The total approach

SERGE BARIL

HEAT TRACING

FOR PIPES AND VESSELS

For industrial and commercial markets.

DESIGN GUIDE

A complete range of heat tracing cables,
design, and technical support
for all your project needs.

INTRODUCTION

This design guide provides simple instructions for the thermal design and selection of the proper Serge Baril heat trace products for your 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 the heat lost through the thermal insulation from the equipment in the system. In some applications, heat tracing will also be able to provide enough heat to significantly change the process temperature.

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

SERGE BARIL Heating Cable Products

Serge Baril supplies several distinctively different types of electric heaters - Self-regulating CCA, FPS and SCS families, MIC mineral insulated heaters and TH 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.

SERGE BARIL Self-Regulating Heater Cable

Serge Baril Self-Regulating Heater Cable will adjust its own output in response to the pipe temperature. Available in a variety of temperature and power ratings up to 375°F (190°C) and 20 W/ft (66 W/m). Product features include:

▪ **VARIABLE OUTPUT** The heater 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.

TABLE 1

PIPE HEAT LOSS (W/ft - W/m)

Insulation	ΔT		IPS	1/2	12	3/4	18	1	25	1 1/4	32	1 1/2	38	2	50	2 1/2	63
Thickness	°F	°C	Tubing	3/4	18	1	25	1 1/4	32	1 1/2	38	2	50				
1.0 in.	10	5		0.3	0.9	0.4	1.2	0.4	1.2	5.0	14.8	0.6	1.8	0.7	2.1	0.8	2.4
(25 mm)	50	25		1.7	5.0	1.9	5.6	2.2	6.5	2.5	7.4	2.8	8.3	3.3	9.7	3.8	11.2
	100	50		3.5	10.3	3.9	11.5	4.5	13.3	5.3	15.6	5.8	17.1	6.8	20.1	7.9	23.3
	150	75		5.4	15.9	6.2	18.3	7.1	21.0	8.3	24.5	9.1	26.9	10.7	31.6	12.4	36.6
	200	100		7.5	22.1	8.6	25.4	9.9	29.2	11.5	33.9	12.6	37.2	14.9	44.0	17.2	50.8
	250	125		9.8	28.9	11.2	33.1	12.8	37.8	15.0	44.3	16.5	48.7	19.4	57.3	22.4	66.1
1.5 in.	10	5		0.3	0.9	0.3	0.9	0.4	1.2	0.4	1.2	0.4	1.2	0.5	1.5	0.6	1.8
(38 mm)	50	25		1.3	3.8	1.5	4.4	1.7	5.0	1.9	5.6	2.1	6.2	2.5	7.4	2.8	8.3
	100	50		2.8	8.3	3.1	9.2	3.5	10.3	4.1	12.1	4.4	13.0	5.1	15.1	5.9	17.4
	150	75		4.4	13.0	4.9	14.5	5.5	16.2	6.4	18.9	6.9	20.4	8.1	23.9	9.2	27.2
	200	100		6.1	18.0	6.8	20.1	7.7	22.7	8.9	26.3	9.7	28.6	11.2	33.1	12.8	37.8
	250	125		7.9	23.3	8.9	26.3	10.0	29.5	11.6	34.2	12.6	37.2	14.6	43.1	16.7	49.3
2.0 in.	10	5		0.2	0.6	0.3	0.9	0.3	0.9	0.4	1.2	0.4	1.2	0.4	1.2	0.5	1.5
(50 mm)	50	25		1.2	3.5	1.3	3.8	1.4	4.1	1.6	4.7	1.8	5.3	2.0	5.9	2.3	6.8
	100	50		2.4	7.1	2.7	8.0	3.0	8.9	3.4	10.0	3.7	10.9	4.3	12.7	4.8	14.2
	150	75		3.8	11.2	4.2	12.4	4.7	13.9	5.4	15.9	5.8	17.1	6.7	19.8	7.6	22.4
	200	100		5.3	15.6	5.9	17.4	6.6	19.5	7.5	22.1	8.1	23.9	9.3	27.5	10.5	31.0
	250	125		6.9	20.4	7.7	22.7	8.6	25.4	9.8	28.9	10.6	31.3	12.1	35.7	13.7	40.4
2.5 in.	10	5		0.2	0.6	0.2	0.6	0.3	0.9	0.3	0.9	0.3	0.9	0.4	1.2	0.4	1.2
(63 mm)	50	25		1.0	3.0	1.2	3.5	1.3	3.8	1.4	4.1	1.6	4.7	1.8	5.3	2.0	5.9
	100	50		2.2	6.5	2.4	7.1	2.7	8.0	3.0	8.9	3.3	9.7	3.7	10.9	4.2	12.4
	150	75		3.4	10.0	3.8	11.2	4.2	12.4	4.8	14.2	5.1	15.1	5.8	17.1	6.6	19.5
	200	100		4.8	14.2	5.3	15.6	5.9	17.4	6.6	19.5	7.1	21.0	8.1	23.9	9.1	26.9
	250	125		6.2	18.3	6.9	6.1	7.6	22.4	8.6	25.4	9.3	27.5	10.6	31.3	11.9	35.1
3.0 in.	10	5		0.2	0.6	0.2	0.6	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.4	1.2
(75 mm)	50	25		1.0	3.0	1.1	3.2	1.2	3.5	1.3	3.8	1.4	4.1	1.6	4.7	1.8	5.3
	100	50		2.0	5.9	2.2	6.5	2.5	7.4	2.8	8.3	3.0	8.9	3.4	10.0	3.7	10.9
	150	75		3.2	9.4	3.5	10.3	3.9	11.5	4.3	12.7	4.6	13.6	5.3	15.6	5.9	17.4
	200	100		4.4	13.0	4.9	14.5	5.4	15.9	6.0	17.7	6.5	19.2	6.7	19.8	8.2	24.2
	250	125		5.8	17.1	6.3	18.6	7.0	20.7	7.8	23.0	8.4	24.8	9.5	28.0	10.6	31.3

- **CAN BE OVERLAPPED WITHOUT DAMAGE**

Because the heater controls its own output, overlapped sections produce less heat, eliminating "hot spots" and possible burn-through which is common with other types of cable.

- **FAIL-SAFE** Upon reaching the upper limits of its temperature range, the heater diminishes its 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, it can be cut to any length in the field without affecting the heat output or creating "dead zones".

MIC Mineral Insulated Heater Cable

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

- **CORROSION-RESISTANT** The incoloy 825 sheath provides excellent corrosion resistance and immunity from chloride stress corrosion - a common problem with stainless steel.

- **IDEAL FOR HIGH TEMPERATURE APPLICATIONS** MIC can withstand exposure temperatures up to 1100°F (593°C). Exposure temperatures can be increased to 1400°F (760°C) with special components.

- **RATINGS TO 600V** MIC is available in a variety of voltages to match the available power supply.

- **HIGH HEAT OUTPUT** MIC 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 a thin wall cable construction for easier field installation. This allows the heater to be overlapped up to 25 W/ft (82 W/m).

TH Tank Heating Panels

- **LOW INSTALLATION COST** Flexible silicone construction allows the panel to conform to the tank wall. No bonding or heat transfer aids are required.

- **HIGH TEMPERATURE** TH Tank Heating Panels maintain temperatures up to 175°F (79°C) and can withstand exposure to 500°F (260°C).

- **RATINGS TO 240 VOLTS** Standard panels are available from 120 volts.

- **POWER OUTPUT TO 2000 WATTS** Standard panels are available from 500 watts.

3	75	4	100	6	150	8	200	10	250	12	300	14	350	16	400	18	450	20	500	24	600
0.9	2.7	1.1	3.2	1.5	4.4	1.9	5.6	2.4	7.1	2.7	8.0	3.0	8.9	3.4	10.0	3.8	11.2	4.2	12.4	5.0	14.8
4.4	13.0	5.4	15.9	7.5	22.1	9.5	28.0	11.5	33.9	13.5	39.9	14.7	43.4	16.7	49.3	18.6	54.9	20.5	60.5	24.4	72.0
9.2	27.2	11.3	33.4	15.7	46.3	19.8	58.4	24.2	71.4	28.2	83.2	30.8	90.9	34.9	103.0	38.9	114.8	43.0	126.9	51.1	150.8
14.4	42.5	17.6	52.0	24.6	72.6	31.0	91.5	37.8	111.6	44.2	130.5	48.3	142.6	54.6	161.2	61.0	180.1	67.3	198.7	80.0	236.2
20.0	59.0	24.5	72.3	34.2	101.0	43.2	127.5	52.6	155.3	61.5	181.5	67.1	198.1	75.9	224.1	84.7	250.0	93.6	276.3	111.2	328.3
26.0	76.8	31.9	94.2	44.6	131.7	56.1	165.6	68.4	201.9	80.0	236.2	87.3	257.7	98.7	291.4	110.2	325.3	121.7	359.3	144.6	426.9
0.7	2.1	0.8	2.4	1.1	3.2	1.4	4.1	1.6	4.7	1.9	5.6	2.1	6.2	2.4	7.1	2.6	7.7	2.9	8.6	3.4	10.0
3.2	9.4	3.9	11.5	5.3	15.6	6.7	19.8	8.1	23.9	9.4	27.7	10.2	30.1	11.5	33.9	12.8	37.8	14.2	41.9	16.8	49.6
6.8	20.1	8.2	24.2	11.2	33.1	14.0	41.3	16.9	49.9	19.7	58.2	21.4	63.2	24.2	71.4	26.9	79.4	29.6	87.4	35.1	103.6
10.6	31.3	12.8	37.8	17.6	52.0	21.9	64.6	26.5	78.2	30.8	90.9	33.6	99.2	37.9	111.9	42.2	124.6	46.5	137.3	55.0	162.4
14.7	43.4	17.8	52.5	24.4	72.0	30.5	90.0	36.9	108.9	42.9	126.6	46.7	137.9	52.7	155.6	58.6	173.0	64.6	190.7	76.5	225.8
19.2	56.7	23.2	68.5	31.8	93.9	39.6	116.9	48.0	141.7	55.8	164.7	60.7	179.2	68.5	202.2	76.3	225.2	84.1	248.3	99.6	294.0
0.5	1.5	0.6	1.8	0.9	2.7	1.1	3.2	1.3	3.8	1.5	4.4	1.6	4.7	1.8	5.3	2.0	5.9	2.2	6.5	2.6	7.7
2.6	7.7	3.1	9.2	4.2	12.4	5.2	15.4	6.3	18.6	7.3	21.5	7.9	23.3	9.0	26.6	9.9	29.2	10.9	32.2	12.9	38.1
5.5	16.2	6.6	19.5	8.9	26.3	11.0	32.5	13.2	39.0	15.3	45.2	16.6	49.0	18.7	55.2	20.8	61.4	22.8	67.3	27.0	79.7
8.6	25.4	10.3	30.4	13.9	41.0	17.2	50.8	20.7	61.1	24.0	70.8	26.1	77.0	29.3	86.5	32.6	96.2	35.8	105.7	42.3	124.9
12.0	35.4	14.4	42.5	19.4	57.3	24.0	70.8	28.8	85.0	33.4	98.6	36.3	107.2	40.8	120.4	45.3	133.7	49.8	147.0	58.8	173.6
15.6	46.1	18.7	55.2	25.3	74.7	31.2	92.1	37.5	110.7	43.5	128.4	47.2	139.3	53.1	156.8	59.0	174.2	64.9	191.6	76.6	226.1
0.5	1.5	0.5	1.5	0.7	2.1	0.9	2.7	1.1	3.2	1.2	3.5	1.3	3.8	1.5	4.4	1.7	5.0	1.8	5.3	2.1	6.2
2.3	6.8	2.7	8.0	3.6	10.6	4.4	13.0	5.2	15.4	6.0	17.7	6.6	19.5	7.3	21.5	8.1	23.9	8.9	26.3	10.5	31.0
4.7	13.9	5.6	16.5	7.5	22.1	9.2	27.2	11.0	32.5	12.7	37.5	13.7	40.4	15.4	45.5	17.1	50.5	18.7	55.2	22.1	65.2
7.4	21.8	8.8	26.0	11.7	34.5	14.4	42.5	17.2	50.8	19.9	58.7	21.5	63.5	24.1	71.1	26.8	79.1	29.4	86.8	34.6	102.1
10.3	30.4	12.3	36.3	16.3	48.1	20.0	59.0	24.0	70.8	27.6	81.5	29.9	88.3	33.6	99.2	37.2	109.8	40.9	120.7	48.1	142.0
13.5	39.9	16.0	47.2	21.3	62.9	26.1	77.0	31.2	92.1	36.0	106.3	39.0	115.1	43.7	129.0	48.5	143.2	53.2	157.0	62.6	184.8
0.4	1.2	0.5	1.5	0.6	1.8	0.8	2.4	0.9	2.7	1.1	3.2	1.1	3.2	1.3	3.8	1.4	4.1	1.6	4.7	1.8	5.3
2.0	5.9	2.4	7.1	3.1	9.2	3.8	11.2	4.5	13.3	5.2	15.4	5.6	16.5	6.3	18.6	7.0	20.7	7.6	22.4	8.9	26.3
4.2	12.4	5.0	14.8	6.5	19.2	8.0	23.6	9.5	28.0	10.9	32.2	11.8	34.8	13.2	39.0	14.6	43.1	16.0	47.2	18.8	55.5
6.6	19.5	7.8	23.0	10.3	30.4	12.5	36.9	14.9	44.0	17.1	50.5	18.5	54.6	20.7	61.1	22.9	67.6	25.0	73.8	29.4	86.8
9.2	27.2	10.8	31.9	14.3	42.2	17.4	51.4	20.7	61.1	23.8	70.3	25.7	75.9	28.7	84.7	31.8	93.9	34.8	102.7	40.9	120.7
12.0	35.4	14.1	41.6	18.6	54.9	22.6	66.7	26.9	79.4	30.9	91.2	33.5	98.9	37.4	110.4	41.4	122.2	45.4	134.0	53.3	157.3

A THERMAL DESIGN-PIPES

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 pipe size. For non-rigid insulation, only the use of braided product without overjackets allows standard sizing for pipes greater than 3 inch (75 mm) diameter. The use of all other cables requires oversizing. As an example, you would use 2 inch (50 mm) pipe diameter heat losses for 1-1/2 inch (38 mm) pipe heating application. Heat loss figures from Table 1 include a 10% safety factor.

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 a 20 m.p.h. (8.94 m/s) wind. If the piping is used indoors, multiply the 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 length 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 (meter) of pipe may be increased by spiraling the heater along the pipe. Use Table 4 to determine the spiral pitch factor.

TABLE 2

INSULATION FACTORS

Preformed Pipe Insulation	Insulation (f)	Based on K factor @50° F (10°C) mean temp (BTU/hr-°F ft²/in.)	(W/m°C)
Glass Fiber	1.00	.250	.036
Calcium Silicate	1.50	.375	.054
Cellular Glass	1.60	.400	.058
Rigid Urethane	0.66	.165	.024
Foamed Elastomer	1.16	.290	.042
Mineral Fiber	1.20	.300	.043
Expanded Perlite	1.50	.375	.054
Mineral Wool	1.04	.260	.038
Polystyrene	1.04	.260	.038
Flexible Elastomer	1.16	.290	.042
Polyisocyanarate	0.68	.170	.025

Example

- Water line to be maintained at 50°F (10°C)
- Minimum ambient temperature is -10°F (-23°C)
- Pipe is 3 inch (75 mm) diameter steel
- Insulation is 1 inch (25 mm) mineral fiber

1. Calculate Temperature Differential

$\Delta T = T_F - T_A$

$\Delta T = 50-(-10)°F$ $\Delta T = 10-(-23)°C$

$\Delta T = 60°F$ $\Delta T = 33°C$

2. Heat Loss

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

From table 1:

@ΔT of 100°F Q=9.2 W/ft

QF=[4.4 + 10/50 X (9.2 - 4.4)] W/ft

QF=4.4 + .96 = 5.4 W/ft

@ΔT of 50°C Q=27.2 W/m

QF= [13 + 8/25 (27.2-13)] W/m

QF= 13 + 4.54= 17.54 W/m

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

QM = QF X 1.2

QM = 17.54W/m X 1.2

QM = 21W/m

Since the piping is outdoors, no adjustment is necessary for the absence of wind.

TABLE 3

HEAT LOSS ADDER

Pipe Size		Pipe Fitting Type									
		Flange Pair		Vent & Drain		Pipe Support		Gate Valve		Globe, Ball & Butterfly Valve	
inch	mm	ft	m	ft	m	ft	m	ft	m	ft	m
.50	12	.3	.1	1.0	.3	1.0	.3	1.0	.3	1.0	.3
.75	18	.3	.1	1.0	.3	1.5	.5	1.5	.5	1.0	.3
1.00	25	.3	.1	1.0	.3	1.5	.5	2.0	.6	1.0	.3
1.50	38	.3	.1	1.0	.3	2.0	.6	2.5	.8	1.5	.5
2.00	50	.3	.1	1.0	.3	2.0	.6	2.5	.8	2.0	.6
3.00	75	.3	.1	1.0	.3	2.0	.6	3.0	.9	2.5	.8
4.00	100	.5	.15	1.0	.3	2.5	.8	4.0	1.2	3.0	.9
6.00	150	.8	.24	1.0	.3	2.5	.8	5.0	1.5	3.5	1.1
8.00	200	.8	.24	1.0	.3	2.5	.8	7.0	2.1	4.0	1.2
10.00	250	.8	.24	1.0	.3	3.0	.9	8.0	2.4	4.5	1.4
12.00	300	.8	.24	1.0	.3	3.0	.9	9.0	2.7	5.0	1.5
14.00	350	1.0	.3	1.0	.3	3.0	.9	10.0	3.0	5.5	1.7
16.00	400	1.0	.3	1.0	.3	3.5	1.1	11.0	3.4	6.0	1.8
18.00	450	1.0	.3	1.0	.3	3.5	1.1	12.0	3.7	7.0	2.1
20.00	500	1.0	.3	1.0	.3	3.5	1.1	13.0	4.0	7.5	2.3
24.00	600	1.0	.3	1.0	.3	4.0	1.2	15.0	4.6	8.0	2.4

Nominal pipe length in feet (meters). 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. For a flanged valve adder choose valve type then add one flange pair for total adder length.

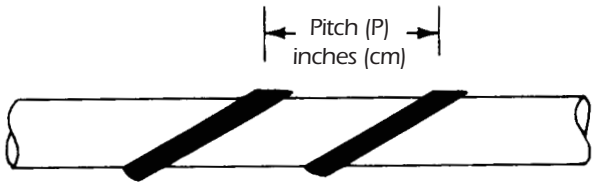


TABLE 4

SPIRAL PITCH

Pipe Size IPS		Ratio of feet (meters) of cable per foot (meter) of pipe															
		1.1		1.2		1.3		1.4		1.5		1.6		1.7		1.8	
inch	mm	inch	cm	inch	cm	inch	cm	inch	cm	inch	cm	inch	cm	inch	cm	inch	cm
1	25	9	23	6	15	5	13	4	10	4	10	3	8	3	8	3	8
1 1/4	32	11	28	8	20	6	15	5	13	5	13	4	10	4	10	3	8
1 1/2	38	13	33	9	23	7	18	6	15	5	13	5	13	4	10	4	10
2	50	16	41	11	28	9	23	7	18	6	15	6	15	5	13	5	13
2 1/2	64	20	51	14	36	11	28	9	23	8	20	7	18	6	15	6	15
3	75	24	61	17	43	13	33	11	28	10	25	9	23	8	20	7	18
4	100	31	79	21	53	17	43	14	36	13	33	11	28	10	25	9	23
6	150	45	114	31	79	25	64	21	53	18	46	17	43	15	38	14	36
8	200	59	150	41	104	32	81	27	69	24	61	22	56	20	51	18	46
10	250	74	188	51	130	41	104	34	86	30	76	27	69	25	64	23	58
12	300	87	221	60	152	48	122	41	104	36	91	32	81	30	76	27	69
14	350	96	244	66	168	53	135	45	114	39	99	35	89	32	81	29	74
16	400	110	279	76	193	61	155	51	130	45	114	40	102	37	94	34	86
18	450	123	312	89	226	68	173	58	147	51	130	45	114	41	104	38	97
20	500	137	348	95	241	76	193	64	163	56	142	50	127	46	117	42	107
24	600	164	417	114	290	91	231	77	196	67	170	60	152	55	140	50	127

Example : For 3 inch (75 mm) pipe, with 1.3 (ft or m) of heater per foot or meter of pipe, P= 13 inches (33 cm).

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 W/ft² (W/m²). Multiply this value by the total surface area calculated in step 2 to determine the total vessel heat loss.

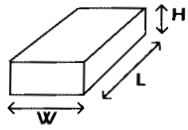
4. Adjustments To Heat Loss Values

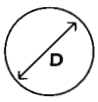
The heat losses in Table 5 are based on glass fiber insulation. If an other insulation is used, multiply the heat loss value by the correction factor (shown in Table 2) for your insulation. Heat losses are based on outdoor applications with a 20 m.p.h. (8.94 m/s) wind. If the vessel is located indoors, multiply the heat loss values by 0.9. Heat losses are based on a 10% safety factor.

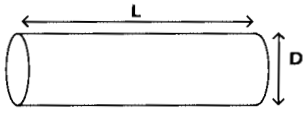
5. Adders For Heat Sinks

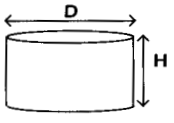
Any non-insulated thermally conductive item that protrudes through the insulation will require extra heat to be applied. Use Table 6 to determine the additional amount of heat to apply for various heat sinks. Add these totals to the heat loss calculated in Section 4.

VESSEL TYPE	EQUATION FOR SURFACE AREA
Rectangle	$2(WxL + WxH + LxH)$
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)









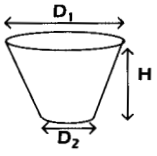


TABLE 5

VESSEL HEAT LOSS (W/ft² - W/m²)

INSULATION THICKNESS Delta T °F	°C	1"	25 mm	1 1/2"	38 mm	2"	50 mm	3"	75 mm
50	25	3.8	36.8	2.5	24.2	1.9	18.4	1.3	12.6
100	50	7.9	76.5	5.3	51.3	4.0	38.7	2.7	26.1
150	75	12.3	119.1	8.3	80.4	6.2	60.0	4.2	40.7
200	100	17.1	165.6	11.5	111.4	8.7	84.2	5.8	56.2
250	125	22.3	215.9	15.0	145.2	11.3	109.4	7.6	73.6
300	150	27.9	270.2	18.7	181.1	14.1	136.5	9.4	91.0

Example

- Tank fluid is to be maintained at 160°F (71°C)
- Minimum ambient temperature is 10°F (-12°C)
- Tank is round with flat ends, resting on a concrete pad
  Height= 10 ft (3 m)
  Diameter= 8 ft (2.44 m)
- Insulation is 2" (50 mm) calcium silicate

1. Calculate temperature differential.

$\Delta T = T_F - T_A$

$\Delta T = 160 - 10 = 150°F$ $\Delta T = 71 - (-12) = 83°C$

2.Determine surface heat loss from Table 5.

The base heat loss is 6.2 W/ft² (67 W/m²) with glass fiber insulation.
For the metric example because the desired temperature differential falls between two values, use interpolation as follows:
From table 5:

@ ΔT of 100°C Q = 84.2 W/m²
QF = 60 W/m² + 8/25 (84.2-60) W/m²
QF = 60+7.74 = 67.74 W/m²

Adjust the heat loss for calcium silicate: from table 2 the adjustment factor is 1.5:
QC = QF x 1.5
QC = 6.2 W/ft² x 1.5 = 9.3 W/ft² QC = 67.74 W/m² x 1.5 = 101.6 W/m²

3.Determine tank surface area.

Sides:	$\pi DL = (\pi)(8)(10) =$	251.3 ft²
Top:	$\pi D^2/4 = (\pi)(8^2)/4 =$	50.3 ft²
Bottom:	$\pi D^2/4 = (\pi)(8^2)/4 =$	50.3 ft²
		351.9 ft²
Sides:	$\pi(2.44)(3) =$	22.98 m²
Top:	$\pi(2.44^2)/4 =$	4.67 m²
Bottom:	$\pi(2.44^2)/4 =$	4.67 m²
		32.32 m²

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 T_F -13°C = 71-13 = 58°C

0.035 x 105 = 3.7 W/ft² 0.68 x 58 = 39.4 W/m²

5. Calculate total tank heat loss.

Sides:	251.3 ft² x 9.3 W/ft² =	2337 watts
Top:	50.3 ft² x 9.3 W/ft² =	468 watts
Bottom:	50.3 ft² x 3.7 W/ft² =	186 watts
		2991 watts
Sides:	22.98 m² x 101.6 W/m² =	2334 watts
Top:	4.67 m² x 101.6 W/m² =	474 watts
Bottom:	4.67 m² x 39.4 W/m² =	184 watts
		2992 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 Add 1.5 watts per degree temperature differential (°C) for each leg
Saddle Support	Add 7.6 watts per degree temperature differential (°F) for each support Add 13.7 watts per degree temperature differential (°C) for each support
Concrete Pad	Calculate the heat loss from the tank bottom separate from the insulated tank. Use 0.035 W/ft² (0.68 W/m²) per degree temperature difference (°F/°C) between fluid temperature (T_F) and 55°F (13°C) ground temperature
24" Manway	Add 3.1 watts per degree temperature differential (°F) for each opening Add 5.6 watts per degree temperature differential (°C) for each opening
36" Manway	Add 7.1 watts per degree temperature differential (°F) for each opening Add 12.8 watts per degree temperature differential (°C) for each opening

SERGE BARIL: The Total Approach

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.

Serge Baril'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 self regulating 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 temperature. 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 the power distribution and installation costs.

5. Area Classification

The heater type and construction vary with the area classification. Serge Baril 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. Serge Baril MI cable products are manufactured with high temperature alloy conductors and a thin, high temperature Incoloy 825 sheath. They can be overlapped up to 25W/ft (84W/m) 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. TH Tank Heaters are specifically designed for vessels. Because they are flexible, they conform to the vessel wall and are easily installed.

When using heat tracing cable, the highest wattage cable available is to be used to limit the total length of heater, thus reducing costs. Because the vessel may not be totally full, it is appropriate to trace the bottom third.

HEATER SELECTION

CCA (Commercial Construction Applications)

The CCA self-regulating family of heaters is for use on pipes or vessels in ordinary non-hazardous, non-corrosive areas.

HEATER SELECTION-CATALOG NUMBER

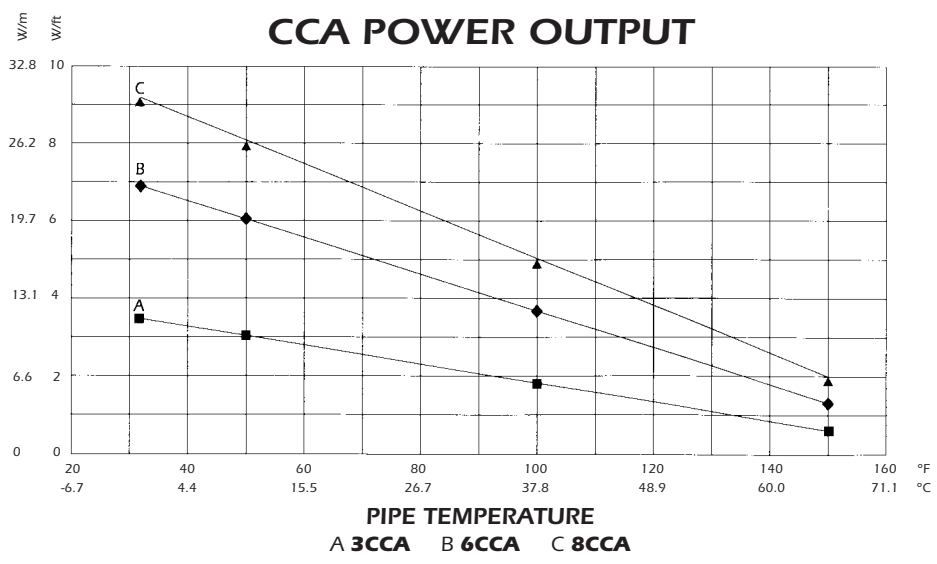
X — **CCA - X** — **XX**

CCA - X: family of products

3 watts/ft at
6 50°F (10°C)
8 on metal pipe

XX:
B copper braid ex: 3CCA-1B
BA copper braid and protective overjacket ex: 3CCA-1BA

CCA - X:
1 =120 VAC
2 =208 / 220 / 240 / 277 VAC



Maximum maintain temperature: 150°F (65°C)

Maximum exposure temperature: ▪ Energized 150°F (65°C) ▪ Intermittent power off 185°F (85°C)

Typical applications (For other than pipe or vessel tracing, see the appropriate application sheet)

Heater with copper braid (non-corrosive areas)
- Pipe freeze protection
- Tank freeze protection
- Maintain temperature on product pipelines
- Sprinkler freeze protection
- Hot water systems

Heater with copper braid and protective overjacket
- Same as with braid, plus
- Drains, roofs & gutters
- Comfort and space heating

Circuit breaker selection: The circuit breaker is sized based on the maximum length (feet or meters) of cable that may be connected at the specific start-up temperature. The maximum heater segment is the longest length of heater allowable between the power connection point and the end seal. More than one segment may be connected to a single breaker as long as the maximum heater length per breaker size is not exceeded.

Heater	Start-up temp.		Max. Length Vs. Circuit Breaker Size															
			120V								240V							
			15A		20A		30A		40A		15A		20A		30A		40A	
	°F	°C	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
3CCA	40	4	286*	87.2*	382*	116.5*	573*	174.7*	764*	232.9*	573*	174.7*	764*	232.9*	1146*	349.4*	1528*	465.8*
Max. segment length	-4	-20	190	58.0	254*	77.4*	381*	116.2*	508*	154.9*	381	116.2	508	154.9	762*	232.3*	1016*	309.7*
120V=221 ft / 67.3 m	-22	-30	165	50.3	220	67.1	330*	100.6*	440*	134.1*	330	100.6	440	134.1	660*	201.2*	881*	268.6*
240V=533 ft / 162.5 m	-40	-40	145	44.2	193	58.8	289*	88.1*	385*	117.4*	289	88.1	385	117.4	578*	176.2*	771*	235.1*
6CCA	40	4	179*	54.6*	239*	72.9*	359*	109.4*	479*	146.0*	359	109.4	479*	146.0*	718*	218.9*	957*	291.7*
Max. segment length	-4	-20	123	37.5	164	50.0	246*	75.0*	328*	100.0*	246	75.0	328	100.0	492*	150.0*	657*	200.3*
120V=165 ft / 50.3 m	-22	-30	108	32.9	144	43.9	216*	65.8*	287*	87.5*	216	65.8	287	87.5	431*	131.4*	575*	175.3*
240V=425 ft / 129.6 m	-40	-40	95	29.0	127	38.7	190*	57.9*	254*	77.4*	190	57.9	254	77.4	381	116.2	508*	154.9*
8CCA	40	4	144*	43.9*	191*	58.2*	287*	87.5*	383*	116.8*	287	87.5	383*	116.8*	574*	175.0*	766*	233.5*
Max. segment length	-4	-20	100	30.5	133	40.5	199*	60.7*	266*	81.1*	199	60.7	266	81.1	399*	121.6*	532*	162.2*
120V=142 ft / 43.3 m	-22	-30	88	26.8	117	35.7	175*	53.3*	234*	71.3*	175	58.3	234	71.3	351*	107.0*	468*	142.7*
240V=347 ft / 105.8 m	-40	-40	78	23.8	104	31.7	155*	47.3*	207*	63.1*	155	47.3	207	63.1	311	94.8	414*	126.2*

* These lengths exceed the maximum segment length and require more than one segment per breaker. For longer maximum circuit lengths under specific applications, consult the factory.

Notes: 1. Circuit Breakers are sized per article 427-4 of N.E.C.
2. When using 240 volt product at 208, 220, or 277 volts, use the circuit adjustment factors shown in the voltage adjustment table below.
3. When using 2 or more heater cables of different wattage ratings in parallel on a single circuit breaker, use the 15A column amperage, divide it by the maximum length to arrive at an amps/foot (amps/meter) figure for each cable. You can then calculate the circuit breaker sizes for these combination loads. These include the N.E.C. sizing factor in Article 427-4.

Voltage Adjustment:

Use of these products at other than rated voltages requires minor adjustments in power and maximum circuit lengths.

	ADJUSTMENT MULTIPLIER							
	208 VAC		220 VAC		277 VAC		Absolute max. segment length*	
Cable	Power	Length	Power	Length	Power	Length	ft	m
3CCA-2	.71	1.06	.81	1.03	1.34	.96	533	162.5
6CCA-2	.83	1.02	.90	1.00	1.17	1.00	425	129.6
8CCA-2	.87	.98	.92	.99	1.12	1.01	347	105.8

*For longer maximum circuit lengths under specific applications, consult the factory.

CAUTION: To minimize the danger of a wet wire fire (arcing fault) if the heating cable is damaged or improperly installed, both the Canadian and the National Electrical Code (NEC 1996) require the use of a ground fault protection device (GFPD) at all times in conjunction with the installation of heat tracers.

FPS (Freeze Protection Systems)

The FPS self-regulating family of heaters is for use on pipes in ordinary and hazardous (classified) areas, both corrosive (BT) and non-corrosive (B,BA) areas.

HEATER SELECTION-CATALOG NUMBER

X **FPS - X** **XX**

FPS - X — family of products

X
- **3** watts/ft at
- **5** 50°F (10°C)
- **8** on metal pipe
- **10**

- **1** =120 VAC
- **2** =208 / 220 / 240 / 277 VAC

XX
- **B** copper braid for non corrosive areas ex: 3FPS-1B
- **BA** modified polyolefin overjacket for aqueous solutions of inorganic chemicals (phosphate, dilute acids, chlorides, bases and carbonates). ex: 3FPS-1BA
- **BT** fluoropolymer overjacket for exposure to excessive moisture, organic chemicals, solvents, etc. ex: 3FPS-1BT

Typical applications

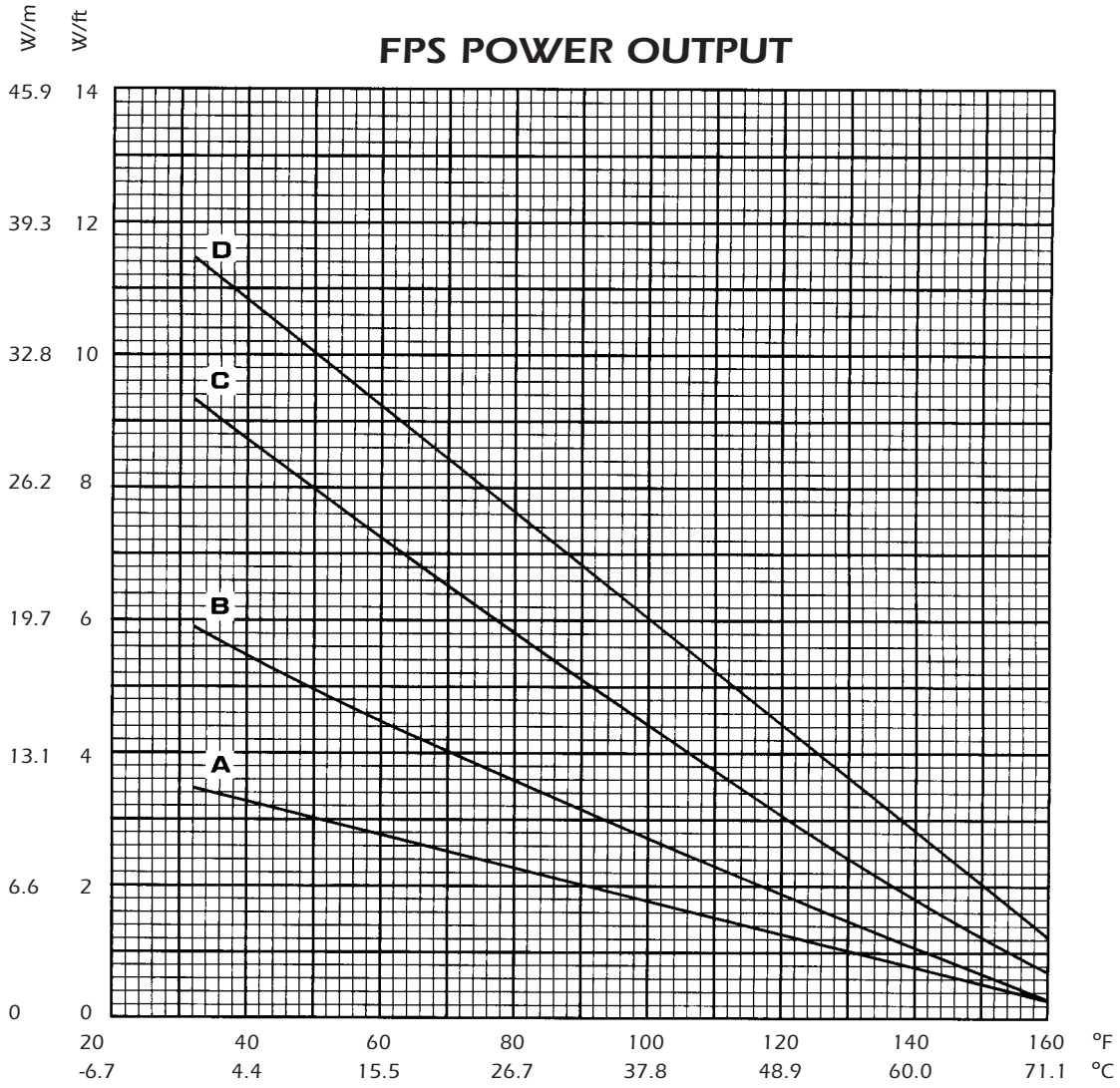
(For other than pipe or vessel tracing, see the appropriate application sheet)

Heater with copper braid (non-corrosive areas)
- Pipe freeze protection
- Tank freeze protection
- Maintain temperature on product pipelines
- Sprinkler freeze protection
- Hot water systems

Heater with copper braid and polyolefin overjacket
- Same as with copper braid

Heater with copper braid and fluoropolymer overjacket (corrosive areas)
- Same as with copper braid plus
- Drains, roofs & gutters
- Comfort and space heating

FPS POWER OUTPUT



A 3FPS **B** 5FPS **C** 8FPS **D** 10FPS

Performance and Rating Data:

T-Rating: Electrical equipment T-Rating codes define the maximum surface temperature that the equipment will reach. It is used in hazardous (classified) area applications. 3,5, and 8 FPS heaters have a T6 rating, 10 FPS has a T5 rating.

Maximum maintain temperature: 150°F (65°C)

Maximum exposure temperature:
- Energized 150°F (65°C)
- Intermittent power off 185°F (85°C)

Circuit breaker selection: The circuit breaker is sized based on the maximum length (feet or meters) of cable that may be connected at the specific start-up temperature. The maximum heater segment is the longest length of heater allowable between the power connection point and the end seal. More than one segment may be connected to a single breaker as long as the maximum heater length per breaker size is not exceeded.

Heater	Start-Up Temp.		Max. Length Vs. Circuit Breaker Size															
			120 Volt								240 Volt							
			15A		20A		30A		40A		15A		20A		30A		40A	
	°F	°C	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
3 FPS	50	10	325	99.1	433*	132.0*	650*	198.2*	866*	264.0*	650	198.2	866*	264.0*	1300*	396.3*	1732*	528.0*
Max. segment length	0	-18	230	70.1	305	93.0	460*	140.2*	610*	186.0*	460	140.2	620	189.0	920*	280.5*	1240*	378.0*
120V=325ft / 99.1m	-20	-29	205	62.5	275	83.8	410*	125.0*	550*	167.7*	410	125.0	550	167.7	820*	250.0*	1100*	335.4*
240V=650ft / 198.2m	-40	-40	175	53.4	233	71.0	350*	106.7*	466*	142.1*	350	106.7	466	142.1	700*	213.4*	932*	284.1*
5 FPS	50	10	225	68.6	300*	91.5*	460*	137.2*	600*	182.9*	460	137.2	600*	183.9*	920*	280.5*	1200*	365.9*
Max. segment length	0	-18	155	47.3	206	62.8	310*	94.5*	412*	125.6*	310	94.5	415	126.5	620*	189.0*	830*	253.0*
120V=270ft / 82.3m	-20	-29	135	41.2	180	54.9	270	82.3	360*	109.8*	275	83.8	370	112.8	550*	167.7*	740*	225.6*
240V=540ft / 164.6m	-40	-40	122	37.2	162	49.4	244	74.4	324*	98.8*	244	74.4	325	99.1	488	148.8	650*	198.2*
8 FPS	50	10	145	44.2	193	58.8	290*	88.4*	386*	117.7*	295	89.9	392	119.5	590*	179.9*	784*	239.0*
Max. segment length	0	-18	102	31.1	137	41.8	205	62.5	274*	83.5*	205	62.5	273	83.2	410	125.0	546*	166.5*
120V=210ft / 64m	-20	-29	92	28.0	123	37.5	184	56.1	246*	75.0*	184	56.1	245	74.7	368	112.2	490*	149.4*
240V=420ft / 128m	-40	-40	84	25.6	111	33.8	167	50.9	222*	67.7*	168	51.2	223	68.0	336	102.4	446*	136.0*
10 FPS	50	10	120	36.6	160	48.8	240*	73.2*	320*	97.6*	240	73.2	320	97.6	480*	146.3*	640*	195.1*
Max. segment length	0	-18	89	27.1	118	36.0	177	54.0	236*	72.0*	177	54.0	236	72.0	354	107.9	473*	144.2*
120V=180ft / 54.9m	-20	-29	80	24.4	107	32.6	160	48.8	214*	65.2*	160	48.8	214	65.2	321	97.9	428*	130.5*
240V=360ft / 109.8m	-40	-40	73	22.3	98	29.9	147	44.8	196*	59.8*	147	44.8	195	59.5	293	89.3	391*	119.2*

*These lengths exceed the maximum segment length and require more than one segment per breaker. For longer maximum circuit lengths under specific applications, consult the factory.

Notes: 1. Circuit Breakers are sized per article 427-4 of N.E.C.
2. When using 240 volt product at 208, 220, or 277 volts, use the circuit adjustment factors shown in the voltage adjustment table below.
3. When using 2 or more heater cables of different wattage ratings in parallel on a single circuit breaker, use the 15A column amperage, divide it by the maximum length to arrive at an amps/foot (amps/meter) figure for each cable. You can then calculate the circuit breaker sizes for these combination loads. These include the N.E.C. sizing factor in Article 427-4.

Voltage Adjustment:

Use of these products at other than rated voltages requires minor adjustments in power and maximum circuit lengths.

ADJUSTMENT MULTIPLIER								
Product	208 VAC		220 VAC		277 VAC		Absolute max. segment length*	
	Power	Length	Power	Length	Power	Length	ft	m
3FPS-2	.85	.98	.91	.99	1.13	1.05	650	198.2
5FPS-2	.87	.98	.92	.97	1.09	1.06	540	164.6
8FPS-2	.88	.94	.93	.95	1.08	1.08	420	128.0
10FPS-2	.89	.94	.94	.95	1.05	1.07	360	109.8

*For longer maximum circuit lengths under specific applications, consult the factory.

CAUTION: To minimize the danger of a wet wire fire (arcing fault) if the heating cable is damaged or improperly installed, both the Canadian and the National Electrical Code (NEC 1996) require the use of a ground fault protection device (GFPD) at all times in conjunction with the installation of heat tracers.

SCS (Steam Cleanable Systems)

The SCS self-regulating family of heaters is for use on pipes or vessels where steam cleanability and/or high wattages and temperatures are required.

HEATER SELECTION-CATALOG NUMBER

X **SCS - X** **XX**

3 watts/ft at
5 50°F (10°C)
8 on metal pipe
10
12
15
18
20

family of products

B copper braid for non-corrosive areas
ex: 3SCS-1B

BT fluoropolymer overjacket for exposure to excessive moisture, organic chemicals solvents, etc.
ex: 3SCS-1BT

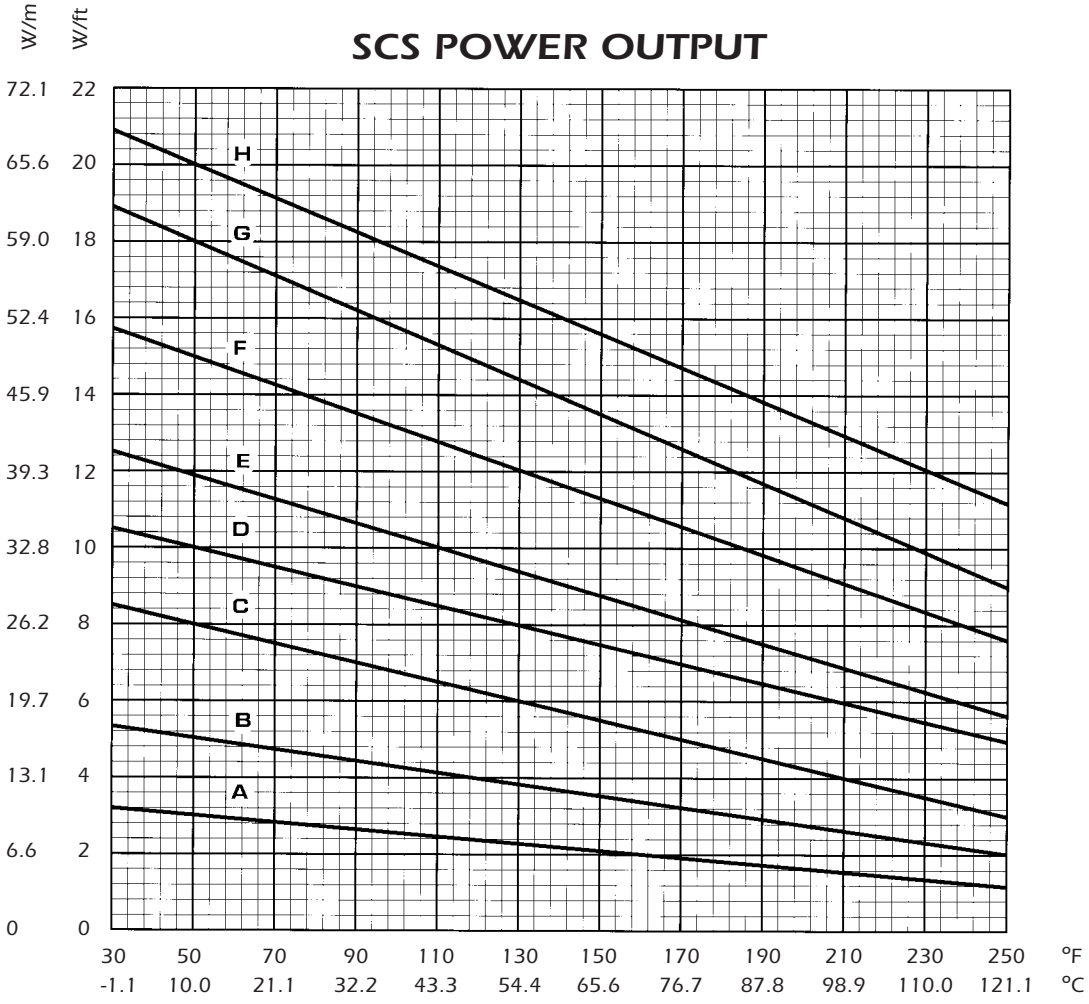
1 =120 VAC
2 =208 / 220 / 240 / 277 VAC

Typical applications

Heater with copper braid (non corrosive areas)
- Pipe freeze protection
- Tank freeze protection
- Maintain temperature on product pipelines

Heater with copper braid and fluoropolymer overjacket (corrosive areas)
- Same as with copper braid

SCS POWER OUTPUT



A 3SCS **B** 5SCS **C** 8SCS **D** 10SCS
E 12SCS **F** 15SCS **G** 18SCS **H** 20SCS

Performance and Rating Data:

T-Rating: Electrical equipment T-Rating codes define the maximum surface temperature that equipment will reach. It is used in hazardous (classified) area applications. All the SCS family of heaters has a T3 rating.

Maximum maintain temperature: 250°F (121°C)

Maximum exposure temperature:
- Energized 250°F (121°C)
- Intermittent power off 375°F (190°C)

Circuit breaker selection: The circuit breaker is sized based on the maximum length (feet or meters) of cable that may be connected. The maximum heater segment is the longest length of heater allowable between the power connection point and the end seal. More than one segment may be connected to a single breaker as long as the maximum heater length per breaker size is not exceeded.

SCS	Max. Length Vs. Circuit Breaker Size																	
	120 Volt								Max. segment length		240 Volt								Max.segment length	
	15 AMP		20 AMP		30 AMP		40 AMP				15 AMP		20 AMP		30 AMP		40 AMP			
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
3	295	89.9	395	120.4	590*	179.9*	790*	240.9*	395	120.4	585	178.4	785	239.3	1170*	356.7*	1570*	478.7*	785	239.3
5	185	56.4	245	74.7	370*	112.8*	490*	149.4*	310	94.5	385	117.4	500	152.4	770*	234.8*	1000*	304.9*	620	189.0
8	145	44.2	195	59.5	290*	88.4*	390*	118.9*	225	68.6	290	88.4	390	118.9	580*	176.8*	780*	237.8*	460	140.2
10	115	35.1	150	45.7	230*	70.1*	300*	91.5*	190	57.9	225	68.6	300	91.5	450*	137.2*	600*	182.9*	375	114.3
12	100	30.5	135	41.2	200*	61.0*	270*	82.3*	170	51.8	200	61.0	265	80.8	400*	122.0*	530*	161.6*	335	102.1
15	80	24.4	110	33.5	160*	48.8*	220*	67.1*	135	41.2	160	48.8	215	65.5	320*	97.6*	430*	131.1*	270	82.3
18	75	22.9	100	30.5	150*	45.7*	200*	61.0*	125	38.1	145	44.2	195	59.5	290*	88.4*	390*	118.9*	245	74.7
20	65	19.8	85	25.9	130*	39.6*	170*	51.8*	105	32.0	125	38.1	170	51.8	250*	76.2*	340*	103.7*	210	64.0

*These lengths exceed the maximum segment length and require more than one segment per breaker.
For longer maximum circuit lengths under specific applications, consult the factory.

Notes:
1. Circuit Breakers are sized per article 427-4 of N.E.C. and are based on start-up temperatures between -40°F and 50°F (-40°C and 10°C).
2. When using 240 volt product at 208, 220, or 277 volts, use the circuit adjustment factors shown in the voltage adjustment table.
3. When using 2 or more heater cables of different wattage ratings in parallel on a single circuit breaker, use the 15A column amperage, divide it by the maximum length to arrive at an amps/foot (amps/meter) figure for each cable. You can then calculate the circuit breaker sizes for these combination loads. These include the N.E.C. sizing factor in Article 427-4.

Voltage Adjustment:

Use of these products at other than rated voltages require minor adjustments in power and maximum circuit lengths.

ADJUSTMENT MULTIPLIER								
	208 VAC		220 VAC		277 VAC		Absolute max. segment length*	
Product	Power	Length	Power	Length	Power	Length	ft	m
3SCS-2	.74	.93	.84	.96	1.30	1.07	785	239.3
5SCS-2	.76	.93	.85	.96	1.29	1.07	620	189.0
8SCS-2	.78	.93	.86	.96	1.25	1.07	460	140.2
10SCS-2	.80	.93	.88	.96	1.23	1.07	375	114.3
12SCS-2	.81	.93	.88	.96	1.21	1.07	335	102.1
15SCS-2	.83	.93	.89	.96	1.19	1.02	270	82.3
18SCS-2	.85	1.01	.91	1.00	1.18	1.00	245	74.7
20SCS-2	.88	1.00	.93	1.00	1.15	1.00	210	64.0

*For longer maximum circuit lengths under specific applications, consult the factory.

CAUTION: To minimize the danger of a wet wire fire (arcing fault) if the heating cable is damaged or improperly installed, both the Canadian and the National Electrial Code (NEC 1996) require the use of a ground fault protection device (GFPD) at all times in conjunction with the installation of heat tracers.

MIC (Mineral Insulated Cable)

The MIC mineral insulated series resistance family of cables is for use on pipes and vessels where higher wattages, voltages, or temperatures and/or longer lengths are required.

Typical applications:

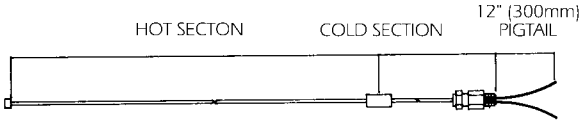
Serge Baril MIC cable is a high performance, industrial grade heat tracing cable used for applications requiring

- High temperature exposure
- High maintain temperature
- High power output
- Rugged cable construction
- Constant power output over entire heater length
- Extended heater life
- Immunity to stress corrosion
- Snow melt systems
- Floor warming systems
- Under tank heating (cryogenic tanks)

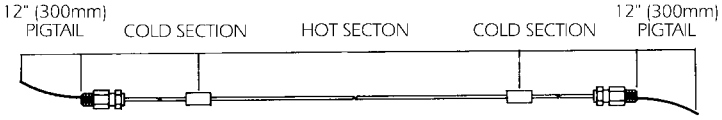
CABLE RATINGS:

CABLE TYPE	K	K	B
SHEATH MATERIAL	INCOLOY 825		
CABLE DIAMETER INCHES (mm)	0.1875 (4.76)		0.3125 (7.94)
NUMBER OF CONDUCTORS	1	2	2
MAXIMUM VOLTS	600	300	600
MAXIMUM EXPOSURE TEMPERATURE °F (°C)	1100 (590)		
MAXIMUM POWER W/ft (W/m)	62 (203.36)	62 (203.36)	88 (288.64)
WEIGHT lb/ft (kg/m)	.07 (.10)		.22 (.33)
FORMS	E	A,E	A,E
STD COLD LEAD ft (m)	7.0 (2.13)		

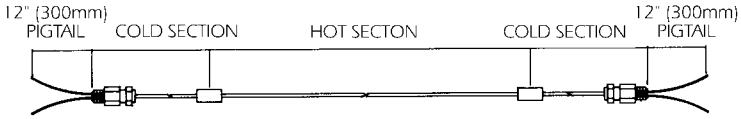
Form A



Form E (1 Conductor)



Form E (2 Conductor)



Catalog Ordering System:

Catalog Number (*) A 670 B 150 07(*)

(*)	A	670	B	150	07
Optional Construction	From A or E	Conductor selection from table	Cable diameter K or B	Hot section length in feet	Cold section length in feet

MIC Accessories:

HTA — HIGH TEMPERATURE ADAPTER is used to heat sink the hot section transition as it passes through the thermal insulation when the hot to cold connection must be located outside the thermal insulation due to sheath temperature over 600°F, (315°C) and cable wattage above 20 W/ft (66 W/m).

VA — VOLTAGE ADJUSTOR provides solid state voltage adjustment when the desired voltage is below 120 V. It is primarily used when cable length is below 20 ft (6 m).

(*)Optional Construction

Prefix	Suffix	Description
P		Pulling Eyes for "A" form only
X		Oversized cold section or special feature
	EM	Mounting of hot-cold junction outside thermal insulation (freeze protection of lines over 600°F / 315°C).
	HTA	Factory mounting of HTA adaptor
	UG	UL listing tag**
	UH	UL hazardous area listing tag**
	FH	FM hazardous listing tag**
	CH	CSA hazardous listing tag**
	CHB	CSA group B hazardous listing tag**
	UM	UL snow melting listing tag**

** Requires volts, amps and watts with each cable order.

RESISTANCE CHARACTERISTICS:

2 CONDUCTOR CABLE, 0.1875" (4.76 mm) DIAMETER
300 VOLTS

Cable Number	Cable res. Ω/ft	Cable res. Ω/m	Max. exposure Temp. Rating	Resistance Curve
556K	.043	.141	600°F (315°C)	1
658K	.058	.190		1
674K	.074	.243		1
693K	.093	.305		1
712K	.117	.384		1
715K	.147	.482		1
721K	.213	.699		1
722K	.213	.699		3
732K	.319	1.05	1100°F (590°C)	N/A
742K	.416	1.36		
752K	.520	1.71		
766K	.660	2.17		
774K	.740	2.43		
810K	1.00	3.28		
813K	1.30	4.26		
818K	1.80	5.90		
824K	2.34	7.68		
830K	2.96	9.71		
838K	3.70	12.14		
846K	4.72	15.48		
860K	5.60	18.37		
866K	6.60	21.65		
894K	9.00	29.52		
919K	18.00	59.04		

2 CONDUCTOR CABLE, 0.325" (7.94 mm) DIAMETER
600 VOLTS

Cable Number	Cable res. Ω/ft	Cable res. Ω/m	Max. exposure Temp. Rating	Resistance Curve
588B	.007	.023	600°F (315°C)	1
614B	.015	.049		1
627B	.027	.089		2
640B	.040	.131		3
670B	.065	.213	1100°F (590°C)	N/A
710B	.104	.341		
715B	.162	.531		
720B	.205	.672		
732B	.325	1.07		
750B	.500	1.64		
774B	.735	2.41		
810B	1.16	3.80		
819B	1.87	6.13		
830B	2.97	9.74		
840B	4.30	14.10		
859B	5.98	19.61		

1 CONDUCTOR CABLE, 0.1875" (4.76 mm) DIAMETER
600 VOLTS

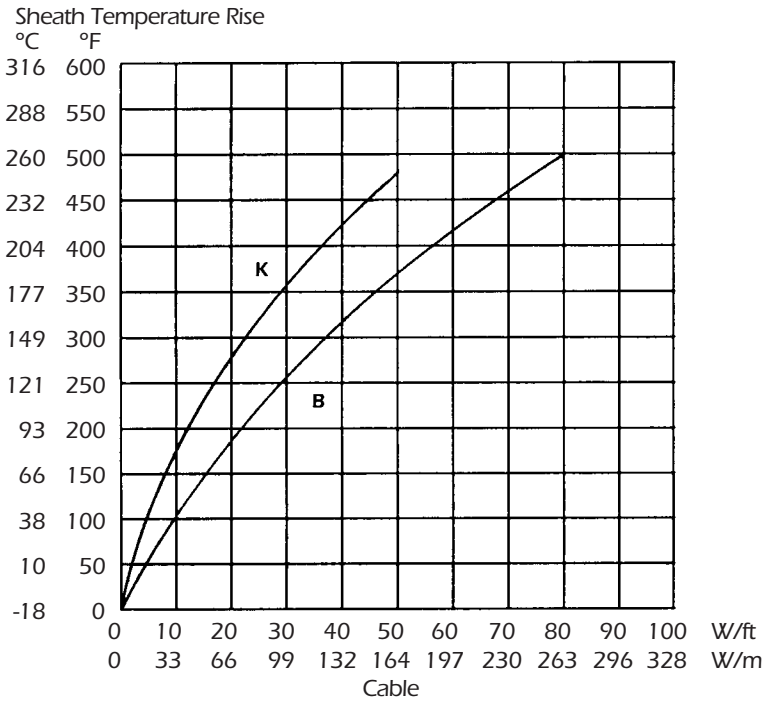
Cable Number	Cable res. Ω/ft	Cable res. Ω/m	Max. exposure Temp. Rating	Resistance Curve
145K	.0046	.015	600°F (315°C)	1
189K	.0090	.030		1
216K	.0165	.054		2
239K	.039	.128	1100°F (590°C)	N/A
250K	.050	.164		
279K	.079	.259		
310K	.095	.312		
316K	.157	.515		
326K	.260	.853		
333K	.330	1.08		
346K	.457	1.50		
372K	.730	2.39		
412K	1.17	3.84		
415K	1.48	4.85		
423K	2.36	7.74		
430K	2.80	9.18		
447K	4.50	14.76		

Note: Factory design is required for the following applications:

1. Power output greater than 45 W/ft (148 W/m).
2. Exposure temperature greater than 1100°F (590°C).
3. Maintain temperature greater than 400°F (204°C).

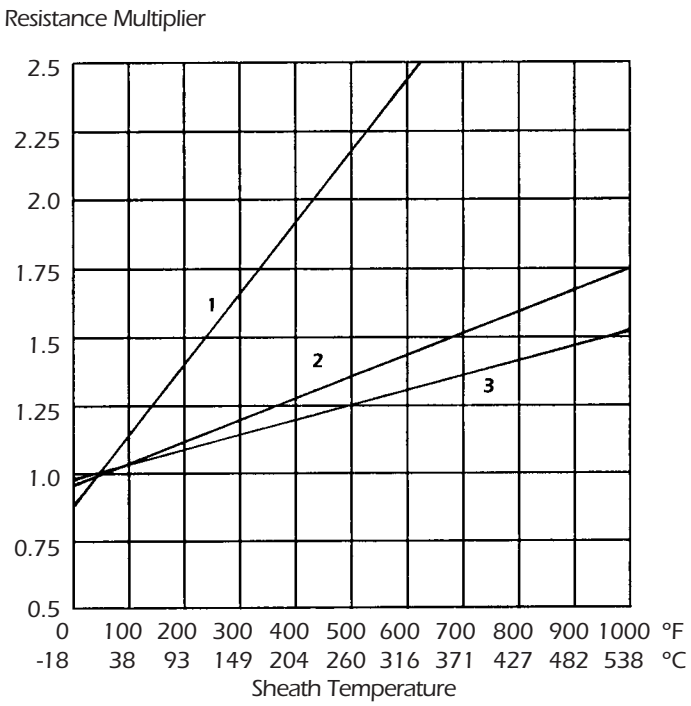
GRAPH-1

CABLE SHEATH TEMPERATURE RISE



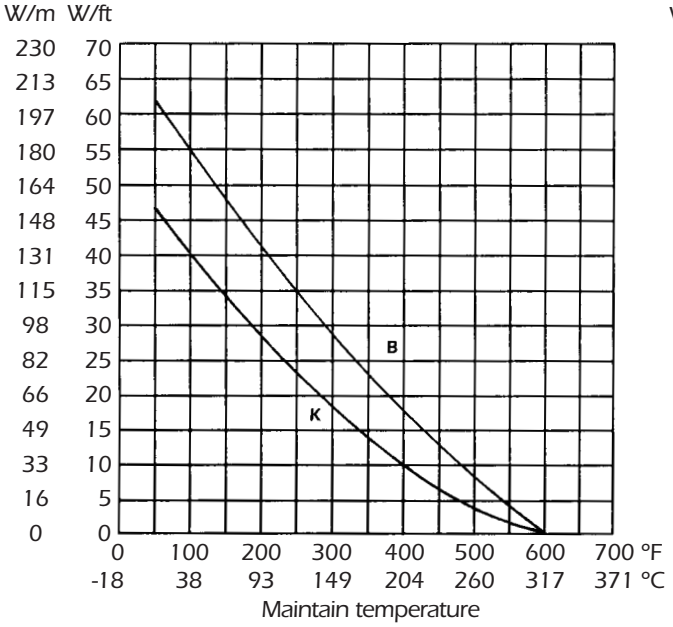
GRAPH-2

CABLE RESISTANCE TEMPERATURE MULTIPLIER



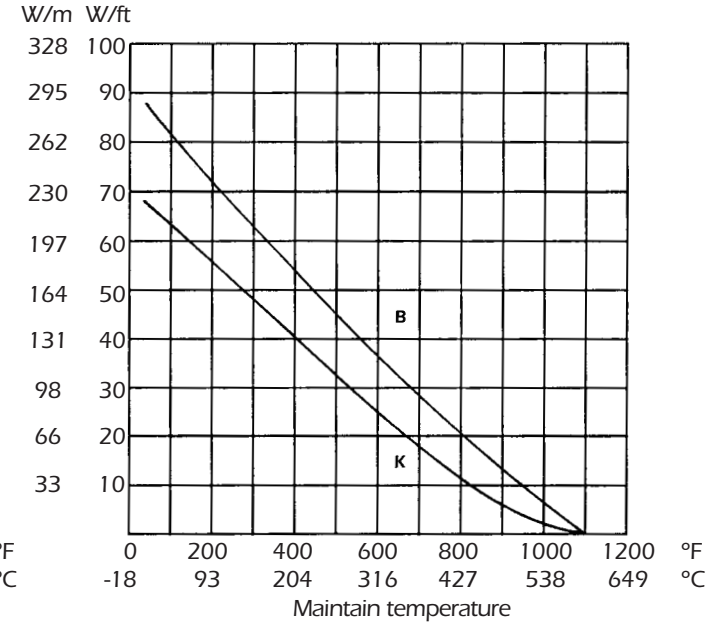
GRAPH-3

MAXIMUM WATTAGES - ALL CABLES
WITH HOT/COLD JUNCTION UNDER INSULATION



GRAPH-4

MAXIMUM WATTAGES - ALL 1100°F (590°C)
CABLES WITH HOT/COLD JUNCTION OUTSIDE INSULATION



Heater Design:

Select the heater cable construction based on the system requirements.

- Voltage (below or above 300 volts)
- Cable size K or B
- Maximum exposure temperature
- Number of conductors desired (one or two)
- Maximum watts/foot (watts/meter) required

Generally, you will want to use the smallest diameter, two conductor "A" form cable that meets your requirements. Two conductor cable provides an out-and-back circuit that simplifies electrical wiring. Smaller diameter cables are easier to install. As maintain temperatures, watt requirements, voltage, and heater length increase, you may require the larger diameter cable.

Select the correct heater cable.

This is done by calculating the optimum resistance needed and then selecting the closest actual resistance available from one of the resistance tables. The optimum resistance is calculated as follows:

$$R = V^2/(W \times L^2)$$

Where **R** = Required cable resistance ohms/foot (ohms/meter)
V = Voltage
W = Desired cable power output watts/foot (watts/meter)
L = Required heater cable length (feet or meters)

Note: the cable resistance (R) from the equation is based on the operating temperature. Low resistance conductors have a significant increase in resistance as the operating temperature increases. The cable resistance given in the resistance tables must be modified for these cables by the following procedure.

A. Based on the desired power output (W) , use the GRAPH-1 to determine the SHEATH TEMPERATURE RISE for the particular cable diameter you select.
B. Add the sheath temperature rise to the desired maintain temperature to determine the SHEATH TEMPERATURE.
C. From GRAPH-2, determine the cable resistance multiplier for your application. Multiply the resistance value given in the resistance tables by this muliplier to determine the cable resistance at operating conditions.

Determine electrical and thermal conditions.

Once the cable resistance has been selected, you will want to verify performance of the cable you have selected from GRAPHS 3 and 4.

Actual Power Output: $W = V^2/(R \times L^2)$ Current draw in amps: $I = V/(R \times L)$

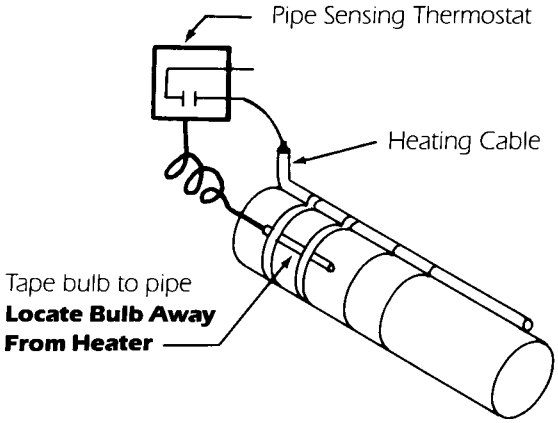
Note: To comply with Canadian and National Electrical Codes, the circuit breaker must be oversized by a minimum of 25% of the heater amperage and must be of the ground leakage type.

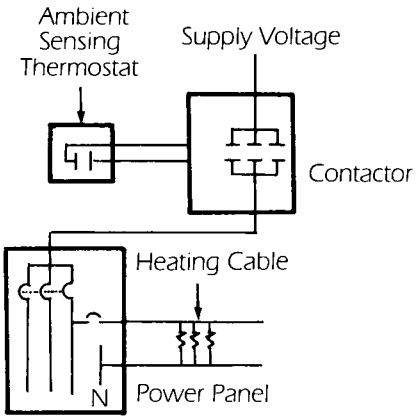
D GENERAL DESIGN CONSIDERATIONS

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 is 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 the actual temperature of each pipe or vessel. The heater is only energized when the temperature of that specific line drops below the 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.

The advantages of this system include close temperature control and minimum energy usage. The disadvantages are the initial control costs and the 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 / 5°C is a typical value). When energizing multiple heater loads a contactor is used to perform the actual switching. The advantages of ambient control include the simplified control wiring and the lower control maintenance costs. The disadvantages include the loss of precise temperature control and excessive energy consumption (since the heaters may be on when the pipe is being warmed from the products flowing through it).

2. Effects Of Heat Sinks

Any thermally conductive material that penetrates through 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

The 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 (FPS, and SCS) may be used based on their maximum "T Rating". Under no conditions will they exceed those temperatures.
- Series MIC mineral insulated heaters and TH tank heaters must be designed not to exceed the temperature.
- For Division 2 areas, this is achieved by limiting the watt density design so the heater sheath temperature will not exceed the required temperature. For Division 1 areas, factory design is required by certain approval agencies (FM, UL).Verify with Serge Baril.

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 of the heater reach that temperature. CCA and FPS cables can be used safely without concern. Other cables must use the following precautions;

A. Use thermal overlimit protection
B. Limit wattage design so cable sheath temperature will not reach the pipe softening point.

The CEC (NEC) requires that metal braids or sheaths be used on all cables.

D GENERAL DESIGN CONSIDERATIONS

6. Designing Self-Regulating Heater Cable For Plastic Pipe

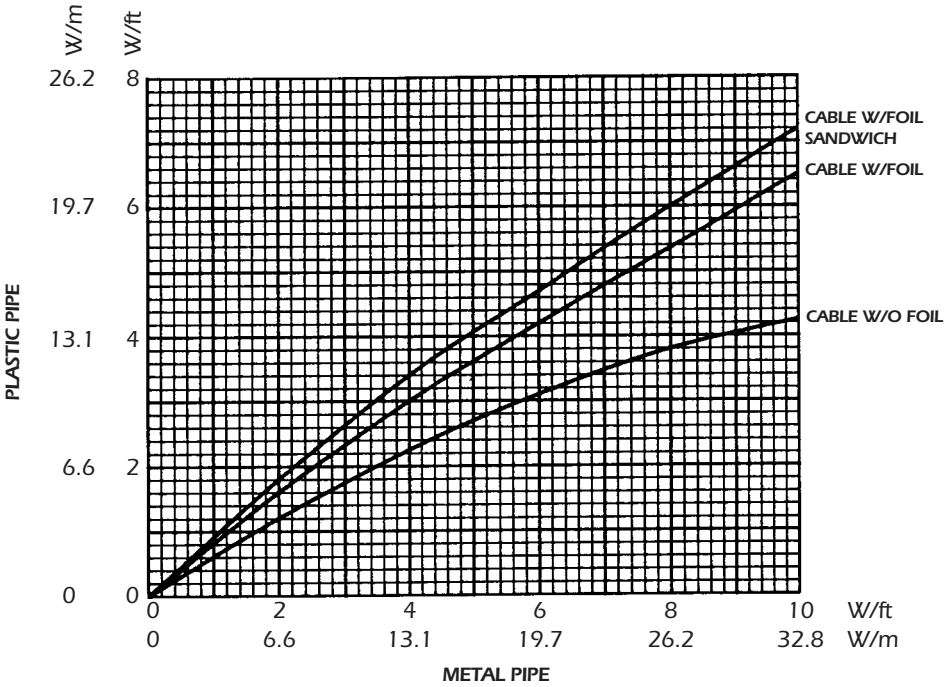
Plastic pipe is not thermally conductive. Although the self-regulating heater cable will itself get hotter in relation to a given pipe temperature, less heat is transferred to plastic pipe than metal pipe. Use the graph below to determine the correct output of self-regulating heater cable when used on plastic pipe. There are three methods of applying heater cable to plastic pipe:

A. Regular attachment at one-foot (300 mm) intervals with fibre glass tape;
B. Foil over the cable: Fasten the cable at one-foot (300 mm) intervals (as above) and then cover with a layer of adhesive backed aluminum foil tape (AT-150);
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.

SELF-REGULATING HEATER CABLE OUTPUT ON PLASTIC PIPE

The 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, the power output must be de-rated for use on plastic pipe because of its lower thermal coupling.

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



7. Use of Metal Foil Tape to Lower Sheath Temperature on Metal Pipe

We do not recommend the use of metal foil tape on all types of heaters to lower the sheath temperature. Do not use this technique to lower the 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°F (0.8 to 1.7°C) rise per vertical foot (300 mm) 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 the 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

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 cables.**

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 the insulation. The heating cable cannot maintain temperatures with wet insulation. 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

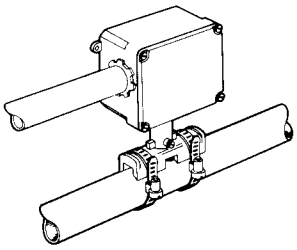
Check your heating system before each freeze season. Process maintenance systems should be on year-round. However, some of the lower maintenance products will not develop a wet insulation "freeze up" until ambient temperatures drop. A system check should verify that all cables are working. Check and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

POWER CONNECTION, SPLICE and TEE

Fixtures and enclosures made of industrial grade plastic.

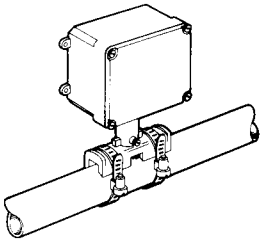
POWER CONNECTION KIT

For connecting heater cable to power wiring.
The kit includes stand-off bracket, molded silicone rubber termination seal kit and end seal kit, grommet, junction box, terminal block and pipe straps.



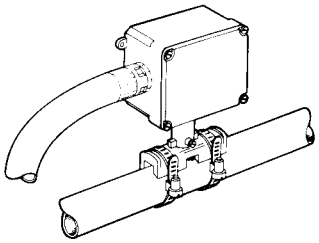
SPLICE CONNECTION KIT

For connecting two pieces of heater cable.
The kit is as above with two silicone rubber termination seal kits.



TEE CONNECTION KIT

For connecting a heater cable on a branch pipe (tee) to the heater cable on the main pipe. The kit is as above and as shown, but has three silicone rubber termination seal kits, and an extra end seal kit.

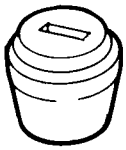


CATALOG NO.

PST- __ J __ __

- **P**
- **S**
- **T**

GROMMET SELECTION GUIDE



- **J** — Cable with braid and/or overjacket
- **U** — Universal for dual Power entry, Splice or Tee connections

PIPE CLAMPS

Pipe size	
inches	mm
.75 - 2.5	19 - 63
3.0 - 10.0	75 - 250
12.0 - 20.0	300 - 500

- **3**
- **12**
- **20**

ex: PST-PJJ-3

General Notes:

1) The kits contain the correct number of grommets and pipe straps for each application.The kits will mount directly on pipe 3/4" (19 mm) and larger. Adaptor kits are available for smaller pipe and tubing.
2) A bare bones power connection kit is available with no junction box, straps or terminal block. The catalog No. is PST-PX (X= Grommet type).
3) An all aluminum family of kits is available (Prefix AL- to be put before the catalog No. ex.: AL-PST-PJJ-3).
4) An all stainless steel family of kits is available (Prefix SS- to be put before the catalog No. ex.: SS-PST-PJJ-3).

CLASS I DIVISION 1 CONNECTION KITS

Serge Baril's HA Series connection kits include all components necessary to complete the installation of Serge Baril's full line of Class I, Division I heat tracing cables. The selection tables below allow for the proper specifying of the complete connection kit assembly **(ex.: HA-P-3).**

HA-____-____

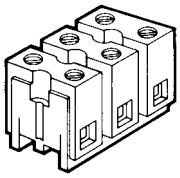
Pipe clamps	Pipe size inches	Pipe size mm
3	.75 - 2.5	19 - 63
12	3.0 - 10.0	75 - 250
20	12.0 - 20.0	300 - 500

	Specify kit configuration
P	Power Connection
S	Splice Connection
T	Tee Connection
E	End Connection
SBA	Includes seals to do four complete connections of any of the above. Customer to provide approved fittings as per instruction sheets. Pipe clamps not provided.

Important Note: FPS and SCS families of products are approved by CSA for Cl. I Div. 1 applications with the use of these components. For other than CSA approval (FM, UL) the D1-FPS, D1-SCS version of the heater is required with these components.

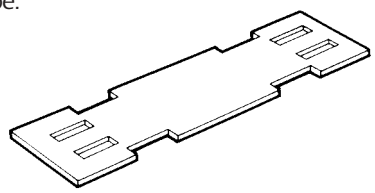
TERMINAL BLOCK **TB-P**

Special floating three-point terminal block can be used in any enclosure to provide positive, sure electrical connections. It is rated at 40 amps. 440 VAC. Requires no lugs.



MOUNTING ADAPTOR FOR TUBING

Used to mount the base of Serge Baril connection devices on to tubing or small diameter pipe. **MA-P**



PILOT LIGHT FOR END OF CIRCUIT

Serge Baril PST-PLK end kits can be supplied to provide an end-of-circuit continuity light.

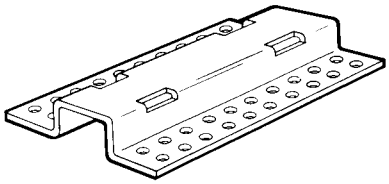
PST-PLK-____-____

120V
208V
240V
277V

Pipe clamps	Pipe size inches	Pipe size mm
3	.75 - 2.5	19 - 63
12	3.0 - 10.0	75 - 250
20	12.0 - 20.0	300 - 500

TANK ADAPTOR **TA-P**

Bracket used to mount the base of Serge Baril connection devices directly to the wall of a tank or vessel.



GT-60, GT-180
This 1/2 inch (13 mm) fiberglass tape can be used to attach temperature sensors to the pipe when corrosive conditions prevent the use of the aluminum foil tape. It is also used to attach heater cable to the pipe. Each roll contains:
GT-60 : 20 yards (18 m)
GT-180 : 60 yards (55 m)

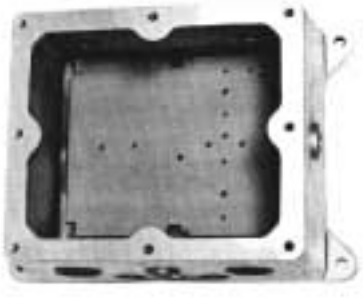
SS-480
This 16-gauge stainless steel tie wire is used to attach Serge Baril MIC heaters to pipes, valves, etc. Each reel contains 160 yards (146 m) of wire.

ETL-E
This black and yellow weatherproof warning sign should be attached to the outside of the pipe insulation at approximately 10 foot (3 m) intervals. This meets code requirements for cautioning maintenance personnel of the presence of electric tracing under the insulation.

AT-150
This 2-inch (50 mm) wide aluminum foil tape is used to attach thermostat sensing bulbs to pipes. It is also used for plastic pipe heat tracing. Each roll contains 50 yards (45 m) of tape.

CS-TYPE CLIP STRIP
This strip can be attached to vessels and tanks on 3 or 4 foot (0.9 or 1.2 m) spacing to hold the cable to the surface. It is also used to hold the cable in place when it is put in concrete for floor heating or snow melting. These steel strips are sold in 10' (3 m) lengths. The strips have clip tabs punched on 3 or 4 inch (75 or 100 mm) centers that are bent around the cable to hold it in place.

3 inch (75 mm) centers CS-3
4 inch (100 mm) centers CS-4



This larger cast aluminum junction box has eight 3/4" (19 mm) openings and is used in congested areas where 4 to 7 cables have to be wired into a common power connection. It may also be used to field mount a small relay, and control or alarm devices such as the VA voltage ajustor. It is also available with 8 point terminal block. The enclosure has a ground flange cover with gasket.
Ordering information:

NEMA 4
JB-2
JB-21 (with terminal block)

NEMA 7
(for classified areas)
JB-7
JB-71 (with terminal block)

The following sealing systems provide moisture-proof seals wherever Serge Baril thermoplastic heating cable jackets have to be cut.

TERMINATIONS

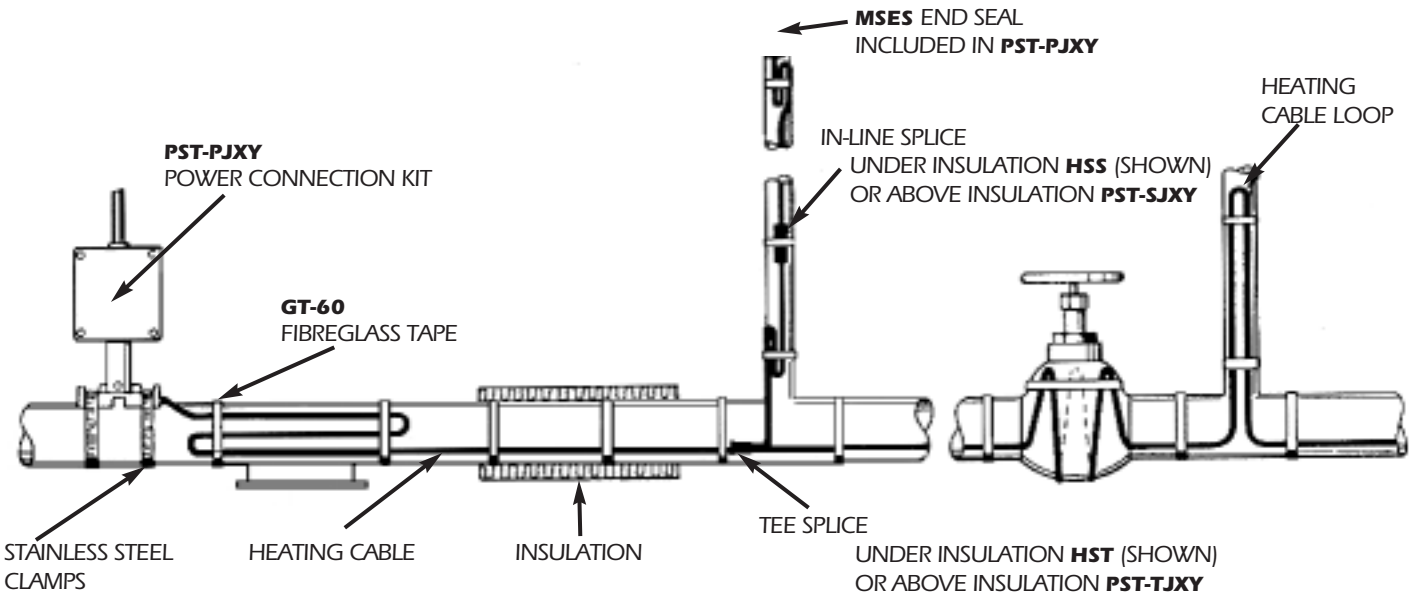
Type of seal	Molded Silicone Rubber	Mastic Shrink Tube	
	All cables	FPS-B, FPS-BA, CCA	SCS-B
Power Termination	MSPS	HSPS	H-HSPS
End Termination	MSES	HSES	H-HSES

SPLICES - UNDER INSULATION

Type of seal	Mastic Shrink Tube	
	FPS-B, FPS-BA, CCA	SCS-B
In-line Splice	HSS	H-HSS
Tee splice	HST	H-HST

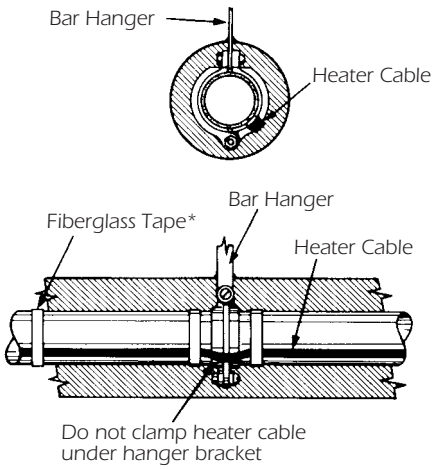
F TYPICAL INSTALLATION TIPS

Typical Self-Regulating Installation



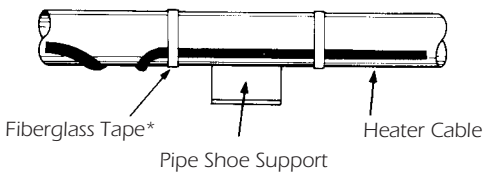
The Following Applies For Both Self Regulating & MIC Heaters

Hanger support



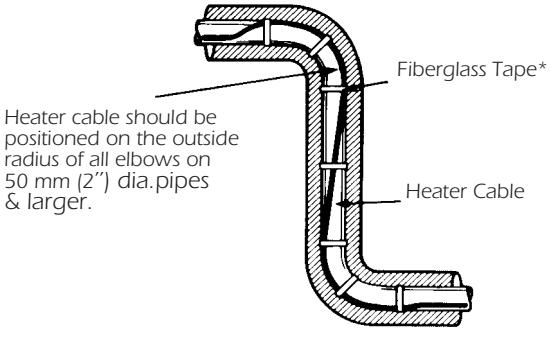
Shoe support

Side View

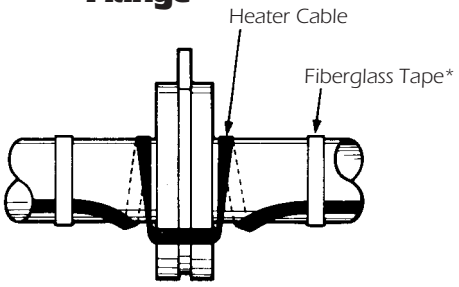


Bottom View

Elbow



Flange

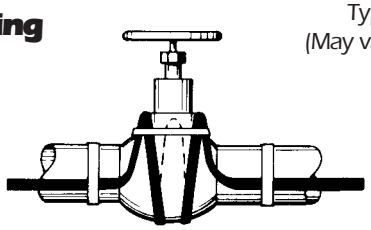


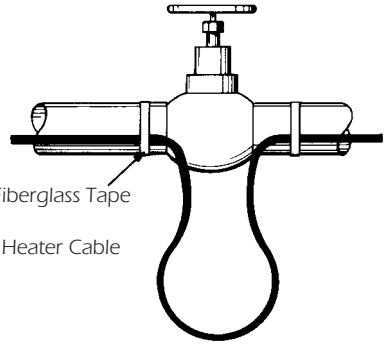
* For MIC cable, SS-480 stainless steel tie wire is used.

INSTALLATION ON VALVE

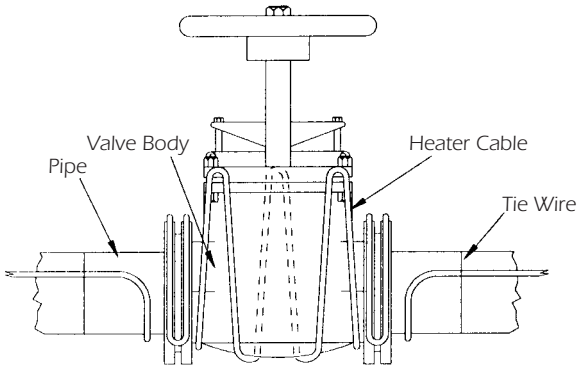
Self-regulating

Typical installation method.
(May vary for different valve shapes)

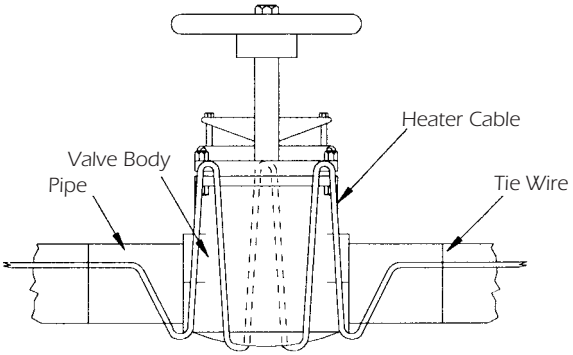




MIC



Flange valve



Screw or Welded Valve

For a complete installation guide, please refer to:
Serge Baril Heat Tracing Systems Installation and Maintenance - Self Regulating Heater Cable, document # HT-213-10910
Serge Baril Heat Tracing Systems Installation and Maintenance - Mineral Insulated Heater Cable, document # HT-222-10920

TEN YEAR EXTENDED WARRANTY

SELF REGULATING HEATER CABLE
MINERAL INSULATED CABLE

SCOPE:

Serge Baril offers an extension of our regular 1 year warranty on all self-regulating and mineral insulated heating cable for a period of up to 10 years from the date of manufacture.

This extended warranty includes all terms, conditions and limitations of the basic warranty with the following additions:

1. The heating cable extended warranty acceptance form has been signed and returned to Serge Baril for registration.

2. The heating cable failure is defined as having a 20% loss in power output.

3. The warranty is void if the product is installed on or with materials containing plasticizers, such as commonly used in vinyl tapes or vinyl insulation.

PROCEDURE:

1. In the event of a claim, a "claim information sheet" must be completed and returned with all the cable removed.

2. Serge Baril will provide replacement cable at normal price levels for the initial replacement.

3. Upon examination of the returned cable and the determination that the cable is defective, Serge Baril will issue a credit for the defective cable.

We are pleased to offer suggestions on the use of our various products, nevertheless, there are no warranties given except such expressed warranties offered in connection with the sale of a particular product. There are no implied warranties of merchantability or of fitness for a particular purpose given in connection with the sale of any goods. In no event shall Serge Baril be liable for consequential, incidental or special damages. The buyer's sole and exclusive remedy and the limit of Serge Baril's liability for any loss whatsoever shall not exceed the purchase price paid by the purchaser for the product or products for which a claim is made.

PRINTED IN CANADA HT-201-10801

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