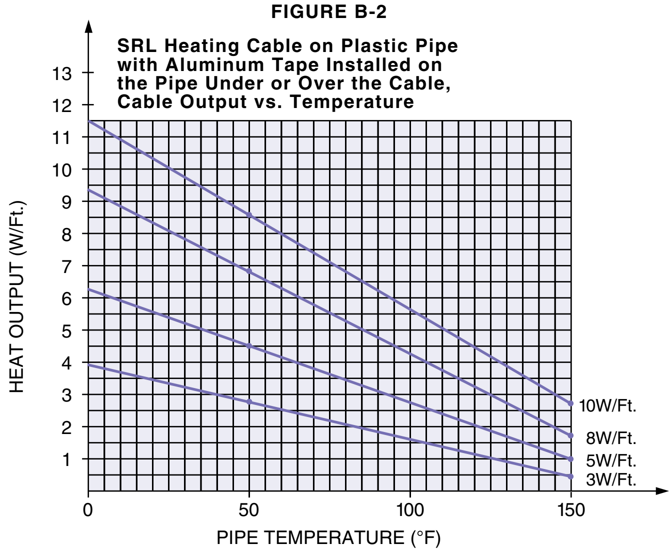
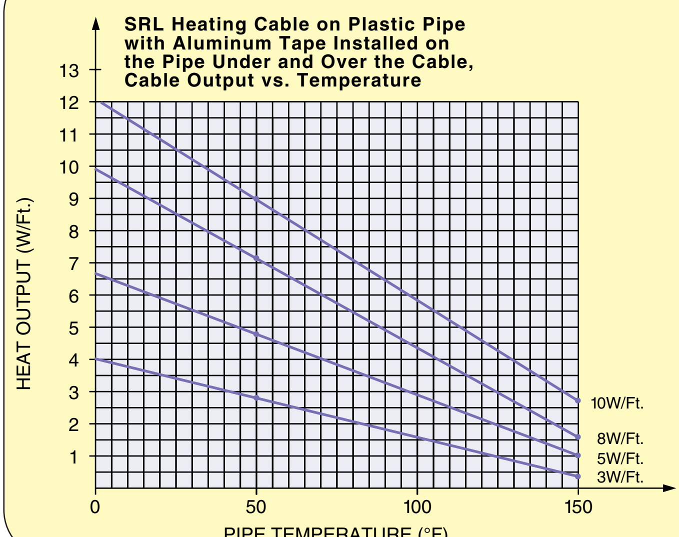


FIGURE B-3

SRL Heating Cable on Plastic Pipe with Aluminum Tape Installed on the Pipe Under and Over the Cable, Cable Output vs. Temperature



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- ### Temperature
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