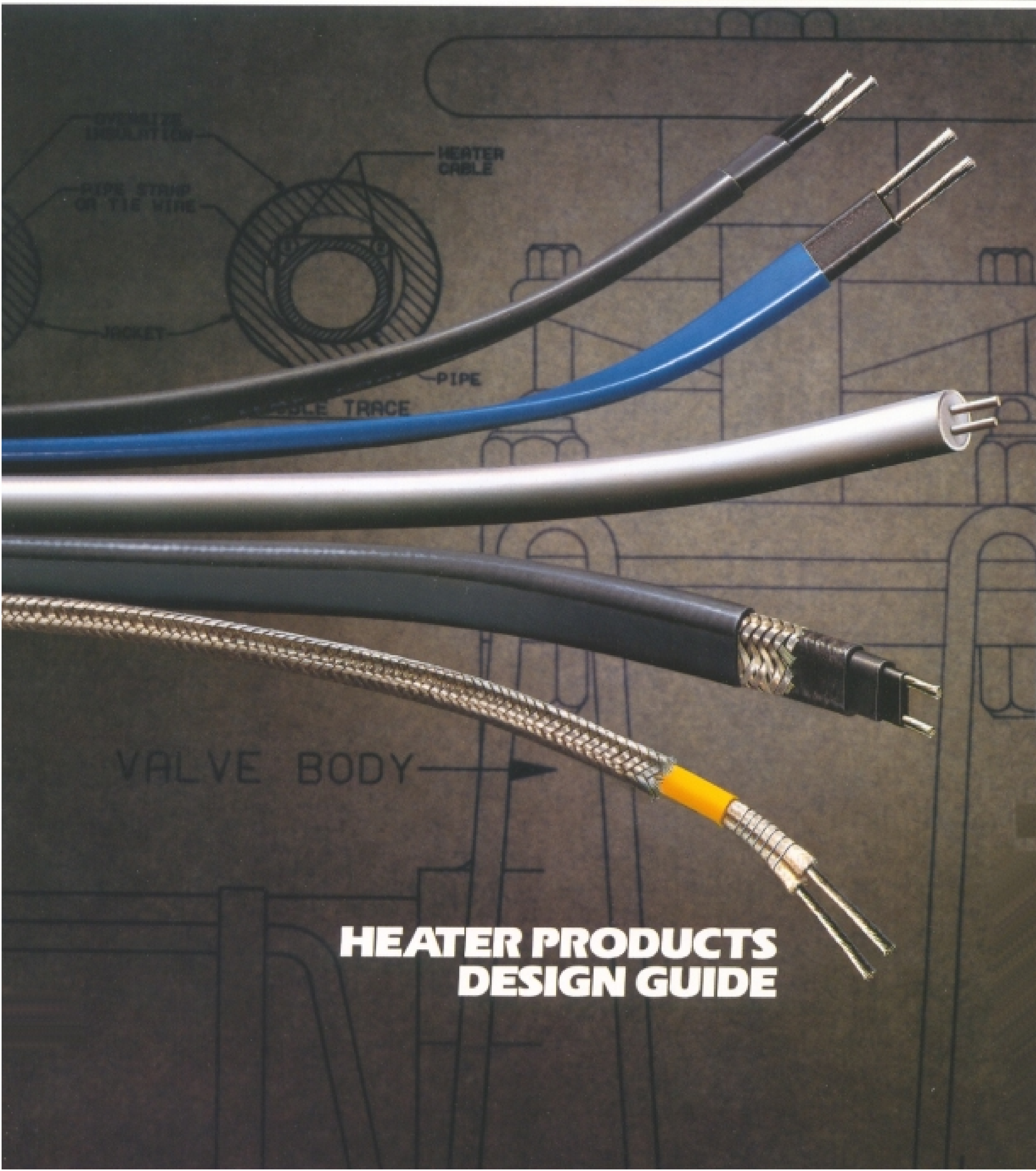
EGS Electrical Group

NELSON HEAT TRACE



HEATER PRODUCTS DESIGN GUIDE

INTRODUCTION

This design guide provides simple instructions for the thermal design and selection of the proper Nelson heat trace products for pipe and vessel heating needs.

To specify components for an effectively designed, totally electric heat trace system, it is necessary to understand the basic principles involved. A heat trace system is designed to replace heat lost through the thermal insulation from equipment in the system. In some applications, heat tracing will also be able to provide enough heat to significantly change the process temperature.

Nelson always recommends the use of thermal insulation since heat loss from bare surfaces is very high and heat transfer between the heater and the pipe/vessel is highly variable.
All insulation should be weatherproofed. Wet insulation is useless and heater output is insufficient to dry it.

NELSON HEATING CABLE PRODUCTS

Nelson supplies several distinctively different types of electric heaters-Self Regulating Limitrace®, Constant Wattage Nelcon®, Mineral Insulated Nelex®, VH Tank heating Panels. Each type has its own characteristics, often making one more suitable for a certain application than the others.
It is important to determine which features are desired.

LIMITRACE Self-Regulating Heater Cable

Limitrace Self Regulating Heater Cable will adjust its own output in response to pipe temperature. Available in a variety of temperature and power ratings up to 375°F and 20 watts per foot. Product features include:

- **VARIABLE OUTPUT**
  Limitrace will react to variations in temperature encountered at every point along its length. Colder sections receive more heat output, while warmer sections receive less. This provides greater energy efficiency and more uniform pipe temperatures.
- **CAN BE OVERLAPPED WITHOUT DAMAGE**
  Because Limitrace controls its own output, overlapped sections produce less heat, eliminating "hot spots" and possible burn-through common with other types of cable.
- **FAIL-SAFE**
  Upon reaching the upper limits of its temperature range, Limitrace diminishes it own heat output to an insignificant level. This guarantees that maximum temperatures (T ratings) cannot be exceeded no matter what product is used in any application.
- **EASY INSTALLATION**
  Because of its infinite parallel path circuitry, Limitrace can be cut to any length in the field without affecting the heat output or creating “dead zones”.

NELCON Constant Wattage Heater Cable

Nelcon Constant Wattage Heater Cable is a parallel resistance heater that produces the same watts-per-foot of heat along its entire length.

- **EASY INSTALLATION**
  Nelcon can be cut to length and terminated in the field.
- **ECONOMICAL**
  Provides good power densities and exposure temperatures with parallel circuit cable capabilities at economical prices.
- **EXPOSURE TEMPERATURES TO 400°F**
  Ideal for maintaining many process temperature applications.

NELEX Mineral Insulated Heater Cable

Nelex is a mineral insulated, series conductor, high temperature heater cable with a special, thin metal sheath. Some of Nelex's advantages are:

- **CORROSION-RESISTANT**
  Incoloy 825 sheath provides excellent corrosion resistance and immunity from chloride stress corrosion - a common problem with stainless steel.
- **IDEAL FOR HIGH TEMPERATURE APPLICATIONS**
  Nelex can withstand exposure temperatures up to 1100°F. Exposure temperatures can be increased to 1400°F with special components.
- **RATINGS TO 600V**
  Nelex is available in a variety of voltages to match the available power supply.
- **HIGH HEAT OUTPUT**
  Nelex has heat output ratings up to 10 times higher than most other cables, reducing the amount of cable required.
- **RUGGED CONSTRUCTION**
  A durable metal sheath provides greater mechanical protection.
- **THIN WALL CONSTRUCTION**
  A unique manufacturing process allows thin wall cable construction for easier field installation.

VH Tank Heating Panels

- **LOW INSTALLATION COST**
  Flexible silicone construction allows panel to conform to tank wall. No bonding or heat transfer aids are required.
- **HIGH TEMPERATURE**
  VH Tank Heating Panels maintain temperatures up to 175°F and can withstand exposure to 400°F.

The design guide has four basic sections:

Thermal Design - Pipes **A.**
Thermal Design - Vessels **B.**
Heater Selection **C.**
General Design Guidelines **D.**

To determine the heat loss that must be replaced by the heating cable, the following should be determined:

- T_F Fluid temperature to be maintained
- T_A Minimum ambient temperature
- Size of pipe to be heated
- Thermal insulation- type and thickness

1. Temperature Differential

Determine the temperature differential to be maintained by subtracting the ambient temperature from the fluid temperature to be maintained. (T_F-T_A)

2. Heat Loss

Use Table 1 to look up the heat loss for the proper pipe diameter and thickness of insulation. If a rigid insulation such as calcium silicate is used, the insulation should be oversized to the next available size. Insulation should also be oversized when using any cable besides the standard self-regulating Limitrace, without overjackets. This will allow adequate space for the heating cable and allow the insulation joints to properly seal. As an example, you would use 2 inch pipe diameter heat losses for 1-1/2 inch pipe heating application if rigid insulation were used. Heat loss figures from Table 1 include a 10% safety factor.

TABLE 1
PIPE HEAT LOSS

Insulation Thickness	ΔT (°F)	IPS 1/2 Tubing 3/4	3/4 1	1 1 1/4	1 1/4 1 1/2	1 1/2 2	2	2 1/2
1.0 in.	10	0.3	0.4	0.4	0.5	0.6	0.7	0.8
(25 mm)	50	1.7	1.9	2.2	2.5	2.8	3.3	3.8
	100	3.5	3.9	4.5	5.3	5.8	6.8	7.9
	150	5.4	6.2	7.1	8.3	9.1	10.7	12.4
	200	7.5	8.6	9.9	11.5	12.6	14.9	17.2
	250	9.8	11.2	12.8	15.0	16.5	19.4	22.4
1.5 in.	10	0.3	0.3	0.4	0.4	0.4	0.5	0.6
(38 mm)	50	1.3	1.5	1.7	1.9	2.1	2.5	2.8
	100	2.8	3.1	3.5	4.1	4.4	5.1	5.9
	150	4.4	4.9	5.5	6.4	6.9	8.1	9.2
	200	6.1	6.8	7.7	8.9	9.7	11.2	12.8
	250	7.9	8.9	10.0	11.6	12.6	14.6	16.7
2.0 in.	10	0.2	0.3	0.3	0.4	0.4	0.4	0.5
(50 mm)	50	1.2	1.3	1.4	1.6	1.8	2.0	2.3
	100	2.4	2.7	3.0	3.4	3.7	4.3	4.8
	150	3.8	4.2	4.7	5.4	5.8	6.7	7.6
	200	5.3	5.9	6.6	7.5	8.1	9.3	10.5
	250	6.9	7.7	8.6	9.8	10.6	12.1	13.7
2.5 in.	10	0.2	0.2	0.3	0.3	0.3	0.4	0.4
(63 mm)	50	1.0	1.2	1.3	1.4	1.6	1.8	2.0
	100	2.2	2.4	2.7	3.0	3.3	3.7	4.2
	150	3.4	3.8	4.2	4.8	5.1	5.8	6.6
	200	4.8	5.3	5.9	6.6	7.1	8.1	9.1
	250	6.2	6.9	7.6	8.6	9.3	10.6	11.9
3.0 in.	10	0.2	0.2	0.3	0.3	0.3	0.3	0.4
(75 mm)	50	1.0	1.1	1.2	1.3	1.4	1.6	1.8
	100	2.0	2.2	2.5	2.8	3.0	3.4	3.7
	150	3.2	3.5	3.9	4.3	4.6	5.3	5.9
	200	4.4	4.9	5.4	6.0	6.5	6.7	8.2
	250	5.8	6.3	7.0	7.8	8.4	9.5	10.6

3. Adjustments to Heat Loss Values

The heat losses in Table 1 are based on glass fiber insulation. If other insulations are used, multiply the heat loss value by the correction factor (shown in Table 2) for your insulation. Heat losses are based on outdoor applications with 20 m.p.h. wind. If piping is used indoors, multiply heat loss values by 0.9.

4. Adjustments for Heat Sinks

Any thermally conductive item that protrudes through the insulation will require extra heat to be applied to the pipe. The footage shown in Table 3 should be added to the required heater cable length to compensate for these extra heat losses. When multiple-tracing or spiraling cable, increase the cable adders proportionately.

5. Spiral Pitch Factor

For some applications the effective cable heat output per foot of pipe may be increased by spiraling the heater along the pipe. Use Table 4 to determine the spiral pitch factor.

3	4	6	8	10	12	14	16	18	20	24
0.9	1.1	1.5	1.9	2.4	2.7	3.0	3.4	3.8	4.2	5.0
4.4	5.4	7.5	9.5	11.5	13.5	14.7	16.7	18.6	20.5	24.4
9.2	11.3	15.7	19.8	24.2	28.2	30.8	34.9	38.9	43.0	51.1
14.4	17.6	24.6	31.0	37.8	44.2	48.3	54.6	61.0	67.3	80.0
20.0	24.5	34.2	43.2	52.6	61.5	67.1	75.9	84.7	93.6	111.2
26.0	31.9	44.6	56.1	68.4	80.0	87.3	98.7	110.2	121.7	144.6
0.7	0.8	1.1	1.4	1.6	1.9	2.1	2.4	2.6	2.9	3.4
3.2	3.9	5.3	6.7	8.1	9.4	10.2	11.5	12.8	14.2	16.8
6.8	8.2	11.2	14.0	16.9	19.7	21.4	24.2	26.9	29.6	35.1
10.6	12.8	17.6	21.9	26.5	30.8	33.6	37.9	42.2	46.5	55.0
14.7	17.8	24.4	30.5	36.9	42.9	46.7	52.7	58.6	64.6	76.5
19.2	23.2	31.8	39.6	48.0	55.8	60.7	68.5	76.3	84.1	99.6
0.5	0.6	0.9	1.1	1.3	1.5	1.6	1.8	2.0	2.2	2.6
2.6	3.1	4.2	5.2	6.3	7.3	7.9	9.0	9.9	10.9	12.9
5.5	6.6	8.9	11.0	13.2	15.3	16.6	18.7	20.8	22.8	27.0
8.6	10.3	13.9	17.2	20.7	24.0	26.1	29.3	32.6	35.8	42.3
12.0	14.4	19.4	24.0	28.8	33.4	36.3	40.8	45.3	49.8	58.8
15.6	18.7	25.3	31.2	37.5	43.5	47.2	53.1	59.0	64.9	76.6
0.5	0.5	0.7	0.9	1.1	1.2	1.3	1.5	1.7	1.8	2.1
2.3	2.7	3.6	4.4	5.2	6.0	6.6	7.3	8.1	8.9	10.5
4.7	5.6	7.5	9.2	11.0	12.7	13.7	15.4	17.1	18.7	22.1
7.4	8.8	11.7	14.4	17.2	19.9	21.5	24.1	26.8	29.4	34.6
10.3	12.3	16.3	20.0	24.0	27.6	29.9	33.6	37.2	40.9	48.1
13.5	16.0	21.3	26.1	31.2	36.0	39.0	43.7	48.5	53.2	62.6
0.4	0.5	0.6	0.8	0.9	1.1	1.1	1.3	1.4	1.6	1.8
2.0	2.4	3.1	3.8	4.5	5.2	5.6	6.3	7.0	7.6	8.9
4.2	5.0	6.5	8.0	9.5	10.9	11.8	13.2	14.6	16.0	18.8
6.6	7.8	10.3	12.5	14.9	17.1	18.5	20.7	22.9	25.0	29.4
9.2	10.8	14.3	17.4	20.7	23.8	25.7	28.7	31.8	34.8	40.9
12.0	14.1	18.6	22.6	26.9	30.9	33.5	37.4	41.4	45.4	53.3

TABLE 2
INSULATION FACTORS

Preformed Pipe Insulation	Insulation (f)	Based on K factor @ 50° F mean temp (BTU/hr-°F-ft^2/in.)
Glass Fiber	1.00	.250
Calcium Silicate	1.72	.375
Cellular Glass	1.84	.400
Rigid Urethane	0.76	.165
Foamed Elastomer	1.16	.290
Mineral Fiber	1.20	.300
Expanded Perlite	1.42	.375
Mineral Wool	1.04	.260
Polystyrene	1.04	.260
Flexible Elastomer	1.16	.290
Polyisocyanarate	0.68	.170

Example:

- Water line to be maintained at 50°F
- Minimum ambient temperature is 10°F
- Pipe is three-inch diameter steel
- Insulation is one-inch thick mineral fiber insulation

1. Calculate Temperature Differential

ΔT=TF-TA
ΔT=50-(-10) F
ΔT=60°F

2. Heat Loss

Use Table 1 to find heat loss. Where the desired temperature differential falls between two values, use interpolation:

From Table 1: @ 50°F Q = 4.4 w/ft.
@ 100°F Q= 9.2 w/ft.
QF=4.4 w/ft. + 10/50 x (9.2 – 4.4 w/ft.)
QF=4.4 + .96=5.4w/ft.

3. Adjustments to Heat Loss

Adjust the heat loss for mineral fiber. From Table 2, the adjustment factor is 1.2.
QM = QF x 1.2
QM = 5.4 w/ft. x 1.2
QM = 6.5 w/ft.
Since the piping is outdoors, no adjustment is necessary for the absence of wind.

TABLE 3
HEAT LOSS ADDER

Additional Heater Feet For Various Heat Sinks

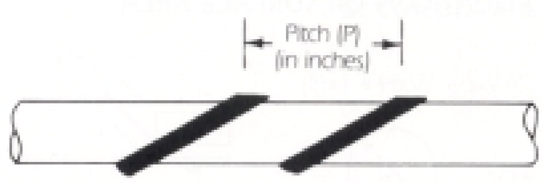
Pipe Size	Standard Flange	Blind Flange	Pipe Support (1)	Screwed Or Welded Valve	Flanged Valve	Butterfly Valve
.50	.3	.5	1.0	1.0	1.0	1.0
.75	.3	.5	1.5	1.0	1.5	1.0
1.00	.3	.5	1.5	1.0	2.0	1.0
1.50	.3	.5	1.5	1.5	2.5	1.5
2.00	.3	.5	2.0	2.0	2.5	2.0
3.00	.5	.75	2.0	2.5	3.0	2.5
4.00	.5	.75	2.5	3.0	4.0	3.0
6.00	.75	1.0	2.5	3.5	5.0	3.5
8.00	.75	1.0	2.5	4.0	7.0	4.0
10.00	.75	1.0	3.0	5.0	8.0	4.5
12.00	.75	1.0	3.0	6.0	9.0	5.0
14.00	1.0	1.5	3.0	7.0	10.0	5.5
16.00	1.0	1.5	3.5	8.0	11.0	6.0
18.00	1.0	1.5	3.5	9.0	12.0	7.0
20.00	1.0	1.5	3.5	10.0	13.0	7.5
24.00	1.0	1.75	4.0	12.0	15.0	8.0

Nominal pipe length in feet. Adders are for various inline pipe fittings to compensate for greater areas of heat loss.
NOTE: Values above are based on area average of various fittings available, and the assumption that fitting insulation will be equivalent to pipe insulation. The nominal length of tracer to be applied to a particular fitting would be the values shown in this chart plus the flange-to-flange length of the fitting.

TABLE 4
SPIRAL PITCH FACTOR

Pipe Size	Feet of Cable per Foot of Pipe							
IPS	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**
1	9	6	5	4	4	3	3	3
1 1/4	11	8	6	5	5	4	4	3
1 1/2	13	9	7	6	5	5	4	4
2	16	11	9	7	6	6	5	5
2 1/2	20	14	11	9	8	7	6	6
3	24	17	13	11	10	9	8	7
4	31	21	17	14	13	11	10	9
6	45	31	25	21	18	17	15	14
8	59	41	32	27	24	22	20	18
10	74	51	41	34	30	27	25	23
12	87	60	48	41	36	32	30	27
14	96	66	53	45	39	35	32	29
16	110	76	61	51	45	40	37	34
18	123	89	68	58	51	45	41	38
20	137	95	76	64	56	50	46	42
24	164	114	91	77	67	60	55	50

Example: For 3" pipe, with 1.3 feet of Limitrace per foot of pipe. P = 13 Inches



To calculate the heat loss that must be replaced by the heater, the following should be determined:

- T_F Fluid temperature to be maintained
- T_A Minimum ambient temperature
- Vessel surface area
- Thermal insulation type and thickness

1. Temperature Differential

Determine the temperature differential to be maintained by subtracting the ambient temperature from the fluid temperature to be maintained. ($T_F - T_A$).

2. Vessel Surface Area

Determine the total surface area A of the vessel using the appropriate formula (see below).

3. Surface Heat Loss

Use Table 5 to determine the surface heat loss from the vessel in watts/ft^2. Multiply this value by the total surface area calculated in step 2 to determine the total vessel heat loss.

4. Adjustments To Heat Loss Values

The heat losses in Table 5 are based on glass fiber insulation. If other insulations are used, multiply the heat loss value by the correction factor (shown in Table 2) for your insulation.

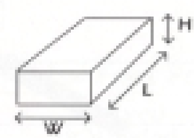
Heat losses are based on outdoor applications with 20 m.p.h. wind. If vessel is located indoors, multiply heat loss values by 0.9.

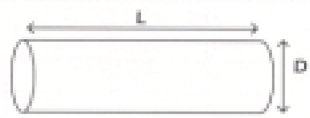
Heat losses are based on a 10% safety factor.

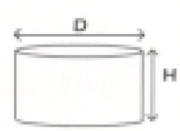
5. Adders For Heat Sinks

Any non-insulated thermally conductive item that protrudes through the insulation will require extra heat to be applied. Use Table 6 to determine the additional amount of heat to apply for various heat sinks. Add these totals to the heat loss calculated in Section 4.

VESSEL TYPE	EQUATION FOR SURFACE AREA
Rectangle	$2(W \times L + W \times H + L \times H)$
Sphere	πD^2
Round Horizontal	$\pi DL + \pi D^2/2$ (sides) (ends)
Round Vertical	$\pi DH + \pi D^2/4 + \pi D^2/4$ (sides) (top) (bottom)
Cone	$\pi H \times (D_1 + D_2)/2 + \pi D_1^2/4 + \pi D_2^2/4$ (sides) (top) (bottom)







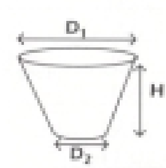


TABLE 5
VESSEL HEAT LOSS

INSULATION THICKNESS (Inches) Delta T	1 (25 mm)	1 1/2 (38 mm)	2 (50 mm)	3 (75 mm)
50	3.8	2.5	1.9	1.3
100	7.9	5.3	4.0	2.7
150	12.3	8.3	6.2	4.2
200	17.1	11.5	8.7	5.8
250	22.3	15.0	11.3	7.6
300	27.9	18.7	14.1	9.4

EXAMPLE:

- Tank fluid is to be maintained at 160°F
- Minimum ambient temperature is 10°F
- Tank is round with flat heads, resting on concrete pad
  - Height = 10 ft
  - Diameter = 8 ft
- Insulation is 2" calcium silicate

1. Calculate temperature differential.

$(T_F - T_A) = 160 - 10 = 150°F$

2. Determine surface heat loss from Table 5.

The base heat loss is 6.2 w/ft^2 with glass fiber Insulation. To adjust for calcium silicate, multiply by 1.50 (from Table 2). This gives 9.3 w/ft^2. This applies to the top and sides.

3. Determine tank surface area.

Sides: $\pi DL = (\pi)(8)(10) = 251.3\ ft^2$
Top: $\pi D^2/4 = (\pi)(8^2)/4 = 50.3\ ft^2$
Bottom: $\pi D^2/4 = (\pi)(8)^2/4 = \underline{50.3\ ft^2}$
$351.9\ ft^2$

4. Determine heat loss from bottom.

Because the tank is resting on a concrete pad without insulation, the heat loss from the tank bottom must be determined from table 6.

$(T_F - 55°F) = (160-55) = 105°F$

From table 6, 0.035 x 105 = 3.7 watts/ ft^2

5. Calculate total tank heat loss.

Sides: $251.3\ ft^2 \times 9.3\ w/ft^2 = 2337$ watts
Top: $50.3\ ft^2 \times 9.3\ w/ft^2 = 468$ watts
Bottom: $50.3\ ft^2 \times 3.7\ w/ft^2 = \underline{186 \text{ watts}}$
2991 watts

TABLE 6
ADDERS FOR NON-INSULATED VESSEL HEAT SINKS

Heat Sink Type	Watt Loss Adder
Support Leg	Add 0.84 watts per degree temperature differential (°F) for each leg
Saddle Support	Add 7.6 watts per degree temperature differential (°F) for each support
Concrete Pad	Calculate the heat loss from the tank bottom separate from the insulated tank. Use 0.035 w/ft^2 per degree temperature difference (°F) between fluid temperature (T_F) and 55°F ground temperature
24" Manway	Add 3.1 watts per degree temperature differential (°F) for each opening
36" Manway	Add 7.1 watts per degree temperature differential (°F) for each opening

TABLE 7
HEATER SELECTION GUIDE

PRODUCT FAMILY	MAX. POWER	MAX. VOLT °F(°C)	MAX MAINT. TEMP °F(°C)	MAX EXPOSURE TEMP °F(°C)
Limitrace LT-Self-Regulating	10w/f	277	150(65)	185(85)
Limitrace HLT-Self-Regulating	20w/f	277	250(121)	375(191)
Nelcon Constant Wattage	12w/f	277	300(149)	400(204)
Nelex Custom MI	70w/f	600	700(371)	1100(593)
VH Tank Heating Panels	2000w	240	175(79)	400(204)

Application for table

LT: Freeze protection & low temperature maintenance, roof and gutter de-icing, hot water systems, non-metallic pipes and tanks.
HLT: Process maintenance & steam-cleanable freeze protection.
Nelcon: Process maintenance & steam-cleanable freeze protection.
Nelex: Can handle longer circuits and higher wattages at elevated temperatures.
VH: Metallic tanks and vessels for freeze protection and process maintenance.

There is no one, fixed way that is correct to heat a pipe or vessel to the exclusion of all the other methods. However, certain types of heaters lend themselves to specific applications.

Nelson's full line of products allows the use of selection criteria based on the best product for the application.

1. Maximum Exposure Temperature
Select the heater type based on the maximum temperature the process will reach. Do not exceed the heater rating. Do not use insulation sandwiching for the use of plastic cables on high temperature steam lines. It will increase installed insulation costs by 50% and is very craft-sensitive. MI Cable should be used instead.

2. Maintain Temperature
Select the heater type based on the maximum process maintenance temperature desired. With thermostatic control, higher temperature heaters can be used to maintain lower temperatures.

3. Heat Requirement
Select the heater type that provides adequate heat output based on your heat loss calculations at minimum ambient. Additional heat output can be achieved with spiraling or multiple heaters, but this often increases cost. Because self-regulating heaters reduce their heat output with increased temperature, their efficiency is reduced at higher maintenance temperatures. MI cable is often a more economical choice at elevated maintenance temperatures.

4. Voltage
Increased voltage provides two advantages, lower amperage and longer circuit lengths. Both decrease power distribution and installation costs

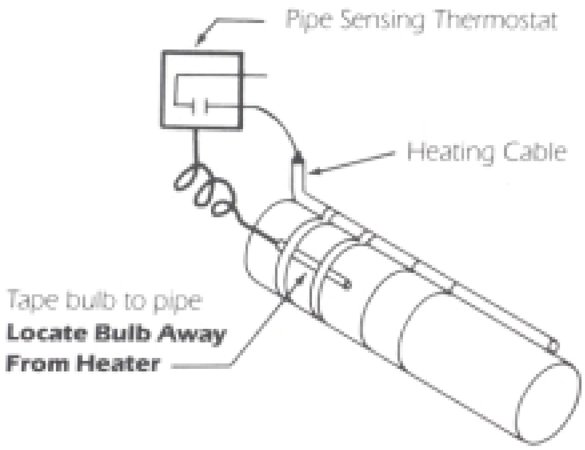
5. Area Classification
Heater type and construction vary with area classification. Nelson offers heater options for all area classifications

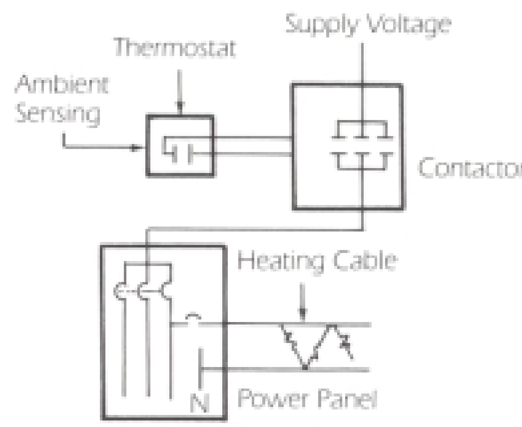
6. Ease Of Installation
Parallel, self-regulating heaters are normally used for lower temperature applications because they are flexible and can be cut to length in the field. With increased maintenance temperatures or higher heat requirements, the efficiency of self-regulating heaters is reduced, and MI cable often provides the best overall system. Nelson's MI cable products are manufactured with high temperature alloy conductors and a thin, high temperature Incoloy 825 sheath. They can be overlapped up to 25 w/ft and can be formed without the use of special tools.

7. Vessel Heating
Heat tracing pipes requires the use of a strip heater. These heaters can also be used for vessel heating, but they are more difficult to install. VH Tank Heaters are specifically designed for vessels. Because they are flexible, they conform to the vessel wall and are easily installed.

HEAT TRACE CONSIDERATIONS

1. Types of Heater Control. There are two types of temperature control, ambient (air sensing) and line sensing. On small projects either of these types of control are achieved with individual component temperature controllers. On larger projects it may be advantageous in terms of cost and maintenance, to use larger central control cabinets with electronic control.





Line Sensing Control

Line sensing control means a thermostat is used to sense each pipe or vessel's actual temperature. The heater is only energized when that line's temperature drops below the thermostat's switching point

When controlling a heater circuit that has both flowing and non-flowing segments, the sensor should be put on the non-flowing branch of the circuit. On critical temperature control processes, separate heater circuits may be required.

Advantages of this system include close temperature control and minimum energy usage. Disadvantages are initial control costs and maintenance costs that will rise in proportion to the number of controllers used.

Ambient Air Control

Ambient control means the heater is turned "off" and "on" depending on the temperature of the surrounding air. This system uses an ambient air sensing thermostat that may turn on an entire panel load of heaters when the air reaches a predetermined temperature (40°F is a typical value). When energizing multiple heater loads a contactor is used to perform the actual switching. Advantages of ambient control include simplified control wiring and lower control maintenance costs. Disadvantages include loss of precise temperature control and excessive energy consumption (since heaters may be on when pipe is being warmed from products flowing through it).

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2. Effects Of Heat Sinks. Any thermally conductive material that penetrates though the insulation pulls heat away from the pipe or vessel at a high rate. If extra heater is not installed at these points, the system will be colder in those areas. Self-regulating heaters also require extra cable at those points.

3. Heat-Up Requirements. Heat loss tables do not include adequate power to provide rapid heat up of pipes or vessels filled with product. If heat-up is required, extra heat must be added. This is often accomplished by using extra heaters that are turned on only in heat-up situations.

4. Hazardous Area Design Criteria. Heaters installed in hazardous (explosion hazard) areas must have sheath temperatures that do not exceed the ignition temperature of the hazardous gas or dust that is present. The method of limiting this temperature varies with different types of products:

Self-regulating heaters (Limitrace Product Family) may be used based on their maximum "T Rating." Under no conditions will they exceed those temperatures.

Constant wattage heaters (Nelcon Product Family) series mineral insulated heaters (Nelex Product Families) and VH tank heaters, must be designed not to exceed the ignition temperature. For Division 2 areas, this is achieved by limiting the watt density design so the heater's sheath temperature will not exceed the required temperature.

Each heater installed in a hazardous area should have a metal shield or sheath. This provides an effective return ground path as well as providing added physical protection.

All connections and control equipment should meet the criteria for hazardous area application. For Division 1 applications, please consult the factory.

5. Non-Metallic Surfaces: Non metallic pipes and vessels often have low softening and melting points. Care must be taken in design not to let the surface or heater reach that temperature.

LT series cables can be used safely without concern. Other cables must use the following precautions:

A. Use thermal overlimit protection
B. Use metal foil tape over and under (sandwiching) the heater cable
C. Limit wattage design so cable sheath temperature will not reach the pipe softening point.

6. Designing Self-Regulating Heater Cables For Plastic Pipe. Plastic pipe is not thermally conductive. Although the self-regulating heater cable will itself get hotter in relation to a given pipe temperature, less heat is transferred to plastic pipe than metal pipe. Use Table 8 to determine the correct output of self-regulating heater cable when used on plastic pipe.

There are three methods of applying heater cable to plastic pipe:

A. Regular attachment at one foot intervals-Attachment of cable at one foot intervals with no heat sinking.

B. Foil over the cable-Fasten the cable at one-foot intervals (as above) and then cover with a layer of adhesive backed foil tape.

C. Foil Over/Under (sandwiched) cable -Put a layer of adhesive-backed foil tape on the pipe. Fasten the cable over the foil tape per (A) above. Then put another layer of foil tape over the cable.

7. Use of Metal Foil Tape to Lower Sheath Temperature on Metal Pipe. Metal foil tape can be used on all types of heaters to lower sheath temperature. This should only be done to improve life expectancy DO NOT USE THIS TECHNIQUE TO LOWER SHEATH TEMPERATURES FOR HAZARDOUS APPLICATIONS.

8. Temperature "Piling" in Vertical Installations. Heated air and fluid rises. In a vertical piping run, you can expect to see a 1.5 to 3.0 degree F rise per vertical foot of pipe. Temperature control locations and circuit breakup should be used to overcome this temperature control problem.

9. Static vs. Flowing Pipe Fluid Conditions. Heat tracing is needed during stagnant conditions. It is very difficult to freeze or overheat a pipe while product is flowing through it. Most design concerns should center around static situations. For heating of fluids in flowing pipes, consult the factory.

10. Proper Termination and Sealing of Cable Terminations. Cable ends, splices, etc must be properly sealed to prevent moisture entry. Condensation in junction boxes and rain water leaks in insulation lagging are common moisture sources. Moisture is a primary source of electrical arc failure in heating cable.

11. Foamed/Poured Insulation. When heating cables are to be insulated with foamed, mudded, or poured insulation, the cable should be covered by foil. This is to prevent the cable from being thermally isolated from the pipe. If thermally isolated the cable will not get sufficient heat to the pipe.

12. Wet Insulation/No Insulation. Dry, adequate insulation is a necessity for a pipe heating application. Heat losses are 20 to 50 times greater on wet or uninsulated systems. Water leaks (around valves, hangers and lagging lap joints) will soak insulation. The heating cable cannot maintain temperatures with wet insulations. Wet insulation will also accelerate corrosion. Once insulation becomes wet, the heating cable will not provide sufficient heat to dry it.

13. Annual System Check-Out. Check your heating system before each freeze season. Process maintenance systems should be on year-round. However, some of the lower maintenance products will not develop a wet insulation “Freeze up” until ambient temperatures drop. A system check should verify that all cables are working. Check and repair insulation waterproofing, spot check temperature control function, and whatever else is appropriate to your situation.

Article 427-22 of the National Electrical Code requires ground-fault equipment protection for each branch circuit supplying electric heating equipment. Exceptions to this requirement can be found in the 1999 National Electrical Code.

SELF-REGULATING HEATER CABLE OUTPUT ON PLASTIC PIPE

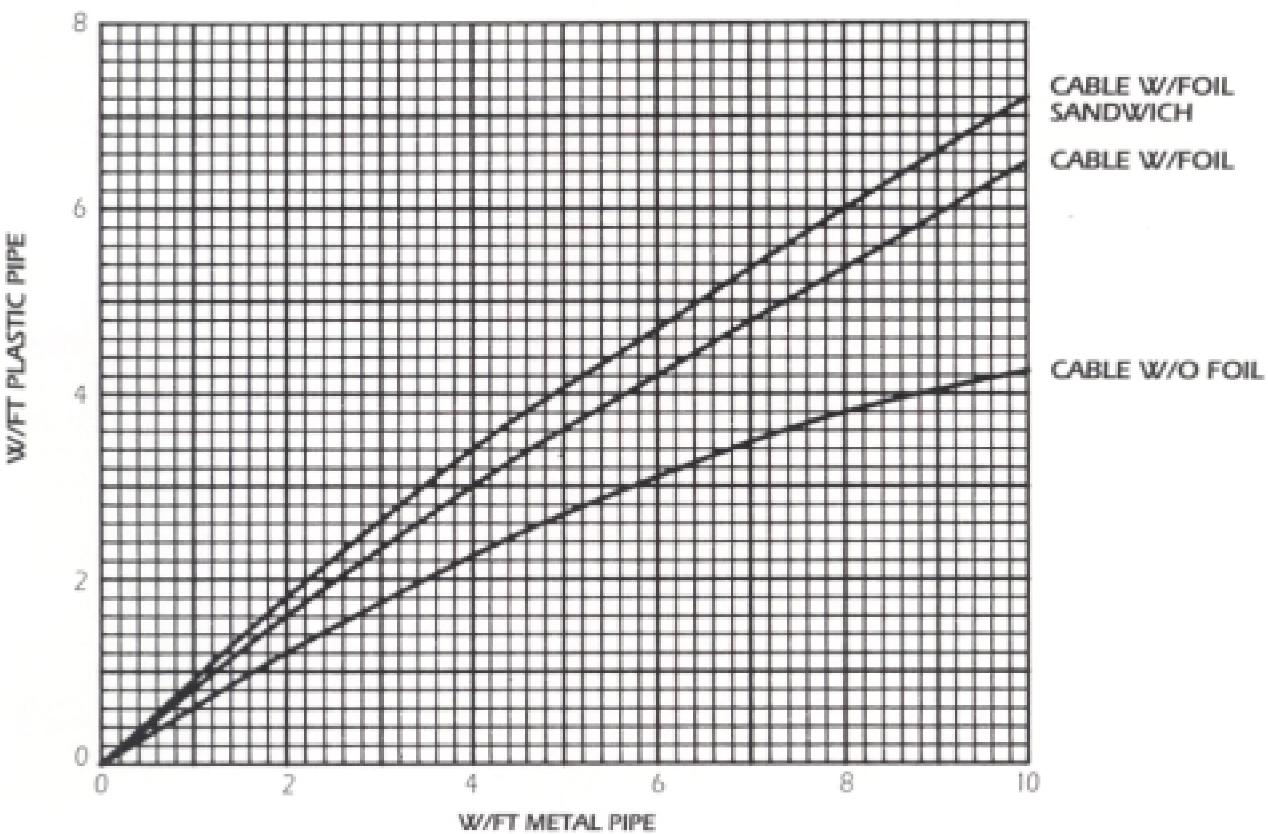
Power output of a self-regulating heater cable is dependent on its thermal coupling to the pipe. Since all published power output data is calculated with the product on metal pipe, power output must be de-rated for use on plastic pipe because of its lower thermal coupling.

To do this, begin with the required watts/foot value (heat loss) on the vertical axes (W/FT Plastic Pipe) in Table 8. Read across to the curve denoting installation method being used. Read down from this point and find the value on the horizontal axis (W/FT Metal Pipe). This would be the power output if the cable was installed on metal pipe, and is the proper value to use in selecting cable

There are three recommended ways to install self-regulating heater cable on plastic pipe-without foil, with foil and in a foil sandwich. Each has a different thermal coupling rating between the heater cable and the pipe.

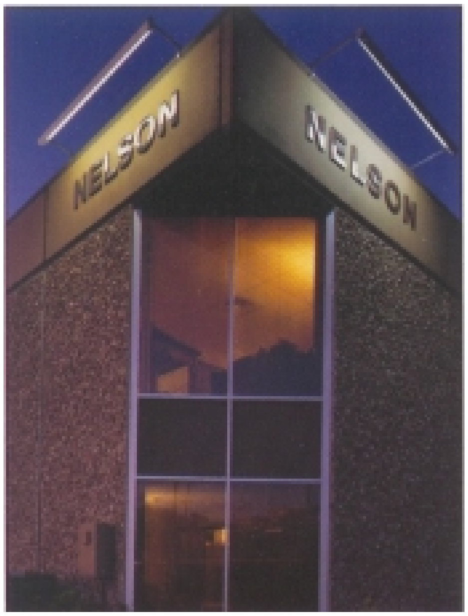
TABLE 8

SELF LIMITING HEATER CABLE OUTPUT ON PLASTIC PIPE



NOTES:
1. Locate wattage required for plastic pipe on vertical axis of graph.
2. Locate type of installation curve desired.
3. Read horizontal axis to determine correct cable selection

NOTES



Nelson:

Nelson is leading the way as the only manufacturer offering a complete line of quality heat trace products - Limitrace® self-regulating heating cable, Nelcon® parallel resistance heating cable, Nelex® mineral-insulated heating cable and the CM- 1 and CM 2 systems.

Should you have questions regarding the applicability of heat trace systems and products in your environment, Nelson also offers complete engineering and design services for technical assistance and specific custom installation.

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