CONNECT AND PROTECT

INDUSTRIAL HEAT TRACING SOLUTIONS

Products & Services

nVent
RAYCHEM

ADVANCED INDUSTRIAL SOLUTIONS

As the world’s largest provider of complete electrical heat management systems, primarily for the general process, oil and gas, chemical, and power generation industries, nVent provides innovative products and turnkey solutions under market-leading brands—nVent RAYCHEM and nVent TRACER. Our premiere turnkey solutions include full life cycle support—ranging from front-end engineering and installation to maintenance and operation services. Our global experience and office presence in 50 countries uniquely position us to manage the heat needed for projects of any size and scope.

THE HEART OF OUR SOLUTIONS

As the inventor of self-regulating heat tracing, our nVent RAYCHEM brand is recognized for technical leadership in the industries we serve. nVent RAYCHEM cable delivers the appropriate amount of heat exactly when and where it is needed, adjusting the output produced in response to ambient and process conditions, making it ideal for heat management systems. Since inventing the technology, nVent has sold over 1.6 billion feet (500,000 km) of nVent RAYCHEM self-regulating cable.

In addition to the self-regulating heat-tracing technology, we also provide parallel constant wattage cables, series polymer insulated cables and series mineral insulated cables for a full range of temperature needs.

Our brand of mineral insulated heating cables and wiring have led the industry for more than 75 years. Able to withstand extreme, harsh environments, Our heat-tracing cables provide the most reliable solution for high-temperature applications. Recently rebranded to nVent RAYCHEM, these cables perfectly reflect the superior reliability that comes with this product brand.

nVent RAYCHEM control & monitoring products represent the industry's most complete range of dedicated heat-tracing control and monitoring systems, from simple thermostats to advanced networked systems, with easy-to-use interface technologies that put information and programming at your fingertips.

Our nVent TRACER Turnkey Solutions Team is widely regarded as the premiere provider of industrial turnkey heat-tracing solutions. With our full suite of services, from front-end engineering and installation to maintenance and operation services, we are capable of handling heat-tracing projects of any size and scope. By focusing on safety and utilizing time-tested methods and solutions, our heat-tracing designs and installations are timely, thorough, and cost-effective.

POLE TO POLE, ONE RELIABLE
PARTNER IN HEAT TRACING

We Manage The Heat You Need

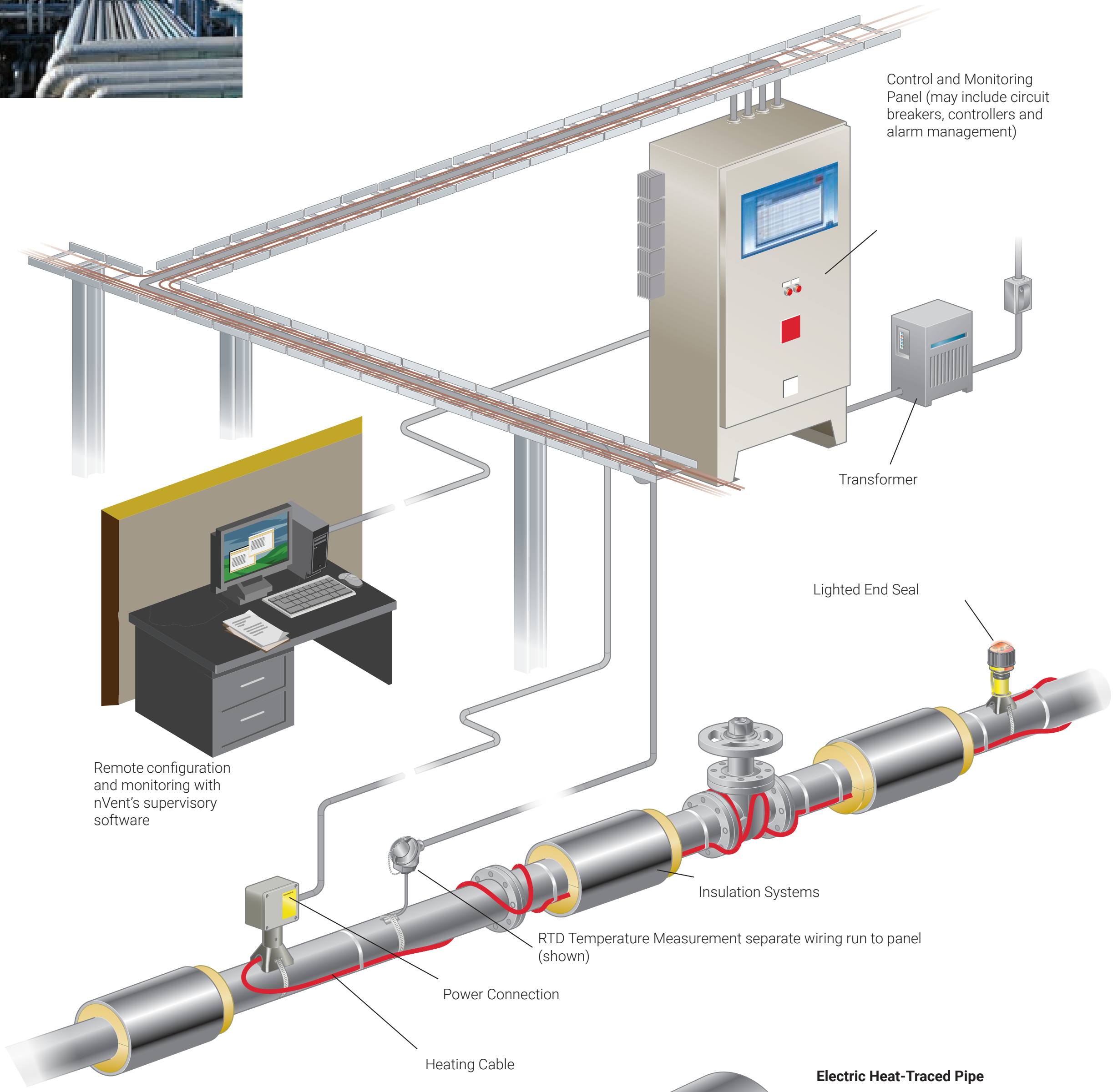
BEFORE YOU BUY, WEIGH THE FACTS

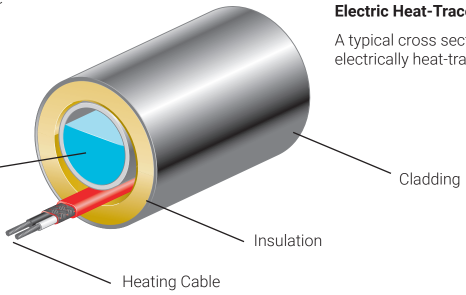
- Widest range of heat-tracing technologies for any application
- Continuous innovation of our products and services
- Advanced line of control and monitoring systems
- Highest excellence in operations with major logistic hubs and customer service centers worldwide
- Global company with local presence—more than 2,500 employees in over 85 locations

We are the leading full-service integrator for heat management systems offering project services for complete construction, project management and maintenance and we provide total care in heat tracing.

Electric Heat-Tracing Systems

An electrical heat-tracing system is much more than just the heating cable. nVent provides a complete system including the transformer, control and monitoring panels, power connections, heating cable, end terminations, and related accessories. We manage the heat you need - from pipe freeze protection, or process temperature maintenance, to process heat-up applications.



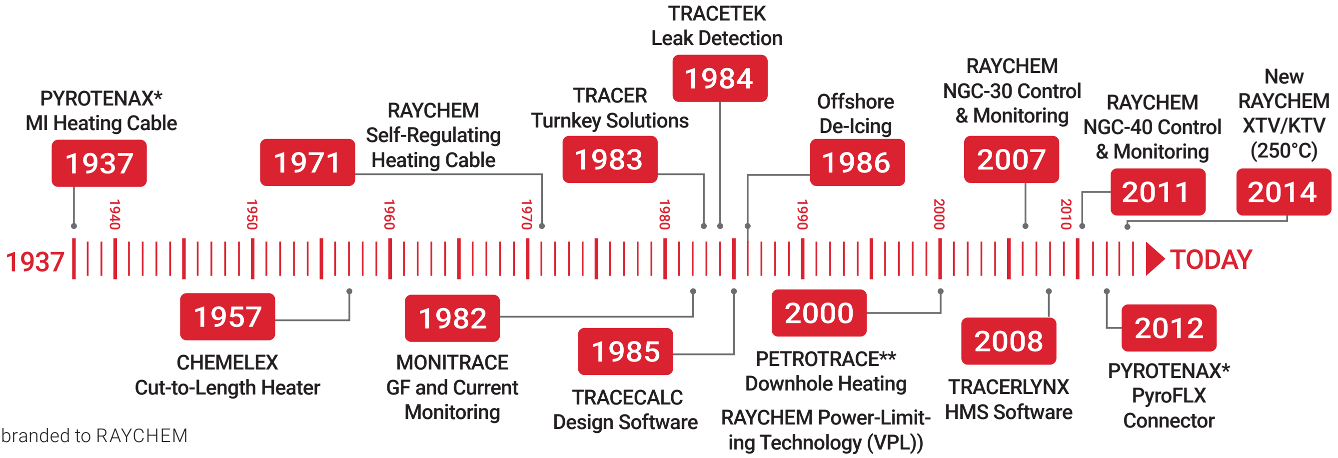


Electric Heat-Traced Pipe

A typical cross section of an electrically heat-traced pipe.

Note: The illustrations on these pages do not necessarily depict actual applications and installations.

A Rich History in Innovations



1937 PYROTENAX* MI Heating Cable

1957 CHEMELEX Cut-to-Length Heater

1971 RAYCHEM Self-Regulating Heating Cable

1982 MONITRACE GF and Current Monitoring

1983 TRACER Turnkey Solutions

1984 TRACETEK Leak Detection

1985 TRACECALC Design Software

1986 Offshore De-Icing

2000 PETROTRACE** Downhole Heating
RAYCHEM Power-Limiting Technology (VPL))

2007 RAYCHEM NGC-30 Control & Monitoring

2008 TRACERLYNX HMS Software

2011 RAYCHEM NGC-40 Control & Monitoring

2012 PYROTENAX* PyroFLX Connector

2014 New RAYCHEM XTV/KTV (250°C)

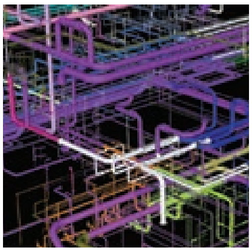
*Rebranded to RAYCHEM
**Discontinued Product Line

Heat Tracing

Turnkey Solutions

Control and Monitoring

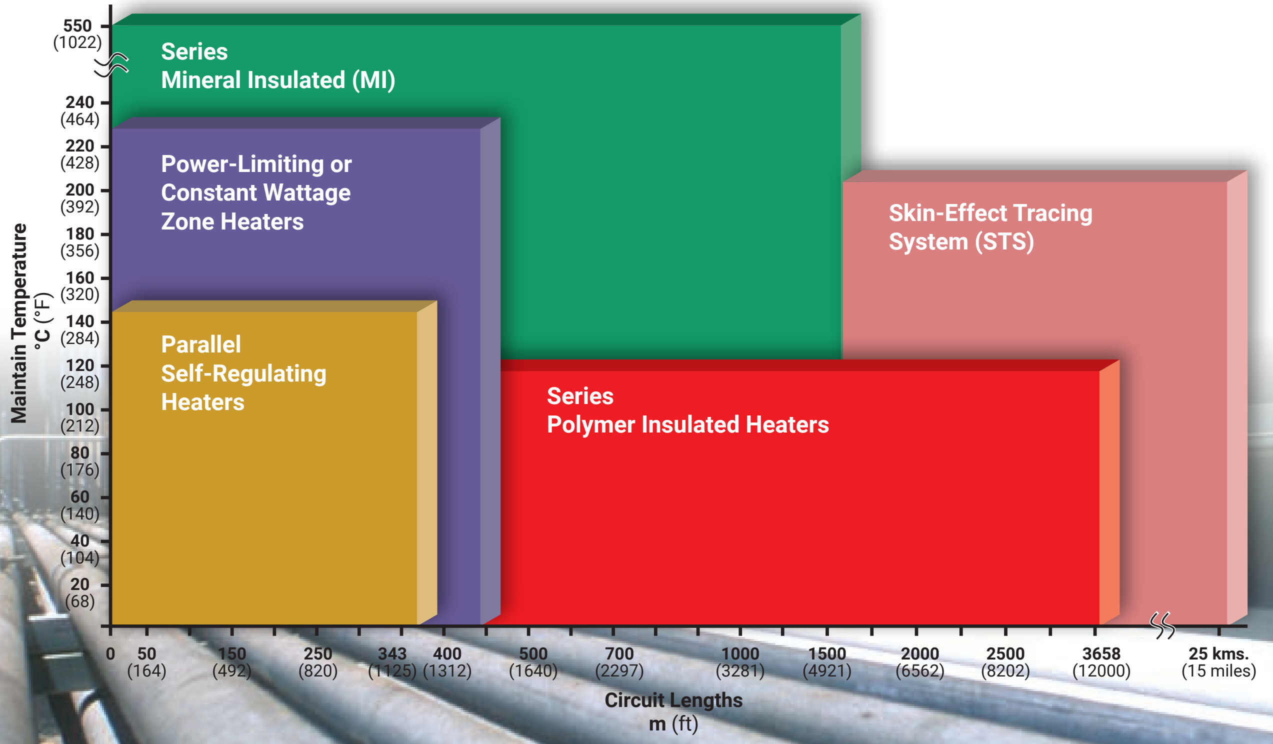
Fire-Rated Wiring Products



3D Plant Modeling

Product Technology Portfolio

nVent offers the industry's most complete line of heat-tracing product technologies to meet every need—for everything from pipe freeze protection to high temperature process maintenance. We provide solutions that cover a wide range of temperature and length requirements for any application.



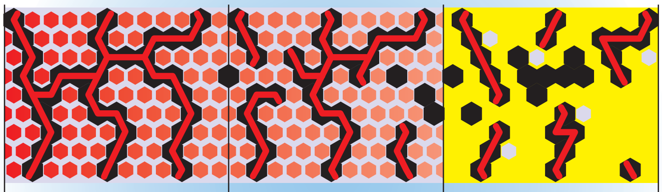
Innovative Heat-Tracing Systems

SELF-REGULATING TECHNOLOGY

nVent RAYCHEM revolutionized the heat-tracing industry when it invented self-regulating heater technology over 40 years ago. Self-regulating heating cables incorporate a heating element made of polymer mixed with conductive carbon black. This special formulation of materials creates an electrical path for conducting current between the parallel bus wires along the entire cable length. In each heating cable, the number of electrical paths between the bus wires changes in response to temperature fluctuations, allowing for more uniform temperatures. Additionally, the ability to cut-to-length on site allow for easy installation.

Applications include: freeze protection, temperature maintenance, viscosity control, or anti-condensation for any process in pipes, tanks or vessels.

How it works:

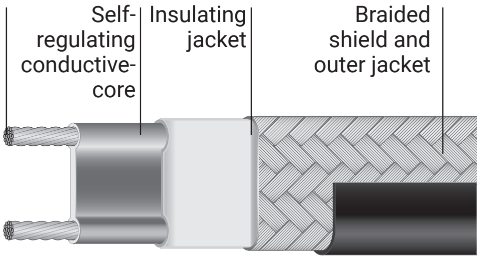


Cold Pipe: In response to cold, the core or fiber contracts microscopically opening up electrical paths.

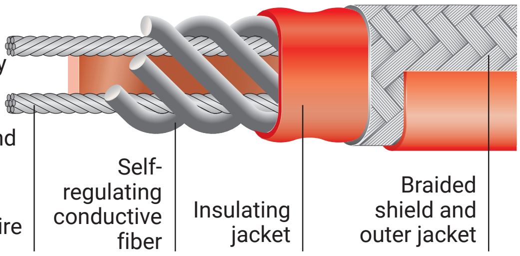
Warm Pipe: In response to warmth, the core or fiber begins to expand microscopically disrupting the electrical paths.

Hot Pipe: The core or fiber expands enough to disrupt almost all of the electrical paths.

BTV and QTVR heating cables have a similar construction.



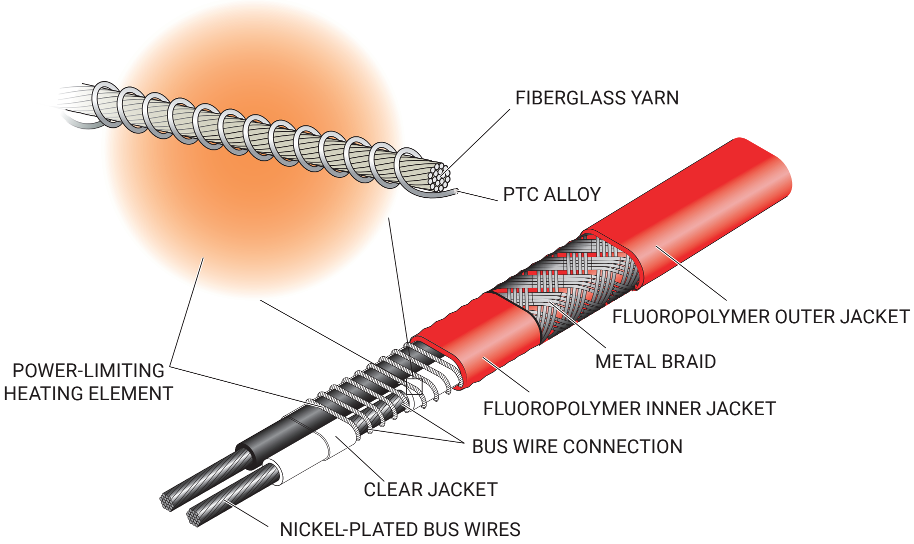
XTV and KTV heating cables have a fiber-wrap construction that can easily be cut back for power connection and termination.



POWER-LIMITING TECHNOLOGY (VPL)

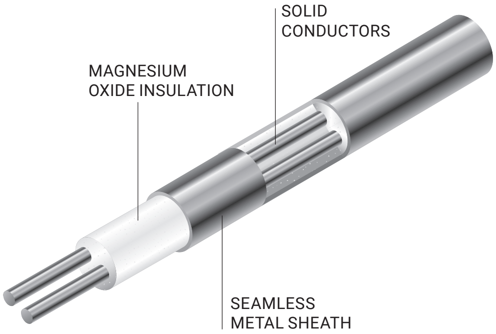
The nVent RAYCHEM Power-Limiting (VPL) heater is based on a coiled resistor alloy heating element wrapped around two parallel bus wires. The resistance of this heating element increases as its temperature increases, creating a positive temperature coefficient (PTC) effect. VPL can be used for high power output and /or high temperature exposure requirements which can reduce the number of heating cable runs required.

Applications include: all industrial applications with a need for high maintain or high continuous exposure temperatures.



MINERAL INSULATED TECHNOLOGY (MI)

PYROTENAX brand has been synonymous with the production of the highest quality mineral insulated (MI) systems for decades. Now rebranded to nVent nVent RAYCHEM, these heating systems provide the optimum solution when extreme high power outputs and temperatures are required. Applications include: industrial processes with a need for very high maintain temperatures (<600°C) or extreme exposure temperatures (<1000°C).

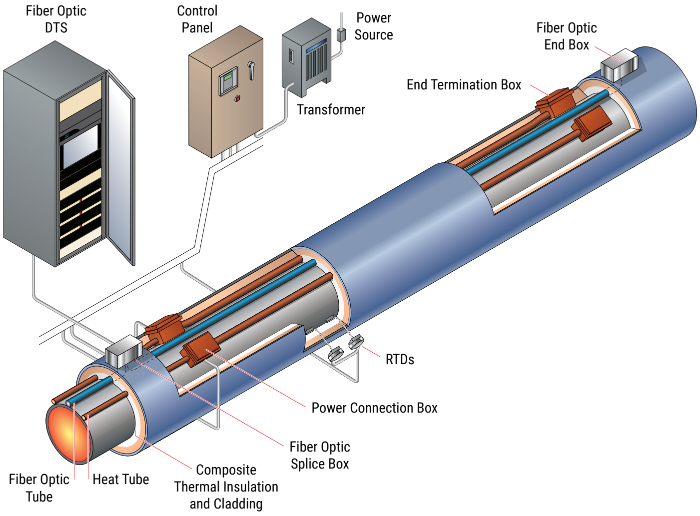


SKIN-EFFECT HEAT-TRACING TECHNOLOGY (STS)

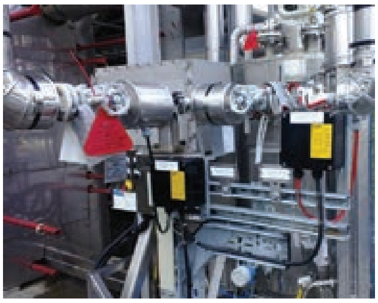
The nVent RAYCHEM STS Skin-Effect Heat-Tracing System is a multipurpose engineered technology configured to deliver heat for medium to long pipelines with circuit lengths up to 25 kilometers/15 miles.

Applications include: temperature maintenance in material transfer lines, snow and ice melting, tank foundation heating, and subsea transfer lines.

This system is ideally suited for the transportation of critical temperature maintain applications such as heavy or waxy crude oil and sulphur and can be bundled with Fiber Optic Distributed Temperature Sensing Systems (DTS) to provide the user with real time temperature monitoring for the entire length of the pipeline.



ADVANCED CONNECTION KITS



nVent RAYCHEM connection kits are rugged, resist corrosion, take less time to install, have fewer parts and permit visible monitoring status of power and continuity.

- One range of connection kits for all self-regulating identified w/ nVent RAYCHEM earlier self-regulating cables.
- An integral part of the complete hazardous area system approval.
- Unique nVent RAYCHEM cold-applied core sealer (patented technology) allows connection without the use and required curing time of RTV silicone.
- Spacious boxes with front access, reliable spring type terminals and captive lid screws for fast installation.

Control and Monitoring Systems

Many aspects can influence the selection of the control and monitoring system for each project and application. The most effective solutions are often a blend of various combined technologies to achieve a balance between total installed costs (TIC), total operating cost (TOC) and long-term benefits associated with the entire heat management system, during the life of the plant.

nVent offers a wide range of control and monitoring systems that provide scalable solutions from the most proven and economical simple mechanical thermostats to the very latest innovations in local control and central monitoring systems.

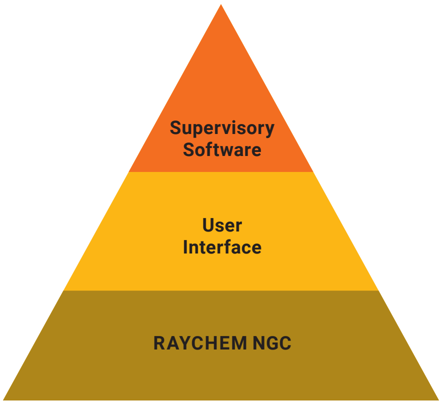
NGC-30 AND NGC-40

nVent RAYCHEM NGC-30 is an advanced electronic multipoint control, monitoring and power distribution system for industrial heat-tracing applications for up to 260 circuits.

nVent RAYCHEM NGC-40 is an advanced modular control, monitoring and power distribution system whose single control module per heat tracing circuit provides the highest reliability architecture for your heat-tracing application.

SUPERVISOR SOFTWARE

nVent's supervisory software is an integrated configuration and monitoring software for the NGC system family. It provides the capability to remotely configure the control systems, monitor status, alarms and other advanced features such as data logging and trending reports for a heat-tracing system.



FEATURES

- Most comprehensive product line to cover single circuit and multi-circuit applications
- Advanced monitoring and diagnostic capabilities
- Modular systems including single point architecture for maximum reliability
- State-of-the-art touch screen user interface
- Multiple RTD capabilities- versatile system for critical applications
- Capable of switching up to 690 V and 60 A current ratings to reduce power distribution costs
- Value-added accessories to provide significant cost savings

TRACER

Specialized Engineered Systems

TRAC-LOC TANK INSULATION SYSTEM

The nVent TRACER Trac-Loc standing seam tank insulation system is a thermally efficient and cost effective solution designed to help reduce a customer's total installed and operating costs. The system is virtually maintenance free and provides a lower insulation cost when compared to conventional insulation methods.

The Trac-Loc insulation system is ideal for large, flat-bottomed tanks used for the storage of materials that are sensitive to temperature fluctuations and require a covering of insulation and jacketing to reduce heat loss or gain. With its unique design, panel construction and installation techniques, Trac-Loc is provided as a complete installed heat management system.

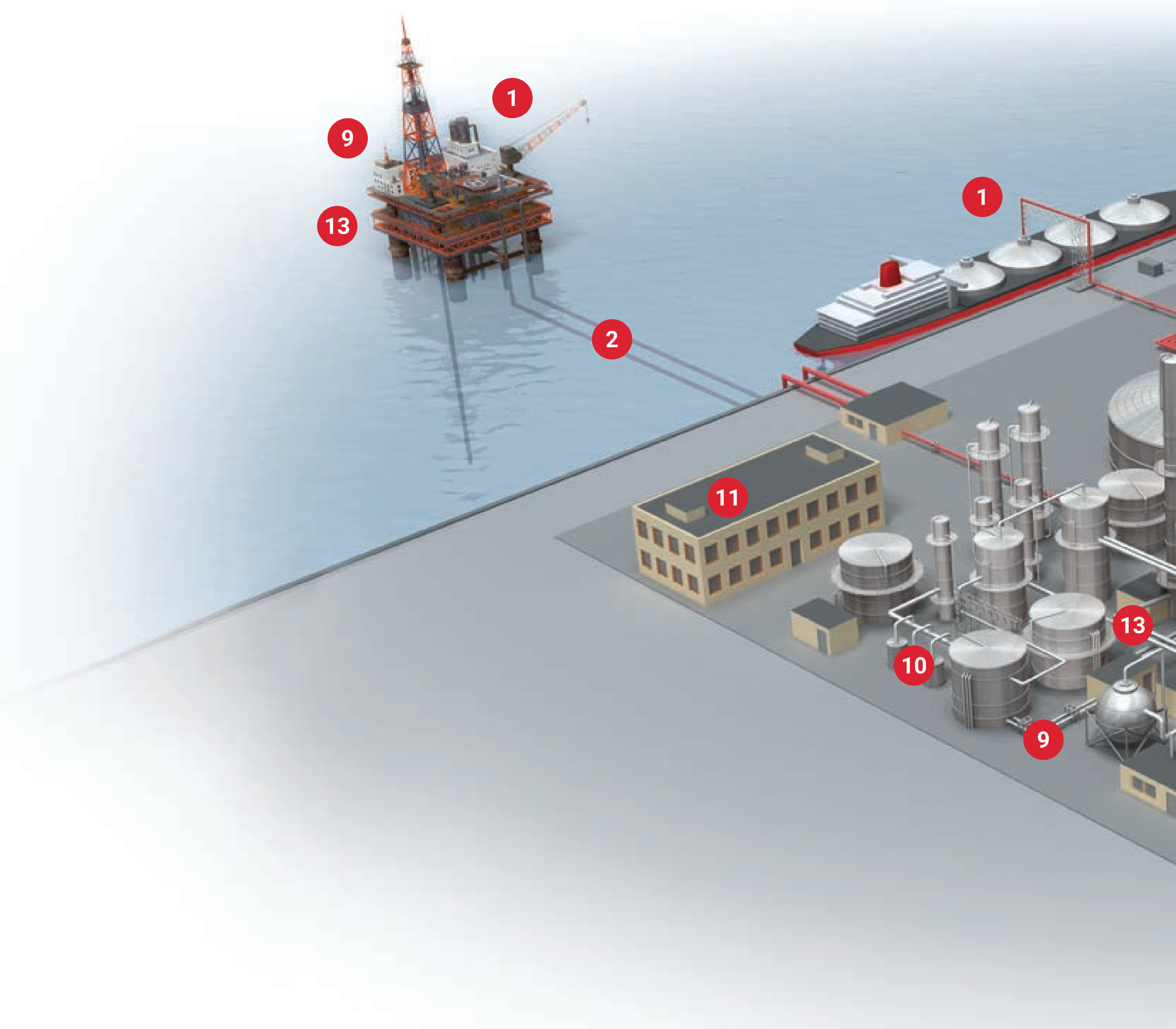
COMPREHENSIVE PIPELINE AND STORAGE TANK LEAK DETECTION SOLUTIONS

Pipelines and tanks throughout the world which transport and store critical temperature maintenance applications, are often located in remote regions which are sensitive to environmental harm and are occasionally prone to local pilfering of both the pipeline service and material components.

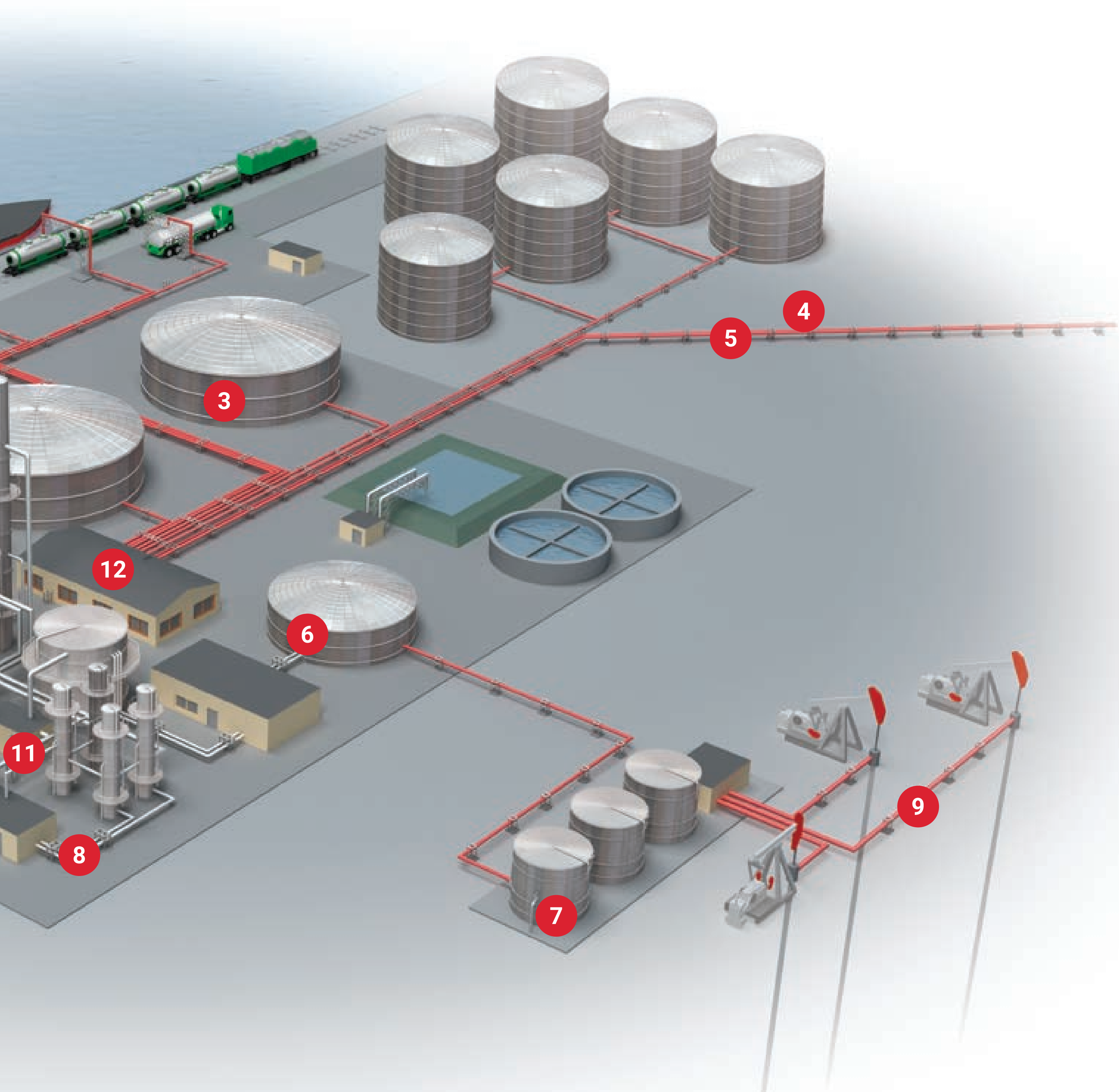
nVent's pipeline and storage tank leak detection solutions including fiber optic DTS, DAS and sensor based DAS are engineered to continually monitor these technologies which help to reduce the environmental and financial impact of a potential catastrophic event while also protecting the valuable commodity which is being stored or transported from local threats.

Advanced Industrial Solutions

NVENT PROVIDES SOLUTIONS TO A WIDE RANGE OF INDUSTRIAL MARKETS, PRIMARILY FOR THE OIL AND GAS, POWER GENERATION, TRANSPORT AND STORAGE, AND (PETRO-) CHEMICAL INDUSTRIES.



1	Anti-icing & de-icing
2	Heating of subsea transfer lines
3	Frost heave prevention of cryogenic LNG tanks
4	Long line heating with STS Skin-Effect Heat-Tracing systems & pre-insulated pipes
5	Comprehensive Pipeline Leak Detection Solutions
6	Tank insulation with Trac-Loc vertical lock seam systems
7	Tank heating



8 Process temperature maintenance

9 Pipe freeze protection

10 Pre-traced, pre-insulated tubing for instrumentation & sample lines

11 Advanced control & monitoring systems

12 Power distribution

13 Fire & performance wiring

Turnkey Solutions

A Heat Management System is an engineered system designed to maintain or protect process piping, equipment, vessels and instruments at predetermined temperatures and within defined design criteria.

Committed to safety through proactive safety management techniques.

Safety

Safety is our number one concern. We are recognized as a leader in the industry in safety performance by consistently challenging the norm through safety innovations including training and motivational programs.

Warm Pipe Warranty

By allowing nVent to handle all of the engineering, design, and construction of your heat-tracing system, we can provide you with a Warm Pipe Warranty, ensuring that the system operates as specified.

Front End Planning

Engaging nVent early in the planning process allows us to help you make decisions which can reduce the overall installed cost of the heat management system.

Detailed Engineering

Our experienced engineers apply product and optimization strategies to design a heat management system which meets your specific requirements at the lowest possible cost.

Post Installation Services and Maintenance

Providing regular Heat Management System audits or implementing a maintenance agreement, nVent provides you with the security of having your system regularly evaluated by experts in the heat-tracing industry, allowing timely resolution of potential system problems.

Procurement

nVent will manage all materials procurement and fabrication activities making sure the right materials get to the right work location at the right time.

Installation and Construction

Our construction teams are fully trained and experienced in heat-tracing installation techniques. Leverage our expertise to ensure timely and correct installation of your heat management system components, insulation and cladding.

Site Services

Using our Site Services allows you to maintain a single point of responsibility and accountability through the entire installation process. This ensures continuity of project knowledge from engineering through start-up. We can manage all the necessary services you need:

Engineering, Procurement, Construction and Construction Management, Quality Assurance.

Commissioning

Our commissioning services ensure that the heat management system is operating as expected. This includes full system audits, programming and set up of control panels and operational checks.

Quality Assurance/ Quality Control

Our Quality Management System addresses all processes including the design, supply, installation, and commissioning to ensure your Heat Management System is operating as intended.

Approvals and Warranty

GLOBAL APPROVALS

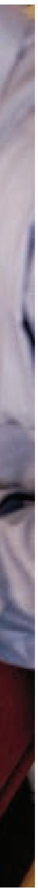
nVent's range of heating systems are tested to the most stringent industry standards to ensure maximum reliability and performance for our customers. They are approved and certified for use in nonhazardous and hazardous locations by the major agencies including FM, CSA, UL, PTB, Baseefa, NEPSI, DNV, ABS and many more.

WARRANTY

As an endorsement of our product quality and our commitment to providing customer value and peace of mind, a 10-Year extended product warranty program is available. Visit our website for more information.

By allowing nVent to handle all of the engineering, design, and construction of your heat-tracing system, we can provide you with a Warm Pipe Warranty, ensuring that the system operates as specified.

Web Services and Software



VISIT NVENT.COM

Our website provides all the latest tools and information you need to design, select, and purchase a complete heat-tracing system. Use our web-based program, or download design software to help you with your projects.

Browse and find the most up-to-date product brochures, data sheets and installation instructions.

DESIGN SOFTWARE

TraceCalc Pro design software brings you the latest advances in automated heat-tracing design capabilities.

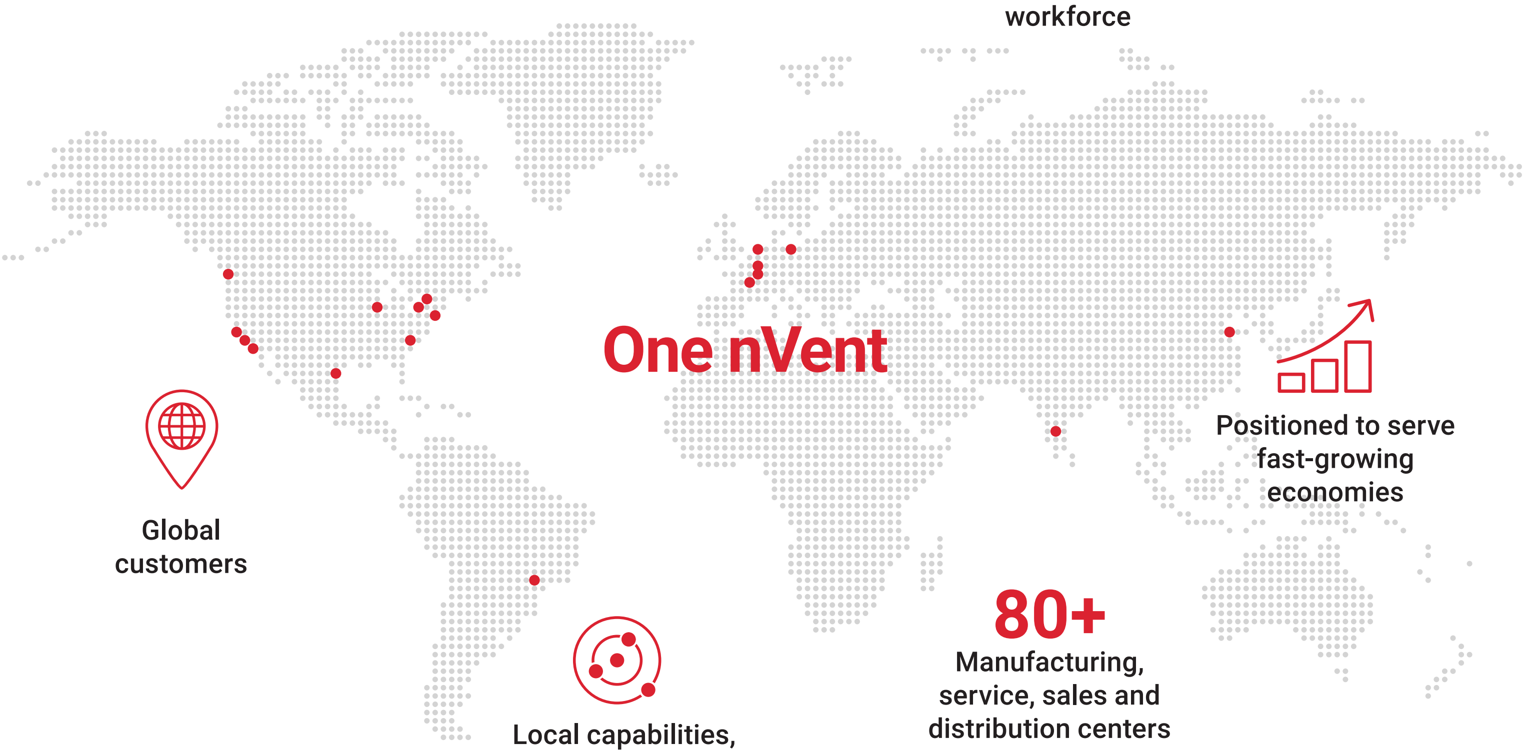
It a provides an intuitive, easy-to-navigate and user-friendly interface to create simple or complex heat-tracing designs for pipes, tanks and vessels.

With Tracecalc Net online tool, you can create a heat-tracing design in a few simple steps to:

- Finding the right products for your application
- Choosing quantities for a complete bill of materials
- Selecting optional control and monitoring systems

TraceCalc Pro

We have the capabilities to make the difference in any building project, from increasing safety to adding comfort while lowering total installed costs.
We are where you need us, with more than 9000 employees and partnerships with leading wholesalers, we service the globe. We travel the globe to support our customers in their most exigent building projects, providing design and installation support where needed.



400+
Patents

9,000
Global
workforce

One nVent

Global
customers

Positioned to serve
fast-growing
economies

80+
Manufacturing,
service, sales and
distribution centers

Local capabilities,
and localized
solutions

nVent
RAYCHEM

DESIGN GUIDES

This section provides design guides for Thermal Management. Each design guide is also available in pdf format on our web site at nVent.com.

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nVent

RAYCHEM

SELF-REGULATING CABLES

This step-by-step design guide provides the tools necessary to design a nVent RAYCHEM self-regulating heat-tracing system for insulated pipes and tubing. For other applications or for design assistance, contact your nVent representative or phone (800) 545-6258. Also, visit our web site at nVent.com

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INTRODUCTION

nVent invented self-regulating heating cable technology more than 40 years ago and today has over a billion feet of nVent RAYCHEM brand self-regulating heating cable installed worldwide.

Self-regulating systems are the preferred choice for most complex pipe-tracing applications. This is due to their parallel construction, which allows them to be cut to length and spliced in the field, and their self-regulating output, which provides more heat where it is needed.

nVent self-regulating heating cables are certified for use in hazardous locations and have been tested and approved for unconditional temperature classifications by worldwide approval agencies.

Conductive-Polymer Technology

nVent uses innovative conductive-polymer technology in both monolithic (solid core) and fiber (polymeric fiber wrap) heating cables, as seen in "Fig. 1" and "FIg. 2". The heating element is made of polymers mixed with conductive carbon black. This special blend of materials creates electrical paths for conducting current between the parallel bus wires along the entire cable length.

In each heating cable the number of electrical paths between the bus wires changes in response to temperature fluctuations. As the ambient temperature surrounding the heating cable decreases, the conductive core or fiber contracts microscopically. This contraction decreases electrical resistance and creates numerous electrical paths between the bus wires. Current flows across these paths to warm the core or fiber.

nVent invented self-regulating heating cable technology more than 40 years ago and today has over a billion feet of self-regulating heating cable installed worldwide.

As the temperature rises, the core or fiber expands microscopically. This expansion increases electrical resistance, and the number of electrical paths decreases. As a result,the heating cable automatically begins to reduce its power output.

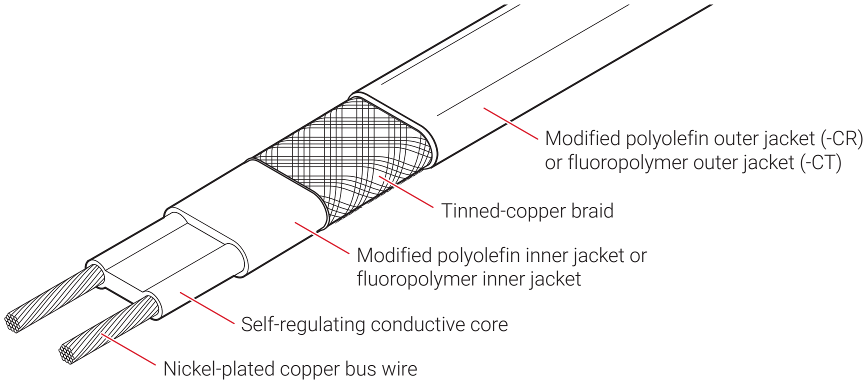


Fig. 1 Monolithic heating cable (nVent RAYCHEM BTV, QTVR, HBTV, and HQTV)

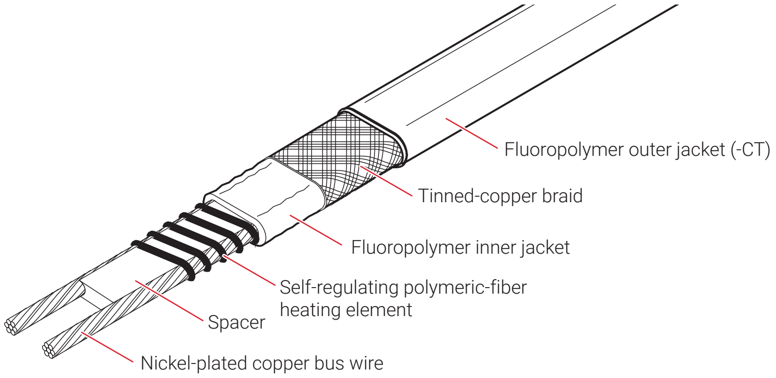


FIg. 2 Fiber-wrap heating cable (nVent RAYCHEM XTV, KTV and HXTV)

SYSTEM OVERVIEW

Typical Self-Regulating System

A typical self-regulating heating cable system is shown in Figure 3. The heating cable is cut to length at the job site and attached to the pipe with glass tape. A power connection kit connects the heating cable bus wires to power in a junction box. Tees and splices accommodate pipe branches to connect two or three heating cables together. An end seal kit is used to terminate the end of the heating cable. These required connection kits are designed and approved to provide a safe and reliable heat-tracing system. For applications requiring tight temperature control, electrical system monitoring, or remote operation, consider a control and monitoring system.

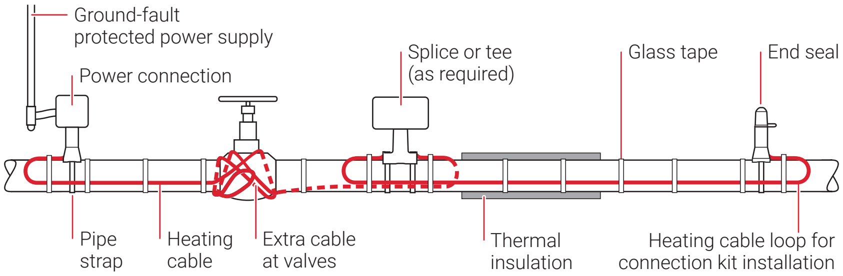


Fig. 3 Typical self-regulating heating cable system

Approvals and Certifications

nVent self-regulating systems are approved and certified for use in nonhazardous and hazardous locations by many agencies. Please refer to technical data sheets for more details.

FM APPROVED

Baseefa

THERMAL DESIGN

Pipe Heat Loss Calculations

Note: All thermal and electrical design information provided here is based upon a "standard" installation; i.e., with heating cable installed on insulated pipes. For any other method of installation, consult your nVent representative for design assistance.

Note: Heat loss calculation is based on a nonflowing pipe.

To select the proper heating cable you must first calculate the pipe heat loss, as outlined in the following four steps:

1 Gather the necessary information.
  - T_M: Maintain temperature
  - T_A: Minimum expected ambient temperature
  - Pipe or tubing size and material
  - Thermal insulation type and thickness

2 Calculate the temperature differential between the pipe maintain temperature and the minimum ambient temperature.

3 Calculate the pipe heat loss.

4 Adjust the heat loss to compensate for specific insulation type.

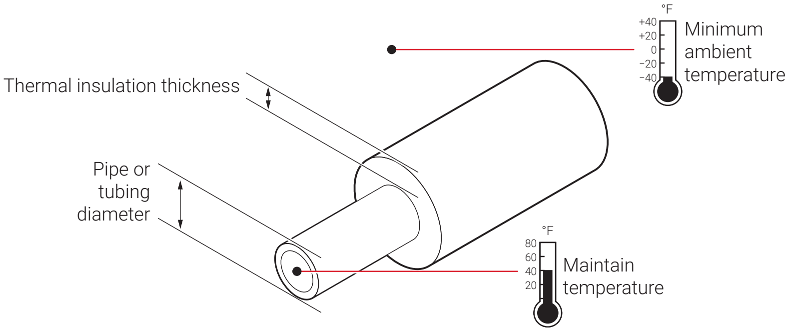


Fig. 4 Pipe heat loss

Thermal Design
1. Gather information
2. Calculate temperature differential
3. Calculate heat loss
4. Compensate for insulation type

Step 1 Gather the necessary information

To select the heating cable, gather and record the following information:

- T_M: Maintain temperature ____________________
- T_A: Minimum expected ambient temperature ____________________
- Pipe or tubing size and material ____________________
- Thermal insulation type and thickness ____________________

Example: Gather information

Maintain temperature	Water freeze protection at 40°F
Minimum ambient temperature	−40°F
Pipe size and material	6-inch diameter, steel
Insulation thickness and type	2-1/2 inch, calcium silicate

Thermal Design
1. Gather information
2. Calculate temperature differential
3. Calculate heat loss
4. Compensate for insulation type

Step ❷ Calculate temperature differential ΔT

To calculate the temperature differential (ΔT), use the formula below:

Formula ΔT	$T_M - T_A$

Example: Calculate temperature differential

Input T_M	40°F (from Step 1)
Input T_A	−40°F (from Step 1)
Calculation	ΔT = 40°F – (−40°F) = 80°F

ΔT = 80°F

Thermal Design
1. Gather information
2. Calculate temperature differential
3. Calculate heat loss
4. Compensate for insulation type

Step ❸ Calculate the pipe heat loss

From "Table 1" match the pipe size and insulation thickness with the temperature differential, ΔT, to find the base heat loss of the pipe (Q_B).

Example: Calculate pipe heat loss

Input	Pipe size = 6 inch (from Step 1)
Input	Insulation thickness = 2-1/2 inch (from Step 1)
Input	ΔT = 80°F (from Step 2)
Input	Pipe heat loss = 3.6 W/ft (from "Table 1")

From "Table 1", Q_B must be calculated through interpolation. For this example, 80°F is 3/5 of the difference between the ΔT of 50°F and the ΔT of 100°F:

Q_B = 3.6 W/ft + [3/5 x (7.4 – 3.6)] (7.4 is the ΔT of 100°F; 3.6 is the ΔT of 50°F)

Calculation	Q_B = 3.6 + 2.3 = 5.9 W/ft
Pipe heat loss	Q_B= 5.9 W/ft @ 40°F

Thermal Design
1. Gather information
2. Calculate temperature differential
3. Calculate heat loss
4. Compensate for insulation type

Step ❹ Compensate for insulation type

Multiply the base heat loss of the pipe (Q_B) from Step 3 by the insulation compensation factor (f) from "Table 2" to get the total heat loss per foot of pipe (Q_T).

Formula	$Q_T = Q_B \times f$

Example: Insulation type compensation

Input	Insulation type = calcium silicate (from Step 1)
Input	f = 1.50 for calcium silicate (from "Table 2")
Input	Q_B = 5.9 W/ft (from Step 3)
Calculation	Q_T = 5.9 W/ft x 1.50 = 8.85 W/ft

Q_T = 8.85 W/ft at 40°F

Now proceed to the Heating Cable Selection section, page 10, to determine the heating cable that will compensate for this heat loss.

Note: Heat loss calculations are based on IEEE Standards.

TABLE 1 PIPE HEAT LOSS (W/FT)

			Pipe diameter (IPS) in inches							
			1/4	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2
	(ΔT)			Tubing size (inches)						
Insulation thickness	°F	°C		3/4	1	1-1/4	1-1/2	2		
0.5"	50	28	1.9	2.5	2.9	3.5	4.1	4.6	5.5	6.5
	100	56	3.9	5.2	6.1	7.2	8.6	9.6	11.5	13.5
	150	84	6.1	8.1	9.5	11.2	13.4	14.9	17.9	21.1
	200	111	8.5	11.3	13.2	15.6	18.6	20.7	24.9	29.2
1.0"	50	28	1.3	1.6	1.9	2.2	2.5	2.8	3.2	3.8
	100	56	2.7	3.4	3.9	4.5	5.2	5.8	6.8	7.8
	150	84	4.2	5.3	6.1	7.0	8.2	9.0	10.6	12.2
	200	111	5.8	7.4	8.4	9.7	11.3	12.4	14.6	16.9
	250	139	7.6	9.7	11.0	12.7	14.8	16.3	19.1	22.1
1.5"	50	28	1.1	1.3	1.5	1.7	1.9	2.1	2.4	2.8
	100	56	2.2	2.8	3.1	3.5	4.0	4.4	5.1	5.8
	150	84	3.5	4.3	4.8	5.5	6.3	6.9	8.0	9.1
	200	111	4.8	5.9	6.7	7.6	8.7	9.5	11.0	12.6
	250	139	6.3	7.8	8.7	9.9	11.4	12.4	14.4	16.5
	300	167	7.9	9.7	11.0	12.4	14.3	15.6	18.1	20.6
	350	194	9.6	11.9	13.3	15.1	17.4	19.0	22.0	25.1
2.0"	50	28	0.9	1.1	1.3	1.4	1.6	1.8	2.0	2.3
	100	56	2.0	2.4	2.7	3.0	3.4	3.7	4.2	4.8
	150	84	3.1	3.7	4.2	4.7	5.3	5.8	6.6	7.5
	200	111	4.3	5.2	5.8	6.5	7.4	8.0	9.2	10.4
	250	139	5.6	6.8	7.5	8.5	9.6	10.4	12.0	13.5
	300	167	7.0	8.5	9.4	10.6	12.1	13.1	15.0	17.0
	350	194	8.5	10.3	11.5	12.9	14.7	15.9	18.2	20.6
2.5"	50	28	0.9	1.0	1.2	1.3	1.4	1.6	1.8	2.0
	100	56	1.8	2.2	2.4	2.7	3.0	3.3	3.7	4.2
	150	84	2.8	3.4	3.7	4.2	4.7	5.1	5.8	6.5
	200	111	3.9	4.7	5.2	5.8	6.5	7.0	8.0	9.0
	250	139	5.1	6.1	6.8	7.6	8.5	9.2	10.5	11.7
	300	167	6.4	7.7	8.5	9.5	10.7	11.5	13.1	14.7
	350	194	7.8	9.3	10.3	11.5	13.0	14.0	15.9	17.9
3.0"	50	28	0.8	1.0	1.1	1.2	1.3	1.4	1.6	1.8
	100	56	1.7	2.0	2.2	2.4	2.7	2.9	3.3	3.7
	150	84	2.6	3.1	3.4	3.8	4.3	4.6	5.2	5.8
	200	111	3.6	4.3	4.8	5.3	5.9	6.4	7.2	8.0
	250	139	4.8	5.7	6.2	6.9	7.8	8.3	9.4	10.5
	300	167	6.0	7.1	7.8	8.7	9.7	10.4	11.8	13.2
	350	194	7.3	8.6	9.5	10.5	11.8	12.7	14.3	16.0
4.0"	50	28	0.7	0.9	0.9	1.0	1.1	1.2	1.4	1.5
	100	56	1.5	1.8	2.0	2.1	2.4	2.5	2.9	3.2
	150	84	2.4	2.8	3.0	3.4	3.7	4.0	4.4	4.9
	200	111	3.3	3.9	4.2	4.6	5.2	5.5	6.2	6.8
	250	139	4.3	5.1	5.5	6.1	6.7	7.2	8.1	8.9
	300	167	5.4	6.3	6.9	7.6	8.5	9.0	10.1	11.2
	350	194	6.6	7.7	8.4	9.3	10.3	11.0	12.3	13.6

Note: Pipe heat loss (Q_B) is shown in watts per foot. Heat loss calculations are based on IEEE Standards with the following provisions:

- Pipes insulated with glass fiber in accordance with ASTM C547
- Pipes located outdoors in a 20-mph wind
- No insulating air space assumed between pipe and insulation
- No insulating air space assumed between the insulation and outer cladding
- Includes a 10% safety factor

TABLE 1 PIPE HEAT LOSS (W/FT)

Pipe diameter (IPS) in inches											
3	**3-1/2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**
7.7	8.6	9.6	13.6	17.4	21.4	25.2	27.5	31.3	35.0	38.8	46.2
16.0	18.0	20.0	28.4	36.3	44.6	52.5	57.4	65.2	73.0	80.8	96.3
25.0	28.1	31.2	44.3	56.6	69.6	81.9	89.5	101.7	113.8	126.0	150.2
34.6	39.0	43.3	61.5	78.5	96.6	113.6	124.2	141.1	158.0	174.8	208.5
4.4	4.9	5.4	7.5	9.4	11.5	13.5	14.7	16.6	18.6	20.5	24.4
9.1	10.2	11.2	15.6	19.7	24.0	28.1	30.6	34.7	38.7	42.8	50.9
14.2	15.9	17.5	24.3	30.7	37.4	43.8	47.8	54.1	60.4	66.7	79.4
19.7	22.0	24.2	33.7	42.5	51.9	60.7	66.2	75.0	83.8	92.5	110.0
25.8	28.7	31.7	44.0	55.6	67.9	79.4	86.6	98.1	109.6	121.0	143.9
3.2	3.6	3.9	5.3	6.7	8.1	9.4	10.2	11.5	12.9	14.2	16.8
6.7	7.4	8.1	11.1	13.9	16.8	19.6	21.3	24.0	26.8	29.5	35.0
10.5	11.6	12.7	17.3	21.6	26.2	30.5	33.2	37.5	41.8	46.1	54.6
14.5	16.1	17.6	24.0	30.0	36.3	42.3	46.0	52.0	57.9	63.8	75.7
19.0	21.0	23.0	31.4	39.2	47.5	55.3	60.2	68.0	75.7	83.5	99.0
23.8	26.3	28.8	39.3	49.2	59.6	69.3	75.4	85.1	94.9	104.6	124.0
28.9	32.0	35.0	47.8	59.8	72.4	84.3	91.7	103.5	115.4	127.2	150.8
2.6	2.9	3.1	4.2	5.2	6.3	7.3	7.9	8.9	9.9	10.9	12.9
5.5	6.0	6.6	8.8	10.9	13.1	15.2	16.5	18.6	20.7	22.8	26.9
8.5	9.4	10.2	13.8	17.0	20.5	23.8	25.8	29.0	32.3	35.5	42.0
11.8	13.0	14.2	19.1	23.6	28.4	32.9	35.7	40.2	44.7	49.2	58.2
15.5	17.0	18.5	24.9	30.9	37.2	43.1	46.7	52.6	58.5	64.3	76.1
19.4	21.3	23.2	31.2	38.7	46.6	54.0	58.6	65.9	73.3	80.6	95.3
23.6	25.9	28.3	38.0	47.1	56.6	65.6	71.2	80.2	89.1	98.1	115.9
2.3	2.5	2.7	3.6	4.4	5.2	6.1	6.6	7.4	8.2	9.0	10.6
4.7	5.2	5.6	7.4	9.1	10.9	12.6	13.7	15.3	17.0	18.7	22.0
7.4	8.1	8.7	11.6	14.2	17.0	19.7	21.3	23.9	26.5	29.1	34.3
10.2	11.2	12.1	16.1	19.7	23.6	27.2	29.5	33.1	36.7	40.3	47.5
13.3	14.6	15.8	21.0	25.8	30.9	35.6	38.6	43.3	48.0	52.8	62.2
16.7	18.3	19.8	26.3	32.3	38.7	44.6	48.4	54.3	60.2	66.1	77.9
20.3	22.2	24.1	32.0	39.3	47.1	54.3	58.8	66.0	73.2	80.4	94.7
2.0	2.2	2.4	3.1	3.8	4.5	5.2	5.6	6.3	7.0	7.6	9.0
4.2	4.6	4.9	6.5	7.9	9.4	10.8	11.7	13.1	14.5	15.9	18.7
6.6	7.1	7.7	10.1	12.4	14.7	16.9	18.3	20.5	22.6	24.8	29.2
9.1	9.9	10.7	14.0	17.1	20.4	23.4	25.3	28.3	31.4	34.4	40.4
11.9	12.9	14.0	18.3	22.4	26.6	30.6	33.1	37.1	41.0	45.0	52.8
14.9	16.2	17.5	23.0	28.1	33.4	38.4	41.5	46.5	51.4	56.3	66.2
18.1	19.7	21.3	28.0	34.1	40.6	46.7	50.5	56.5	62.5	68.5	80.5
1.7	1.8	2.0	2.5	3.1	3.6	4.1	4.4	5.0	5.5	6.0	7.0
3.5	3.8	4.1	5.3	6.4	7.5	8.6	9.3	10.3	11.4	12.4	14.5
5.5	6.0	6.4	8.3	10.0	11.8	13.4	14.5	16.1	17.8	19.4	22.7
7.6	8.3	8.9	11.4	13.8	16.3	18.6	20.0	22.3	24.6	26.9	31.4
10.0	10.8	11.6	15.0	18.1	21.3	24.3	26.2	29.2	32.2	35.2	41.1
12.5	13.5	14.6	18.8	22.6	26.7	30.5	32.8	36.6	40.3	44.1	51.5
15.2	16.5	17.7	22.8	27.5	32.4	37.1	39.9	44.5	49.0	53.6	62.6

TABLE 2 INSULATION FACTORS

Preformed pipe insulation	Insulation factor (f)	k factor at 50°F (10°C) (BTU/hr–°F–ft^2/in)
Glass fiber (ASTM C547)	1.00	0.25
Calcium silicate (ASTM C533)	1.50	0.37
Cellular glass (ASTM C552)	1.60	0.40
Rigid cellular urethane (ASTM C591)	0.64	0.16
Foamed elastomer (ASTM C534)	1.16	0.29
Mineral fiber blanket (ASTM C553)	1.20	0.30
Expanded perlite (ASTM C610)	1.90	0.48

HEATING CABLE SELECTION

Note: The data presented here are nominal and conservative. Additional engineering analysis at specific voltages may allow optimization that could extend circuit lengths and/or available power output. Consult nVent for more information.

If your application is freeze protection of water piping, follow the five-step heating cable selection process outlined below.

1 Gather the following information:
  - Pipe size and material
  - Insulation type and thickness
  - Maintain temperature (T_M)
  - Minimum ambient temperature (T_A)
  - Minimum start-up temperature
  - Service voltage
  - Chemical environment
  - Maximum intermittent exposure temperature*
  - Electrical area classification**

2 Select the heating cable family.
3 Select the service voltage.
4 Determine the heating cable power output rating.
5 Select the jacket type.

* Determines whether a higher exposure temperature heating cable is needed.

** Determines whether special design requirements and connection kits must be used.

If your application is maintenance of another fluid at a temperature other than 40°F (5°C) or is temperature-sensitive, you will need the information above plus the following data:

	Example data
• Process temperature	70°F
• Maximum ambient temperature	105°F
• Fluid degradation temperature***	150°F

***Determines whether thermostatic control is necessary.

HEATING CABLE CATALOG NUMBER

Before beginning, take a moment to understand the structure underlying heating cable catalog numbers. You will refer to this numbering convention throughout the product selection process. Your goal is to determine the catalog number for the product that best suits your needs.

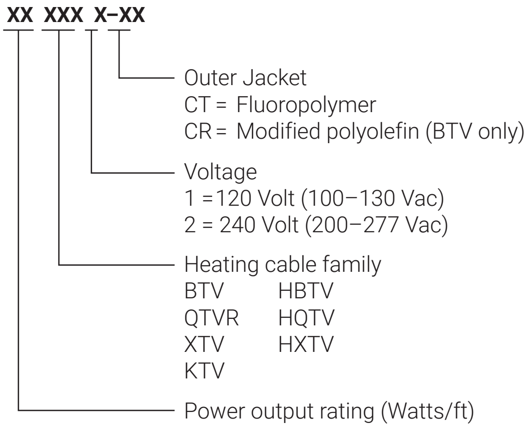


Fig. 5 Heating cable catalog number

Heating Cable Selection
1. Gather information
2. Select heating cable family
3. Select service voltage
4. Determine power output rating
5. Select jacket type

Step 1 Gather the necessary information

To select the heating cable, gather and record the following information:

- Pipe size and material ______________
- Insulation type and thickness ______________
- Maintain temperature (T_M) ______________
- Minimum ambient temperature (T_A) ______________
- Minimum start-up temperature ______________
- Service voltage ______________
- Chemical environment ______________
- Maximum intermittent exposure temperature ______________
- Electrical area classification ______________

Example: Gather necessary information

• Pipe size and material*	6 inches in diameter, steel
• Insulation type and thickness*	2-1/2 inch, calcium silicate
• Maintain temperature (T_M)*	Water freeze protection at 40°F
• Minimum ambient temperature (T_A)*	–40°F
• Minimum start-up temperature	0°F
• Service voltage	120 Vac
• Chemical environment	Organic chemicals
• Maximum intermittent exposure temperature**	366°F
• Electrical area classification***	Non-hazardous

* From Thermal Design, Step 1
** Determines whether a higher exposure temperature heating cable is needed.
***Determines whether special design requirements and connection kits must be used.

Heating Cable Selection
1. Gather information
2. Select heating cable family
3. Select service voltage
4. Determine power output rating
5. Select jacket type

Step 2 Select the heating cable family

Based on your application's maintain temperature, pipe material, maximum exposure temperature, and T-rating, select the appropriate heating cable.

For non-hazardous locations, use "Table 3" to select the heating cable family. Base your selection on your application's maintain temperature, pipe material, and maximum intermittent exposure temperature.

For Class I, Division 1 or 2 hazardous locations, also use "Table 3" or "Table 4", but first determine the required T-rating for the area.

Temperature identification numbers (T-ratings) are defined by the National Electrical Code (NFPA 70), Articles 500 and 505; and the Canadian Electrical Code Part I, Section 18. If the T-rating of the area has been defined, then select a heating cable from Table "Table 3" or "Table 4" having a T-rating equivalent to or less than the T-rating of this location (for example, T6 is a lower T-rating than T3).

The purpose of the T-rating is to ensure that electrical equipment does not exceed the Auto Ignition Temperatures (AIT) of flammables handled in a hazardous location.

If the T-rating for the area has not been defined, use one of the following methods.

FOR CSA CERTIFICATION

- Select the material with the lowest AIT in °C.

This temperature is the maximum allowable heating cable sheath temperature.

FOR FM APPROVAL

- Select material with the lowest AIT in °C.

This temperature is the maximum allowable heating cable sheath temperature.

FOR FM APPROVAL, DIVISION 1 HAZARDOUS LOCATIONS

- Select material with the lowest AIT in °C.
- Multiply the ignition temperature by 0.8.

This temperature is the maximum allowable heating cable sheath temperature. Use "Table 4" to select the heating cable family.

TABLE 3 HEATING CABLE PRODUCT PERFORMANCE DATA

nVent RAYCHEM Heating Cable Family	Maximum maintain temperature	Maximum continuous exposure temperature*	Maximum intermittent exposure temperature**	T-rating/ maximum sheath temperature	Pipe material
BTV	150°F (65°C)	150°F (65°C)	185°F (85°C)	T6 185°F (85°C)	plastic/ metal
QTVR	225°F (110°C)	225°F (110°C)	225°F (110°C)	T4 275°F (135°C)	plastic[1]/ metal only
KTV	300°F (150°C)	300°F (150°C)	482°F (250°C)[2]	T2C 446°F (230°C)	metal only
5XTV1,2	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
10XTV1,2	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
15XTV2	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
15XTV1	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2D 419°F (215°C)	metal only
20XTV1	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2C 446°F (230°C)	metal only
20XTV2	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2C 446°F (230°C)	metal only

* With the heating cable power on
** 1000 hours (power on/power off)
[1] For plastic pipes please consult TraceCalc Pro design software or contact the Customer Service Center.
[2] The 250°C rating applies to all products printed “MAX INTERMITTENT EXPOSURE 250C”

Example: Nonhazardous location

Input	40°F maintain temperature (from Thermal Design, Step 1)
Input	366°F intermittent exposure temperature (from Step 1)
Input	Heating cable family XTV (from Table 3)

Catalog number xx**XTV**x-xx

TABLE 4 HEATING CABLE PRODUCT PERFORMANCE DATA (FM-CID1 HAZARDOUS LOCATIONS)

nVent RAYCHEM Heating Cable Family	Maximum maintain temperature	Maximum continuous exposure temperature*	Maximum intermittent exposure temperature**	T-rating/ maximum sheath temperature	Pipe material
HBTV-CT	150°F (65°C)	150°F (65°C)	185°F (85°C)	T6 185°F (85°C)	plastic/ metal
HQTV-CT	225°F (110°C)	225°F (110°C)	225°F (110°C)	T4 275°F (135°C)	plastic[1]/ metal only
5HXTV1,2-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
10HXTV1,2-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
15HXTV2-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T3 392°F (200°C)	metal only
15HXTV1-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2D 419°F (215°C)	metal only
20HXTV1-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2C 446°F (230°C)	metal only
20HXTV2-CT	250°F (121°C)	250°F (121°C)	482°F (250°C)[2]	T2C 446°F (230°C)	metal only

* With the heating cable power on
** 1000 hours (power on/power off)

[1] For plastic pipes please consult TraceCalc Pro design software or contact the Customer Service Center.

[2] The 250°C rating applies to all products printed “MAX INTERMITTENT EXPOSURE 250C”

Example: CID1 hazardous location

For the same inputs, the heating cable family is HXTV from Table 4 on page 13.

FOR FM APPROVED SYSTEMS IN CID1 HAZARDOUS LOCATIONS

Due to the potentially hazardous nature of Division 1 locations, the requirements below must be followed at all times.

- Use only nVent RAYCHEM brand HBTV-CT, HQTV-CT, and HXTV-CT heating cables and HAK-C-100 connection kits specifically approved by FM.
- Complete and send the field information form found in the Approval for Class I, Division 1 Hazardous Locations in USA form (H56987), available on nVent.com, to the nVent Customer Service Center — phone (800) 545-6258, fax (800) 527-5703 — for design verification.
- Be sure the installer completes and returns the Required Installation Record for Class I, Division 1 Hazardous Locations in USA form (H57426), available on nVent.com, or the one in the back of the installation manual shipped with the product.

FOR CSA CERTIFIED SYSTEMS IN CID1 HAZARDOUS LOCATIONS

Due to the potentially hazardous nature of Division 1 locations, use only nVent RAYCHEM brand BTV-CT, QTVR-CT, KTV-CT and XTV-CT heating cables and HAK-C-100 connection kits specifically certified by CSA.

Heating Cable Selection
1. Gather information
2. Select heating cable family
3. Select service voltage
4. Determine power output rating
5. Select jacket type

Step 3 Select the service voltage

Service voltage options: 1 = 120 volts (100–130 Vac)
2 = 240 volts (200–277 Vac)

Example: Service voltage selection

Input	XTV heating cable (from Step 2)
Input	120 volts (from Step 1)
Voltage option	1
Catalog number	x**XTV1**-xx

Heading Cable Selection
1. Gather information
2. Select heating cable family
3. Select service voltage
4. Determine power output rating
5. Select jacket type

Step 4 Determine the heating cable power output rating

To select the heating cable power output, use "Table 5" to determine the appropriate power output graph based on the heating cable family and voltage already determined.

TABLE 5 HEATING CABLE POWER OUTPUT GRAPH SELECTION

Pipe material	Heating cable	Voltage	Graph number
Metal pipe	BTV, QTVR, HBTV, HQTV	120	1.1
		208	1.2
		240	1.3
		277	1.4
Metal pipe	KTV, XTV and HXTV	120	1.5
		208	1.6
		240	1.7
		277	1.8
Plastic pipe*	BTV and HBTV	120	1.9
		208	1.10
		240	1.11
		277	1.12

* Graphs assume the use of aluminum tape over the heating cable.

Using the selected graph, locate the heating cable with thermal output greater than the heat loss (Q_T) at the pipe maintenance temperature (T_M).

If the pipe heat loss, Q_T, is between the two heating cable power output curves, select the higher-rated heating cable. If Q_T is greater than the power output of the highest-rated heating cable, you can:

- Use two or more heating cables run in parallel.
- Spiral the heating cable.
- Use thicker insulation to reduce heat loss.
- Use insulation material with a lower k factor.

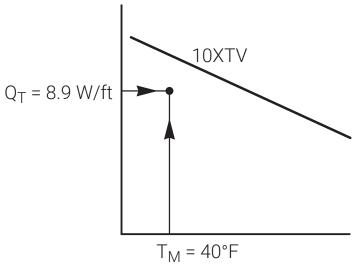


Fig. 6 Heating cable thermal output

Spiraling

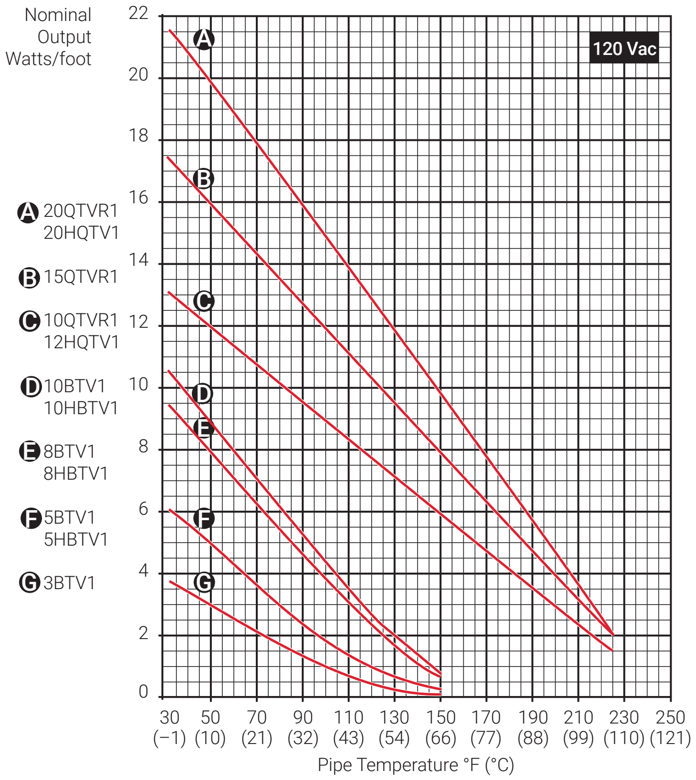
If spiraling is elected, use the formula below to determine the spiral factor (length of heating cable per foot of pipe):

Spiral factor = Q_T / Heater power output at T_M

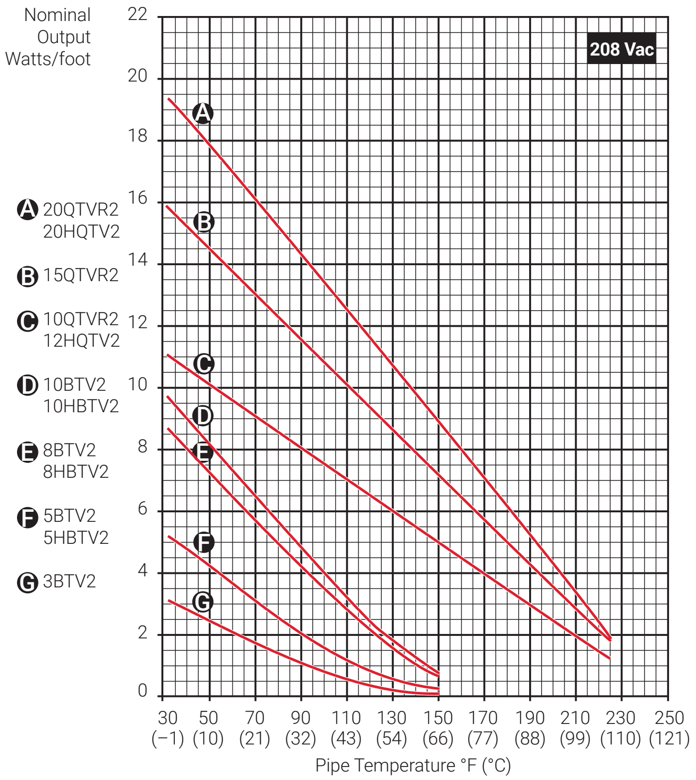
When the spiral factor exceeds 1.6 or the pipe size is less than three inches, consider using two or more heating cables run in parallel rather than spiraling.

Example: Determine power output rating

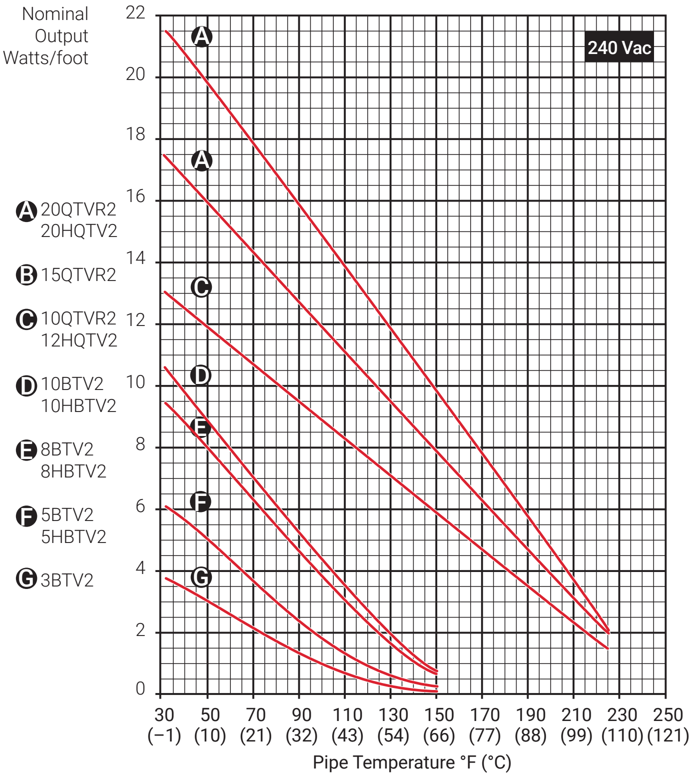
Input	XTV heating cable (from Step 3)
Input	Heat loss is 8.7 W/ft (from Thermal Design, Step 4 and "Table 1")
Input	10XTV output of 10.2 W/ft exceeds 8.7 W/ft at 40°F (from "Graph 5")
Power output rating	10
Catalog number	**10XTV1**-xx



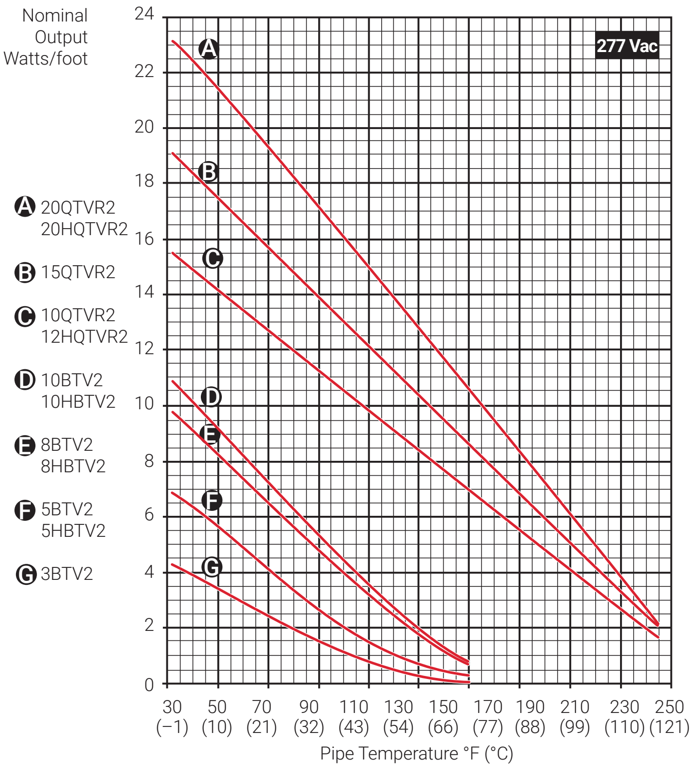
Graph 1 BTV, HBTV, QTVR, and HQTV nominal power output on metal pipes at 120 volts



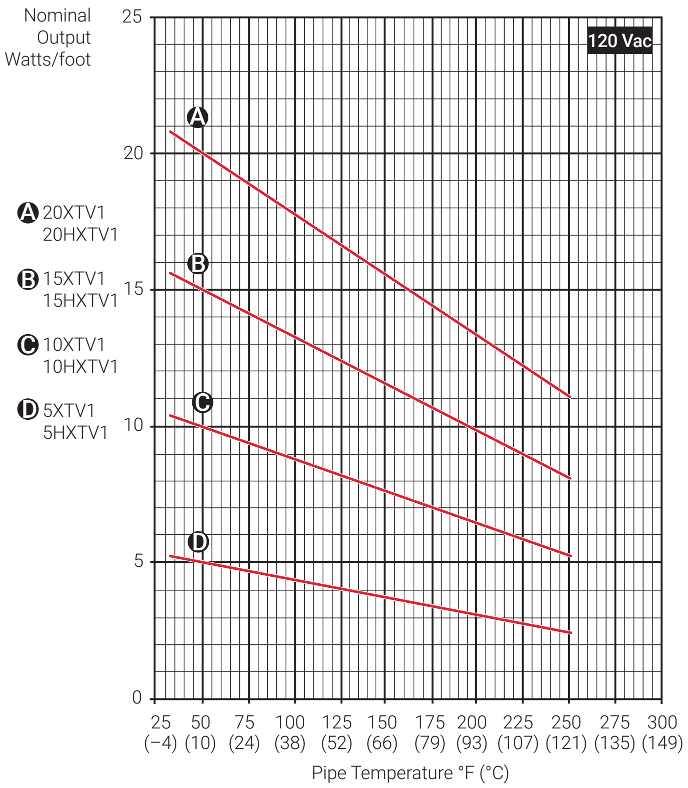
Graph 2 BTV, HBTV, QTVR, and HQTV nominal power output on metal pipes at 208 volts



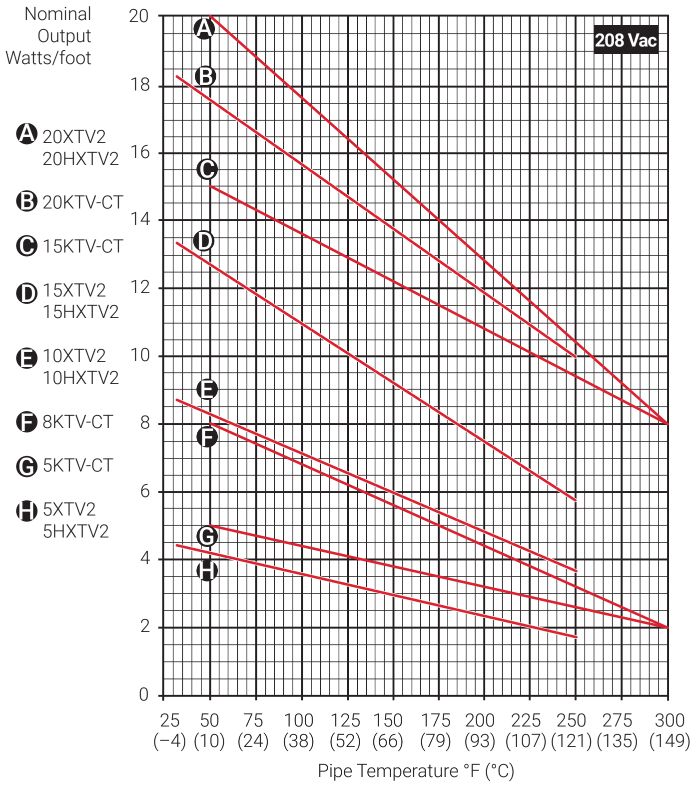
Graph 3 BTV, HBTV, QTVR, and HQTV nominal power output on metal pipes at 240 volts



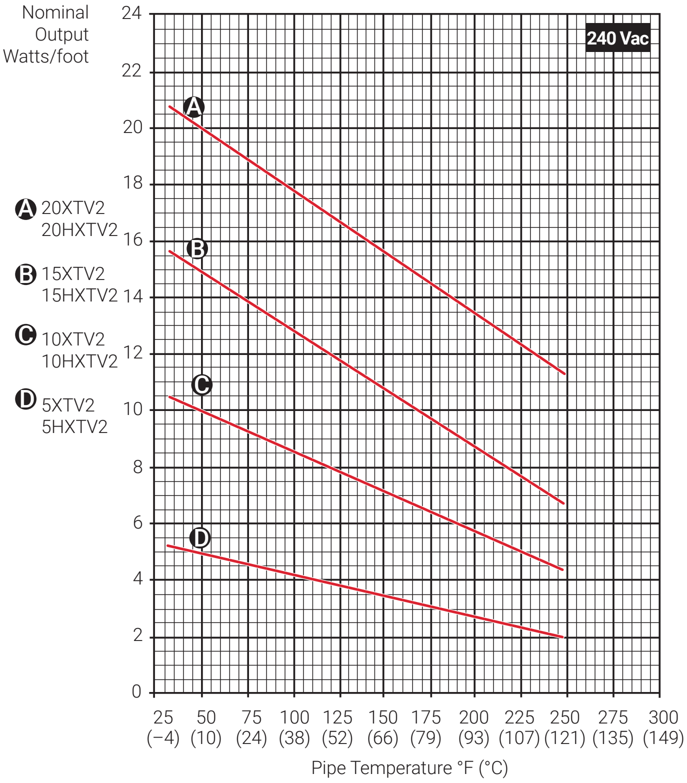
Graph 4 BTV, HBTV, QTVR, and HQTV nominal power output on metal pipes at 277 volts



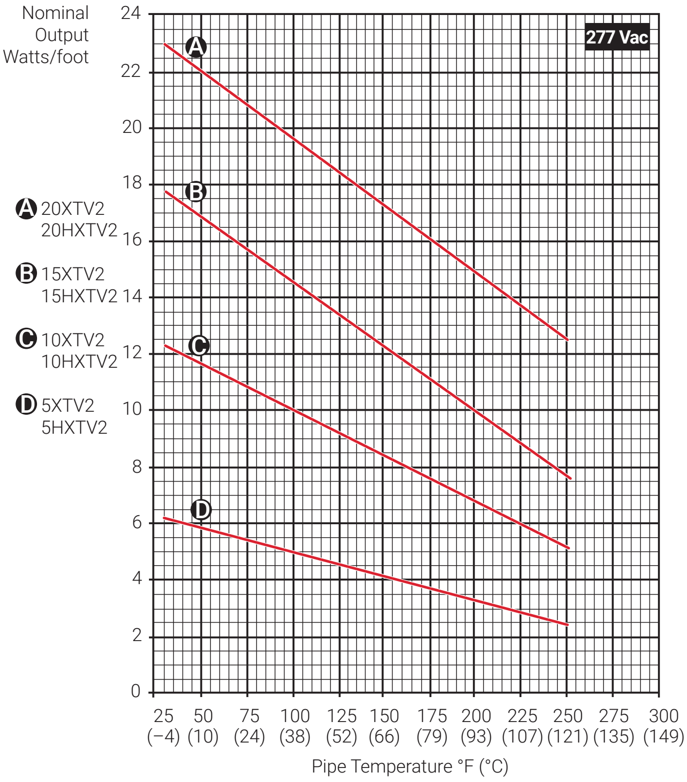
Graph 5 XTV and HXTV nominal power output on metal pipes at 120 volts



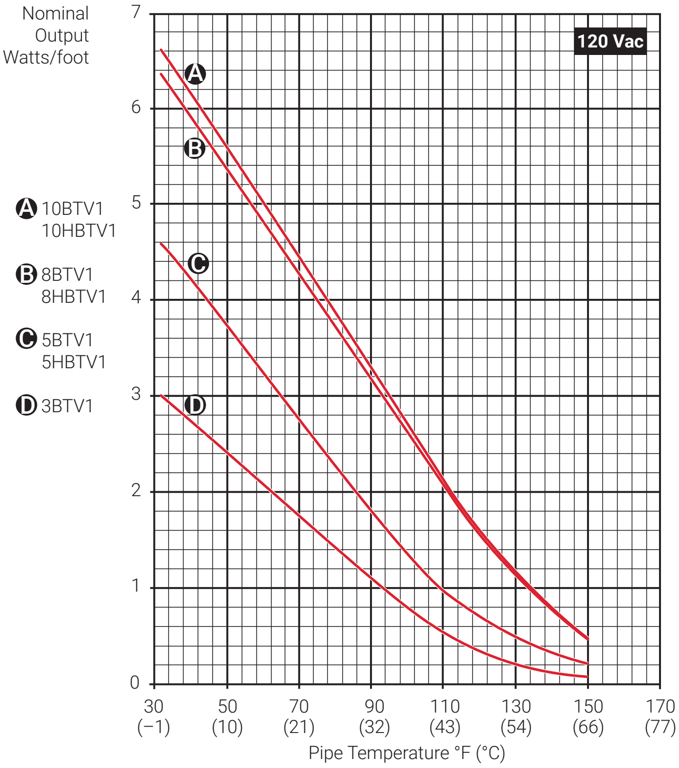
Graph 6 XTV and HXTV nominal power output on metal pipes at 208 volts



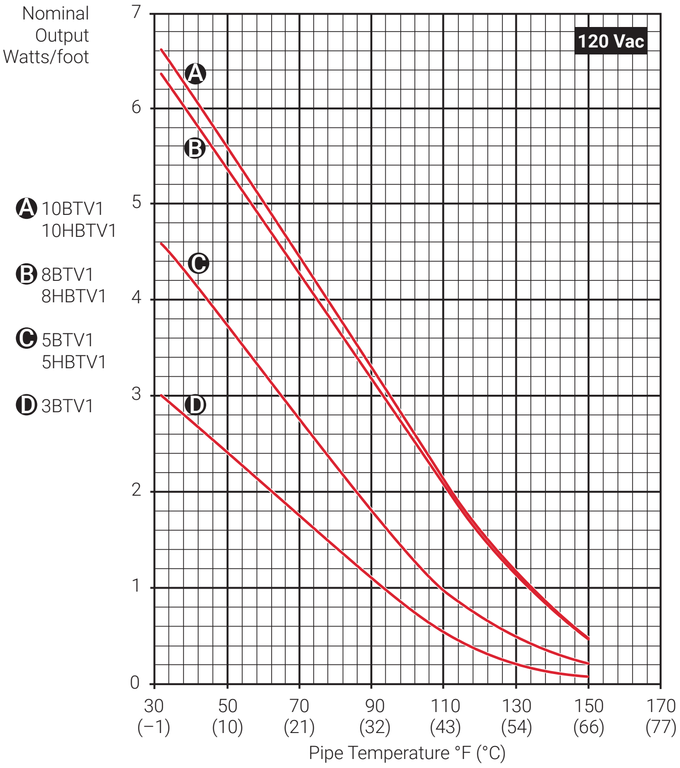
Graph 7 XTV and HXTV nominal power output on metal pipes at 240 volts



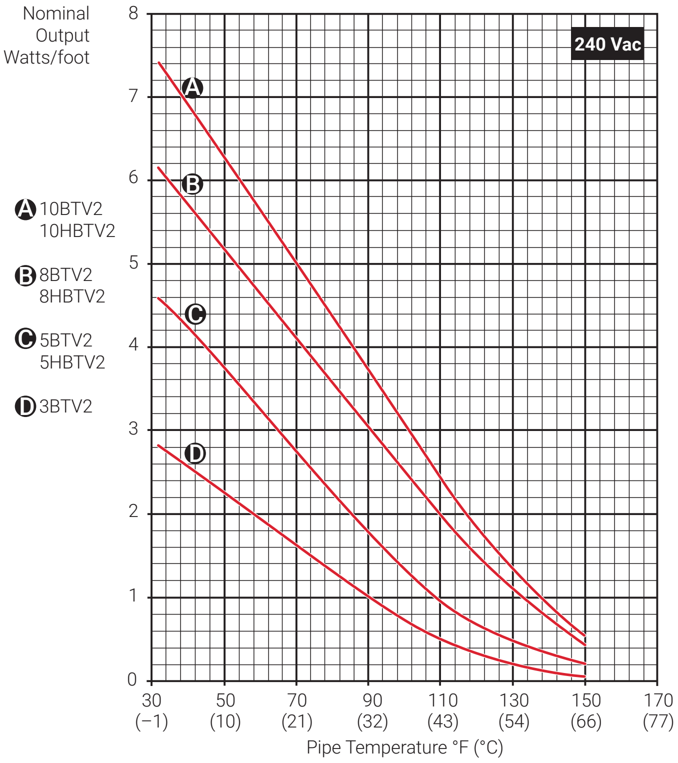
Graph 8 XTV and HXTV nominal power output on metal pipes at 277 volts



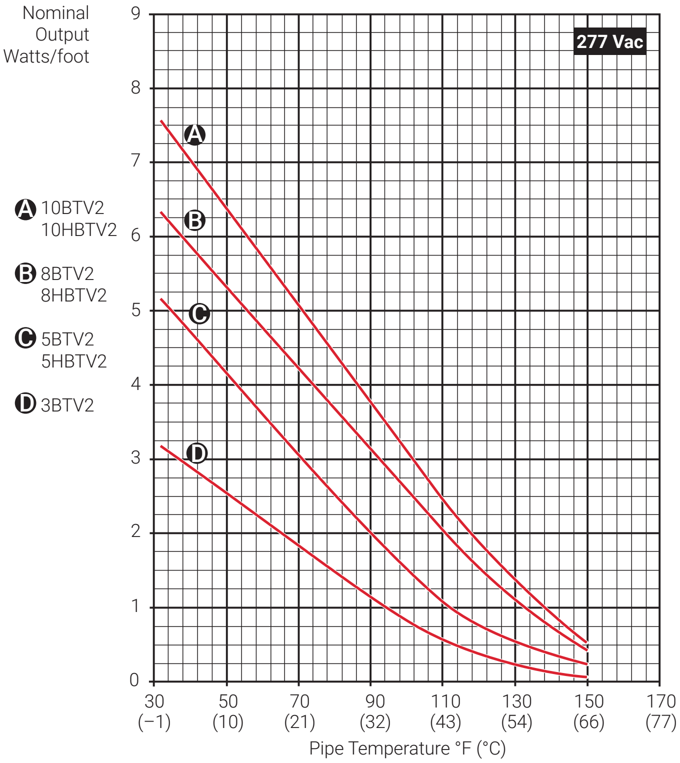
Graph 9 BTV and HBTV nominal power output on plastic pipes at 120 volts



Graph 10 BTV and HBTV nominal power output on plastic pipes at 208 volts



Graph 11 BTV and HBTV nominal power output on plastic pipes at 240 volts



Graph 12 BTV and HBTV nominal power output on plastic pipes at 277 volts

Heating Cable Selection
1. Gather information
2. Select heating cable family
3. Select service voltage
4. Determine power output rating
5. Select jacket type

Step 5 Select the jacket type

While nVent RAYCHEM QTVR, KTV and XTV heating cables are only available with a CT outer jacket, the BTV heating cables are also available in a CR version.

TABLE 6 HEATING CABLE OUTER JACKET OPTIONS

Option	Material	Application
CT	Fluoropolymer	Exposure to organic chemicals or corrosives
CR	Modified polyolefin	Exposure to aqueous inorganic chemicals

If you are unsure about the correct jacket for your application, select the CT version or contact your nVent representative for assistance.

Example: Jacket type selection

Input	10XTV1-xx heating cable (from Step 4)
Input	Organic chemicals
Jacket type	CT
Catalog number	10XTV1-CT

BILL OF MATERIALS

Now that you have selected the correct heating cable for your application, this section helps you to determine:

- Total length of heating cable required
- Electrical design, including circuit breaker sizing and selection
- Quantity and type of connection kits and accessories

Determining the Total Length of Heating Cable

To determine the total length of heating cable, follow these six steps:

1. Gather the necessary information:
   - Pipe length and diameter
   - Type and number of valves
   - Type and number of pipe supports
   - Start-up temperature
   - Number of circuits and tees in the piping
2. Calculate the total length of heating cable for the piping.
3. Calculate the total length of heating cable for the valves.
4. Calculate the total length of heating cable for the pipe supports.
5. Calculate additional heating cable for connection kit installation.
6. Add all the lengths together.

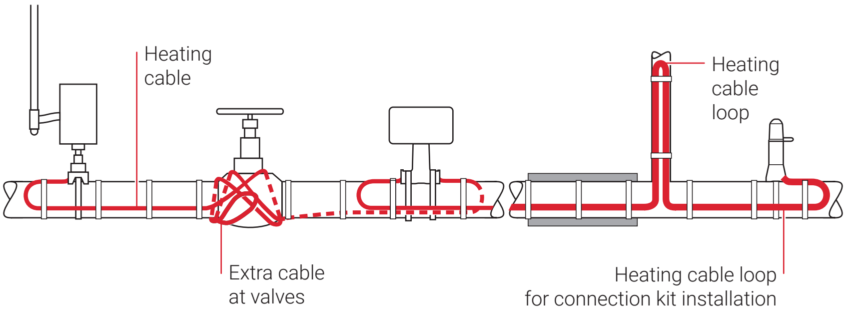


Fig. 7 Typical heating cable layout

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 1 Gather the necessary information

To determine the total length of heating cable, gather and record the following information:

- Pipe length and diameter ______________________
- Type and number of valves ______________________
- Type and number of pipe supports ______________________
- Start-up temperature ______________________
- Number of circuits and tees in piping ______________________

Example: Gather necessary information

Pipe length and diameter	100 feet of 6-inch pipe
Type and number of valves	Three 6-inch gate valves
Type and number of pipe supports	Support shoes, 10 each, 1-foot length
Start-up temperature	0°F
Number of circuits and tees in piping	Power connections: 1 End seals: 3 Pipe tees: 2

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 2 Calculate the total length of heating cable for the piping

Example: Total length of cable for piping calculation

100 ft of pipe (from Step 1) = 100 ft of cable for single tracing

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 3 Calculate the total length of heating cable for the valves

"Table 7" contains guidelines to determine the amount of additional heating cable required to compensate for heat loss on valves. For a more detailed analysis, use TraceCalc Pro design software or consult nVent.

Multiply the number of valves to arrive at the total additional footage of heating cable.

TABLE 7 RECOMMENDED VALVE ALLOWANCE

Pipe diameter (IPS) (inches)	Heating cable feet (meters)		Comments*
1/4	0.3	(0.09)	These recommendations are limited by the amount of heating cable that can physically be installed on small valves. Heat loss may not be fully compensated under extreme conditions.
1/2	0.8	(0.24)	
3/4	1.3	(0.4)	
1	2.0	(0.6)	
1-1/4	3.3	(1.1)	
1-1/2	4.3	(1.3)	
2	4.3	(1.3)	
3	4.3	(1.3)	
4	4.3	(1.3)	
6	5.0	(1.5)	
8	5.0	(1.5)	
10	5.6	(1.7)	These numbers represent the minimum amount of heating cable required for a service loop. Additional cable may be required to compensate for total heat loss.
14	7.3	(2.2)	
18	9.4	(2.9)	
24	12.6	(3.8)	

* Use TraceCalc Pro design software to calculate the exact quantity required for the valve.

Example: Heating cable length for valves calculation

From "Table 7" for a 6-inch diameter pipe,

Each valve requires:	5.0 ft
Cable needed for three valves:	3 x 5.0 ft
Total cable length needed for valves:	15.0 ft

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 4 Calculate the total length of heating cable for the pipe supports

SUPPORT SHOES

For each pipe support shoe, calculate the additional heating cable required as follows:

Determine the heat loss for one support.

- Formula: $Q_{SUPPORT} = 0.7L \times (T_M - T_A)$, where L = Support length (ft) (assumes a 0.25-inch steel welded shoe partially shielded from winds)
- Multiply that heat loss by the total number of supports.
- Add 10 percent to the total heat loss for added safety.
- Obtain the heating cable power output per foot from "Graph 5".
- Divide the total support heat loss by the heating cable power output per foot to get the number of feet of heating cable needed.

Example: Total length of cable for pipe supports calculation

Input	10XTV1-CT heating cable (from Cable Selection, Step 5)
Input	10 one-foot welded steel shoe supports (from Step 1)
Heat loss for one support	0.7 x 1 x (40–(–40)) = 56 W
Heat loss for all supports	10 x 56 W = 560 W
Add safety factor	560 W + 10% = 616 W
Heating cable power output	10.2 W/ft (from Step 3 of Cable Selection)
Heating cable required	616 W/10.2 W/ft = 60 ft of heating cable

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 5 Calculate additional heating cable for connection kit installation

Estimate the number of power connections, tees, and splices for the system. Allow an additional three feet for each connection kit.

Example: Include additional cable

Input	1 power connection, 3 end seals, 2 tees (from Step 1)
Total number of connection kits	6 (from Step 1)
Cable needed for 6 connection kits	6 x 3 ft of additional cable
Total cable length for 6 connection kits	18 ft of cable

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for supports
5. Calculate cable length for connection kits
6. Add all lengths

Step 6 Add all lengths together

Example: Final addition

Cable for piping	100 ft (from Step 1)
Cable for valves	15 ft (from Step 3)
Cable for supports	60 ft (from Step 4)
Cable for connection kits	18 ft (from Step 5)
Sum of all lengths	100 + 15 + 60 + 18 = 193 ft
Total length of heating cable	193 ft

Now that you have the total length of heating cable, you can determine the number of electrical circuits you will need.

Electrical Design

⚠ WARNING: Fire hazard
There is a danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed. To comply with nVent requirements, certifications, and national electrical codes, and to protect against the risk of fire, ground-fault equipment protection must be used on each heating cable circuit. Arcing may not be stopped by conventional circuit breakers.

DETERMINING MAXIMUM LENGTH OF HEATING CABLE ON ONE CIRCUIT BREAKER

Using "Table 8" and "Table 9", match the heating cable catalog number at the expected minimum start-up temperature with the total heating cable length and select a circuit breaker trip rating. The circuit breaker trip rating should not exceed the maximum trip rating shown for heating cables of that product family. For example, the trip rating of a circuit breaker protecting several 10XTV circuits should not exceed 50 amps. To maximize fault current protection, use the lowest allowable circuit breaker.

Maximum circuit length per breaker depends on four factors:

1. Heating cable family and catalog number
2. Minimum start-up temperature
3. Service voltage
4. Circuit breaker trip rating

TABLE 8 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

120- and240-volt heating cables applied to metal pipe with glass tape												
			120-volt cable					240-volt cable				
nVent RAYCHEM Heating cable	Start-up temperature		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
3BTV	50°F	(10°C)	330	330	330	330	†	660	660	660	660	†
	0°F	(−18°C)	200	265	330	330	†	395	530	660	660	†
	−20°F	(−29°C)	175	235	330	330	†	350	465	660	660	†
	−40°F	(−40°C)	155	205	310	330	†	310	410	620	660	†
5BTV	50°F	(10°C)	230	270	270	270	†	460	540	540	540	†
5HBTV	0°F	(−18°C)	140	190	270	270	†	285	380	540	540	†
	−20°F	(−29°C)	125	165	250	270	†	250	330	500	540	†
	−40°F	(−40°C)	110	145	220	270	†	220	295	440	540	†
8BTV	50°F	(10°C)	150	200	210	210	†	300	400	420	420	†
8HBTV	0°F	(−18°C)	100	130	200	210	†	200	265	400	420	†
	−20°F	(−29°C)	85	115	175	210	†	175	235	350	420	†
	−40°F	(−40°C)	80	105	155	210	†	155	210	315	420	†
10BTV	50°F	(10°C)	120	160	180	180	†	240	315	360	360	†
10HBTV	0°F	(−18°C)	80	110	160	180	†	160	215	325	360	†
	−20°F	(−29°C)	70	95	140	180	†	145	190	285	360	†
	−40°F	(−40°C)	65	85	125	170	†	125	170	255	340	†
10QTVR	50°F	(10°C)	100	130	195	195	†	200	265	390	390	†
12HQTV	0°F	(−18°C)	80	105	160	195	†	160	210	320	390	†
	−20°F	(−29°C)	70	95	145	195	†	145	195	295	390	†
	−40°F	(−40°C)	65	90	135	180	†	135	180	275	365	†
15QTVR	50°F	(10°C)	75	100	150	200	220	160	210	320	340	†
	0°F	(−18°C)	60	80	120	160	200	125	170	255	340	†
	−20°F	(−29°C)	55	70	110	145	185	115	155	235	315	†
	−40°F	(−40°C)	50	65	100	135	170	110	145	220	290	†
20QTVR	50°F	(10°C)	60	80	120	160	195	120	160	240	320	390
20HQTV	0°F	(−18°C)	45	60	95	125	160	95	125	190	255	320
	−20°F	(−29°C)	40	55	85	115	145	85	115	175	235	295
	−40°F	(−40°C)	40	55	80	110	135	80	110	165	220	275
5XTV	50°F	(10°C)	180	240	360	385	385	360	480	720	765	765
5HXTV	0°F	(−18°C)	160	210	320	385	385	315	420	625	765	765
	−20°F	(−29°C)	150	200	305	385	385	295	395	595	765	765
	−40°F	(−40°C)	145	195	290	385	385	285	380	570	760	765

TABLE 8 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

120- and240-volt heating cables applied to metal pipe with glass tape

nVent RAYCHEM Heating cable	Start-up temperature		120-volt cable					240-volt cable				
			15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
10XTV 10HXTV	50°F	(10°C)	110	145	220	270	270	220	295	440	540	540
	0°F	(−18°C)	95	130	195	260	270	195	260	385	515	540
	−20°F	(−29°C)	95	125	190	250	270	185	245	370	495	540
	−40°F	(−40°C)	90	120	180	240	270	175	235	355	470	540
15XTV 15HXTV	50°F	(10°C)	75	100	150	200	220	150	200	300	400	445
	0°F	(−18°C)	65	90	135	180	220	130	175	265	355	440
	−20°F	(−29°C)	65	85	130	170	215	125	165	250	335	420
	−40°F	(−40°C)	60	80	125	165	205	120	160	240	320	405
20XTV 20HXTV	50°F	(10°C)	60	80	120	160	190	115	150	230	305	380
	0°F	(−18°C)	50	70	105	140	180	100	135	205	275	345
	−20°F	(−29°C)	50	65	100	135	170	100	130	200	265	330
	−40°F	(−40°C)	50	65	100	130	165	95	125	190	255	320
5KTV	50°F	(10°C)	180	240	360	385	385	360	480	720	765	765
	0°F	(-18°C)	160	215	320	385	385	320	430	640	765	765
	−20°F	(-29°C)	155	205	305	385	385	310	415	620	765	765
	−40°F	(−40°C)	145	195	290	385	385	300	400	600	765	765
8KTV	50°F	(10°C)	130	170	260	300	300	260	345	515	600	600
	0°F	(-18°C)	115	150	225	300	300	230	310	465	600	600
	−20°F	(-29°C)	110	145	215	290	300	225	295	445	595	600
	−40°F	(−40°C)	105	140	205	275	300	215	285	430	570	600
15KTV	50°F	(10°C)	80	105	160	215	220	160	215	320	425	440
	0°F	(-18°C)	75	95	145	195	220	145	190	285	385	440
	−20°F	(-29°C)	70	95	140	185	220	140	185	275	370	440
	−40°F	(−40°C)	65	90	135	180	220	135	180	265	355	440
20KTV	50°F	(10°C)	55	75	115	155	185	115	155	230	305	375
	0°F	(-18°C)	50	70	105	140	175	105	140	210	280	350
	−20°F	(-29°C)	50	65	100	135	165	100	135	200	270	335
	−40°F	(−40°C)	50	65	95	130	160	95	130	195	260	325

† Not permitted

For a fully optimized design, use TraceCalc Pro design software or contact your nVent representative.

Note: nVent and the U.S. National Electrical Code require both ground-fault protection of equipment and agrounded metallic covering (usually braid) on all heating cables. All nVent RAYCHEM products meet the metallic covering requirement. Following are some of the ground-fault breakers that satisfy this equipment protection requirement: Square D Type QOB-EPD or QO-EPD; nVent RAYCHEM/Square D Type GFPD EHB-EPD (277 Vac); Cutler Hammer (Westinghouse) Type QBGFEP.

TABLE 9 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

208- and 277-volt heating cables applied to metal pipe with glass tape

nVent RAYCHEM Heating cable	Start-up temperature		208-volt cable					277-volt cable				
			15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
3BTV	50°F	(10°C)	635	635	635	635	†	710	710	710	710	†
	0°F	(−18°C)	380	510	635	635	†	425	570	710	710	†
	−20°F	(−29°C)	335	445	635	635	†	360	500	710	710	†
	−40°F	(−40°C)	300	395	595	635	†	335	440	670	710	†
5BTV 5HBTV	50°F	(10°C)	430	505	505	505	†	500	590	590	590	†
	0°F	(−18°C)	270	355	505	505	†	310	415	590	590	†
	−20°F	(−29°C)	235	310	470	505	†	270	360	545	590	†
	−40°F	(−40°C)	210	275	415	505	†	240	320	480	590	†

TABLE 9 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

208- and 277-volt heating cables applied to metal pipe with glass tape												
			208-volt cable					277-volt cable				
nVent RAYCHEM Heating cable	Start-up temperature		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
8BTV	50°F	(10°C)	275	370	385	385	†	330	445	465	465	†
8HBTV	0°F	(−18°C)	185	245	370	385	†	220	295	445	465	†
	−20°F	(−29°C)	160	215	320	385	†	195	260	390	465	†
	−40°F	(−40°C)	145	190	290	385	†	170	230	350	465	†
10BTV	50°F	(10°C)	220	290	330	330	†	265	350	400	400	†
10HBTV	0°F	(−18°C)	145	200	300	330	†	180	240	360	400	†
	−20°F	(−29°C)	130	175	260	330	†	160	210	315	400	†
	−40°F	(−40°C)	115	155	235	310	†	140	190	280	375	†
10QTVR	50°F	(10°C)	190	250	365	365	†	210	280	415	415	†
12HQTV	0°F	(−18°C)	150	195	300	365	†	170	225	340	415	†
	−20°F	(−29°C)	135	180	275	365	†	155	205	315	415	†
	−40°F	(−40°C)	125	170	260	345	†	140	190	290	385	†
15QTVR	50°F	(10°C)	145	190	290	310	†	175	230	350	375	†
	0°F	(−18°C)	115	155	230	310	†	140	185	280	375	†
	−20°F	(−29°C)	105	140	215	285	†	125	170	260	345	†
	−40°F	(−40°C)	100	130	200	265	†	120	160	240	320	†
20QTVR	50°F	(10°C)	110	145	220	290	355	135	180	265	355	430
20HQTV	0°F	(−18°C)	85	115	175	230	290	105	140	210	280	355
	−20°F	(−29°C)	80	105	160	215	270	95	130	195	260	325
	−40°F	(−40°C)	75	100	150	200	250	90	120	180	245	305
5XTV	50°F	(10°C)	355	475	715	755	755	390	520	780	825	825
5HXTV	0°F	(−18°C)	310	415	620	755	755	340	455	675	825	825
	−20°F	(−29°C)	290	390	590	755	755	320	425	645	825	825
	−40°F	(−40°C)	280	375	565	750	755	310	410	615	820	825
10XTV	50°F	(10°C)	215	290	435	535	535	235	315	465	570	570
10HXTV	0°F	(−18°C)	190	255	380	510	535	205	275	410	545	570
	−20°F	(−29°C)	180	240	365	490	535	195	260	390	525	570
	−40°F	(−40°C)	170	230	350	465	535	185	250	375	500	570
15XTV	50°F	(10°C)	145	195	295	390	435	160	210	320	425	470
15HXTV	0°F	(−18°C)	125	170	260	345	430	140	185	280	375	465
	−20°F	(−29°C)	120	160	245	325	410	135	175	265	355	445
	−40°F	(−40°C)	120	155	235	315	400	125	170	255	340	430
20XTV	50°F	(10°C)	115	150	230	305	380	125	160	250	330	410
20HXTV	0°F	(−18°C)	100	135	205	275	345	110	145	220	300	375
	−20°F	(−29°C)	100	130	200	265	330	110	140	215	285	355
	−40°F	(−40°C)	95	125	190	255	320	105	135	205	275	345
5KTV	50°F	(10°C)	340	450	680	720	720	380	510	765	810	810
	0°F	(−18°C)	300	405	600	720	720	340	455	680	810	810
	−20°F	(−29°C)	290	390	585	720	720	330	440	660	810	810
	−40°F	(−40°C)	280	375	565	720	720	320	425	635	810	810
8KTV	50°F	(10°C)	245	325	485	565	565	275	365	545	635	635
	0°F	(−18°C)	215	290	440	565	565	245	330	495	635	635
	−20°F	(−29°C)	210	280	420	560	565	240	315	470	630	635
	−40°F	(−40°C)	200	270	405	535	565	230	300	455	600	635

TABLE 9 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

208- and 277-volt heating cables applied to metal pipe with glass tape

			208-volt cable					**277-volt cable**				
nVent RAYCHEM Heating cable	**Start-up temperature**		**15 A**	**20 A**	**30 A**	**40 A**	**50 A**	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
15KTV	50°F	(10°C)	150	200	300	400	415	170	230	340	450	465
	0°F	(–18°C)	135	180	270	360	415	155	200	300	410	465
	–20°F	(–29°C)	130	175	260	350	415	150	195	290	390	465
	–40°F	(–40°C)	125	170	250	335	415	145	190	280	375	465
20KTV	50°F	(10°C)	110	145	215	285	355	120	165	245	325	400
	0°F	(–18°C)	100	130	200	265	330	110	150	225	300	370
	–20°F	(–29°C)	95	125	190	255	315	105	145	210	285	355
	–40°F	(–40°C)	90	120	185	245	305	100	140	205	275	345

† Not permitted

⚠ Note: nVent and the U.S. National Electrical Code require both ground-fault protection of equipment and agrounded metallic covering (usually braid) on all heating cables. All nVent RAYCHEM products meet the metallic covering requirement. Following are some of the ground-fault breakers that satisfy this equipment protection requirement: Square D Type QOB-EPD or QO-EPD; nVent RAYCHEM/ Square D Type GFPD EHB-EPD (277 Vac); Cutler Hammer (Westinghouse) Type QBGFEP.

Example: Determine maximum length of heating cable on one circuit breaker

Input	10XTV1 heating cable (from Cable Selection, Step 3)
Input	120 volts (from Cable Selection Step 1)
Input	0°F start-up temperature (from Cable Selection, Step 1)
Input	Maximum circuit length = 195 feet on a 30-amp breaker (from Table 8)

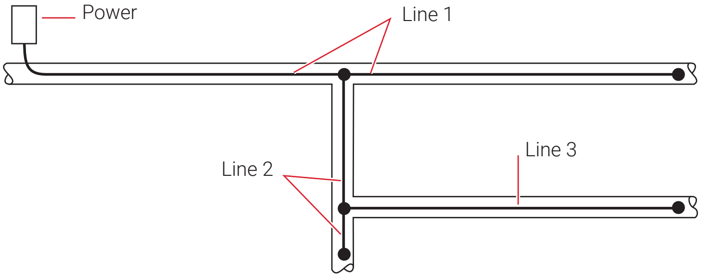
If the total length of cable exceeds 195 feet, you must use a 40-amp circuit breaker, which allows up to 260 feet.

DETERMINE MINIMUM NUMBER OF CIRCUITS

Example: Minimum number of circuits calculation

Input	195 ft allowed per 30-amp circuit (from "Table 8")
Input	Total circuit length = 193 ft (from Bill of Materials, Step 6)
Number of circuits	1 circuit

If the total length of heating cable required exceeded 195 ft, you would need to split the total length into two separate circuits or use a larger circuit breaker size.



Line 1 + Line 2 + Line 3 ≤ Maximum circuit length

Fig. 8 Maximum heating cable circuit length

Ground-fault protection

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

Connection Kit Selection and Accessories

⚠ WARNING: Fire hazard

To prevent fire or shock, nVent RAYCHEM brand specified connection kits must be used. Do not substitute parts or use vinyl electrical tape.

OVERVIEW

nVent offers a full range of connection kits for power connections, splices, and end seals on self-regulating cable systems. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

Different power connection, end seal, splice, and tee kits are required depending on the area classification. The data sheets for these connection kits are included in the Technical Data section.

Data sheets can be found on the nVent web site, nVent.com, or the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalog (H56550).

NON-HAZARDOUS AND HAZARDOUS LOCATION CONNECTION KITS

"Figure 9" shows the connection kits and accessories available for self-regulating heating systems.

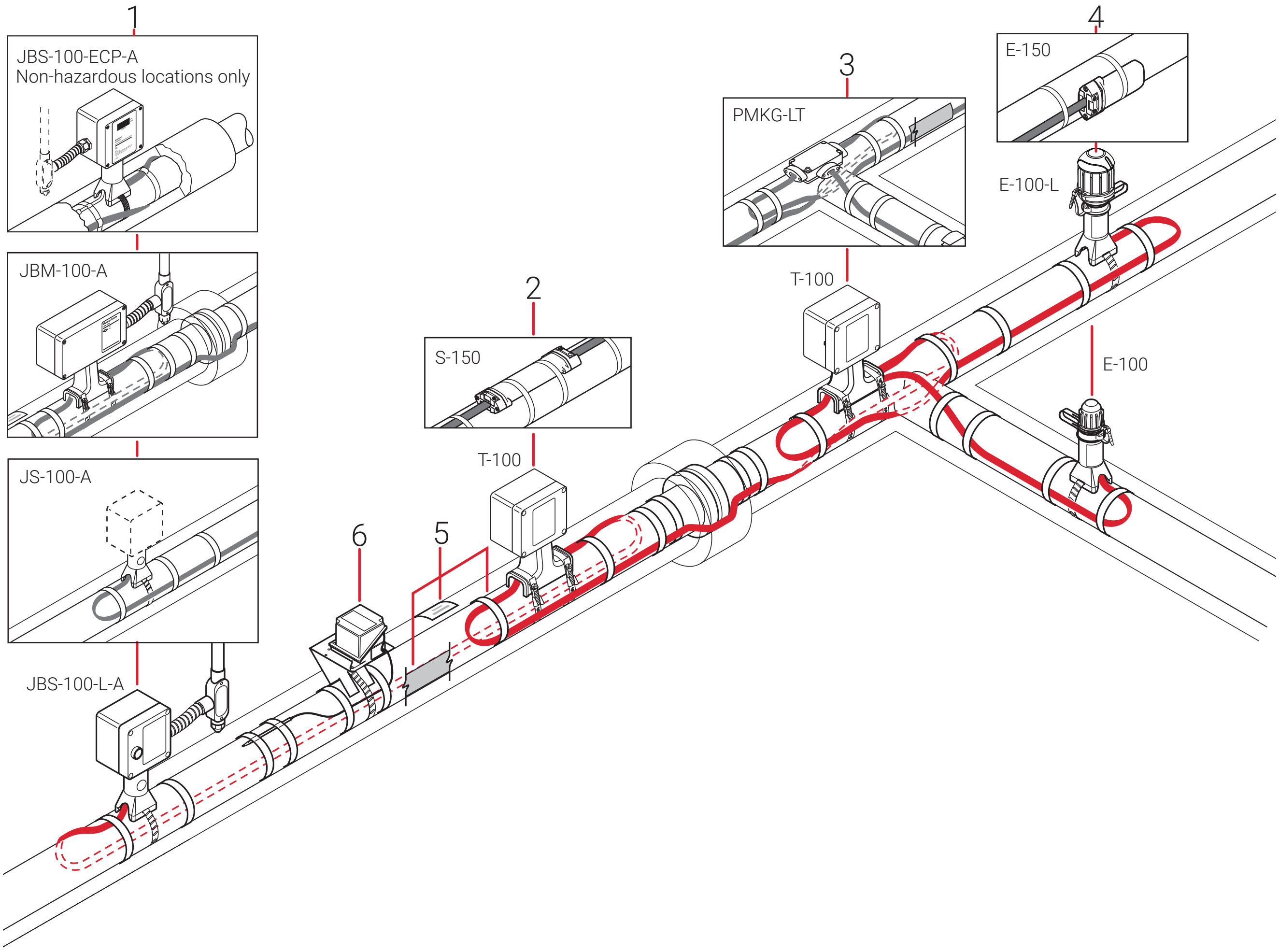


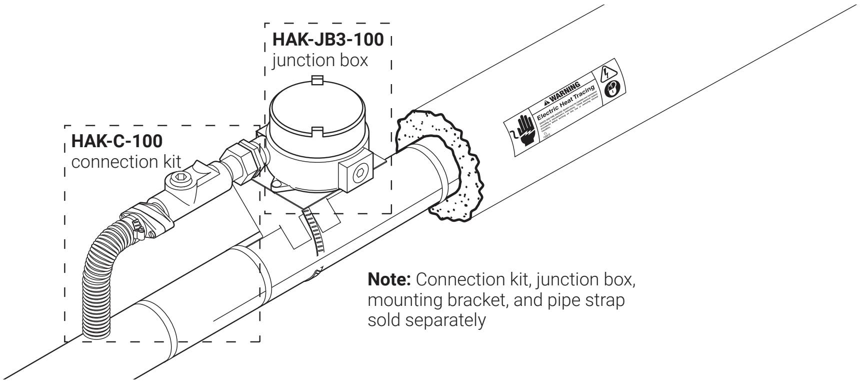
Fig. 9 nVent RAYCHEM Self-regulating heating system connection kits and accessories

TABLE 10 NONHAZARDOUS AND HAZARDOUS NVENT RAYCHEM HEATING CABLE FAMILY CONNECTION KITS AND ACCESSORY SELECTION

Description	Catalog number	Quantity
Connection Kits		
❶ **Power connection**		1 per circuit
Single heating cable	JBS-100-A	
Single heating cable with light	JBS-100-L-A	
Single heating cable with digital electronic controller	JBS-100-ECP-A (nonhazardous locations only)	
Single heating cable (user-supplied junction box)	JS-100-A	
Multiple heating cables (1, 2, or 3)	JBM-100-A	
Multiple heating cable with light	JBM-100-L-A	
❷ **Splice connection**		1 per splice
Above insulation	T-100	
Below insulation	S-150	
❸ **Tee connection**		1 per tee
Above insulation	T-100	
Below insulation	PMKG-LT (BTV and QTVR only)	
❹ **End seal**		1 per power connection plus 1 per tee
Above insulation	E-100	
Above insulation with light	E-100-L-A	
Below insulation	E-150	
Accessories		
❺ Attachment tape, labels, and pipe straps		
Controls (optional)		
❻ Thermostat — Control and Monitoring design guide (H56889)		

CID1 HAZARDOUS LOCATION CONNECTION KITS

All power connections, splices, tees, and end seals in a Division 1 location must use the nVent RAYCHEM HAK-C-100 connection kit and an HAK-JB3-100 or a Division 1 Nationally Recognized Testing Lab (NRTL) approved junction box.



Note: Connection kit, junction box, mounting bracket, and pipe strap sold separately

Fig. 10 CID1 hazardous location connection kits

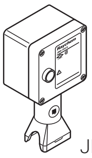
TABLE 11 CID1 CONNECTION KIT SELECTION

				Additional wmaterials required	
Connection type	**Number of HAK-C-100 kits required**	**Number of holes required on the junction box**	**Junction box catalog number**	**Mounting brackets***	**Pipe straps**
Power	1	2	HAK-JB3-100	1	1
Splice	2	2	HAK-JB3-100	1	1
Tee	3	3	HAK-JB3-100	1	1
End seal	1	1	HAK-JB3-100	1	1

* Catalog number UMB

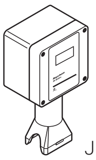
The nVent RAYCHEM HAK-C-100 kit is FM approved and CSA certified to be used for all power connections, splices, tees, and end seals in Division 1 locations.

System Connection Kits

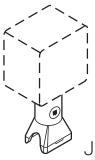

JBS-100-A

nVent RAYCHEM JBS-100-A Power connection for one heating cable in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.

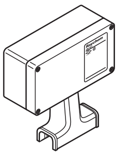
With LED indicator light, order JBS-100-L-A


JBS-100-ECP-A

nVent RAYCHEM JBS-100-ECP-A Power connection and digital electronic controller. Requires one pipe strap to be ordered separately. Non-hazardous locations only.

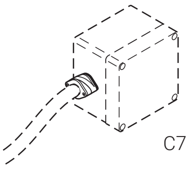

JS-100-A

nVent RAYCHEM JS-100-A Junction box stand for one heating cable in nonhazardous and hazardous locations. A separate customer-supplied NEMA 4X junction box is required. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.

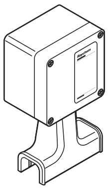

JBM-100-A

nVent RAYCHEM JBM-100-A Multiple-entry power connection for up to three heating cables. Can also be used as a splice or tee connection. For use in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires two pipe straps to be ordered separately.

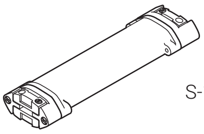
With LED indicator light, order JBM-100-L-A.


C75-100-A

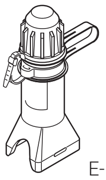
nVent RAYCHEM C75-100-A A NEMA 4X-rated gland kit (3/4" NPT) used to transition heating cables into a junction box in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal. A terminal block (3 x 12 AWG) is included. This kit does not include the junction box or the conduit.


T-100

nVent RAYCHEM T-100 Tee or splice connection for up to three heating cables in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires two pipe straps to be ordered separately.

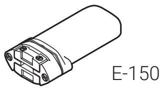

S-150

nVent RAYCHEM S-150 Splice kit for heating cables in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal.

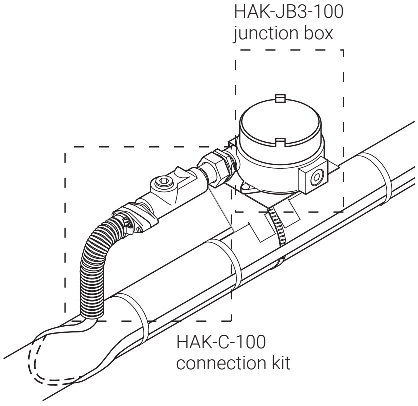

E-100-A

nVent RAYCHEM E-100-A End seal for heating cable in non-hazardous and hazardous locations. Reenterable. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.

With LED indicator light, order E-100-L-A



nVent RAYCHEM E-150 Low-profile end seal for heating cable in non-hazardous and hazardous locations. Includes cold-applied heating cable core seal.



nVent RAYCHEM HAK-C-100 CID1 hazardous location connection kit for one heating cable. Junction box ordered separately.

nVent RAYCHEM HAK-JB3-100 CID1 hazardous location junction box for up to three entries. Requires one pipe strap and a universal mounting bracket (UMB) to be ordered separately.

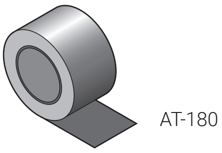
ACCESSORIES

nVent RAYCHEM GT-66 Glass Installation Tape

- For use on pipes other than stainless steel
- 1/2" x 66' roll
- Strap at 1-foot intervals at minimum application temperature of 40°F (5°C)

nVent RAYCHEM GS-54 Glass Installation Tape

- For use on all pipes, particularly stainless steel
- 1/2" x 54' roll
- Strap at 1-foot intervals at minimum application temperature of –40°F (–40°C)



nVent RAYCHEM AT-180 Aluminum Tape

- For use on all pipe materials
- 2-1/2" x 180' roll
- Temperature class: 300°F (150°C)
- Minimum installation temperature: 32°F (0°C)

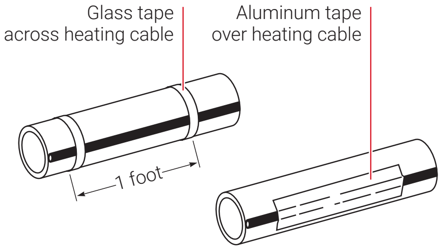
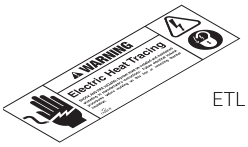


Fig. 11 Tape installation

TABLE 12 ATTACHMENT TAPE REQUIREMENTS

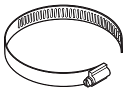
Tape type	Rolls needed per 100 ft of cable Pipe diameter (IPS) in inches 1/2	1	2	3	4	6	8
GT-66	0.6	1.2	4	4	6	8	10
GS-54	0.6	1.2	4	6	6	10	12
AT-180	Use one foot of tape per foot of heating cable						



ETL

ETL (Electric Traced Label)

Attach the label to the outside of the thermal insulation weather barrier to indicate presence of electrical heat tracing. Use one label for every 10 feet (3 m) of pipe, alternating on either side of the pipe.



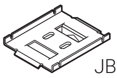
Pipe strap

Pipe Straps

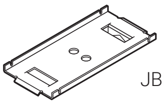
Stainless steel pipe straps to attach connection kit to the heat-traced pipe. Use Table 13 below to assist with pipe strap selection.

TABLE 13 PIPE STRAP SELECTION

Catalog number	Pipe size
PS-01	For conduit ≤ 1"
PS-03	For connection kits on pipes with dimensions < 2"
PS-10	For connection kits on pipes with dimensions 2" – 10"
PS-20	For connection kits on pipes with dimensions 10" – 19.5"



JBS-SPA

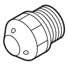


JBM-SPA

Small Pipe Adapters

JBS-SPA Adapter for mounting nVent RAYCHEM E-100, JBS-100, and JS-100-A to small pipe. (≤ 1" diameter)

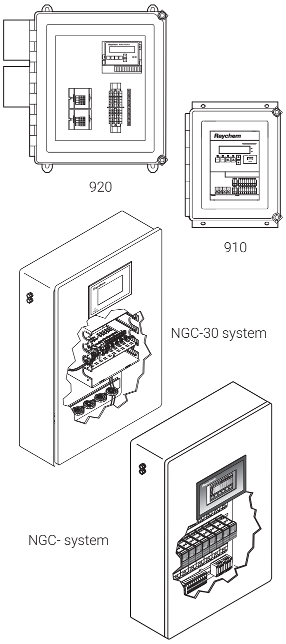
JBM-SPA Adapter for mounting JBM-100 and T-100 to small pipe. (≤ 1" diameter)



JB-DRAIN-PLUG-3/4IN

Conduit Drain

JB-DRAIN-PLUG-3/4IN Conduit drain for JBS-100, JBM-100, and JS-100-A.



920

910

NGC-30 system

NGC- system

Controls

For a complete selection of control and monitoring products, including thermostats, see Control and Monitoring design guide (H56889)

POWER-LIMITING CABLES

This section provides general design guidelines for nVent RAYCHEM power-limiting heat-tracing systems installed on insulated metal pipes. For other applications or design assistance, contact your nVent representative or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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INTRODUCTION

nVent power-limiting heating cables are the preferred technology for applications requiring high power output at elevated temperatures. nVent RAYCHEM VPL heating cables can be used for high maintain temperatures ranging up to 455°F (235°C), depending on cable selection, and can withstand routine steam purges and temperature excursions to 500°F (260°C) with power off.

VPL also can provide a cost-effective alternative to self-regulating heating cables when more than a single run of cable is required (trace ratio > 1).

nVent power-limiting cables have been certified for use in hazardous and non-hazardous locations.

Power-Limiting Technology

nVent power-limiting cables are parallel heating cables formed by a coiled resistor alloy heating element wrapped around two parallel bus wires. At a fixed distance, the insulation is removed from one of the bus wires. The process is repeated, removing the insulation from the other bus wire. This distance between contact points forms the heating zone length.

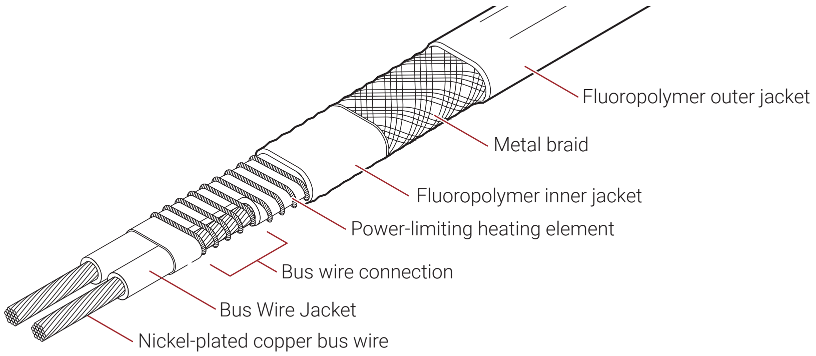


Fig. 1 **Heating cable construction**

The Positive Temperature Coefficient (PTC) of the heating element reduces power output as ambient temperature increases. This effect allows the power-limiting cable to be crossed over itself since the temperature of the heating element is reduced at the cross over points.

SYSTEM OVERVIEW

Typical Power-Limiting System

A typical power-limiting heating cable system is shown in Figure 2. The heating cable is cut to length at the job site and attached to the pipe with glass tape. A power connection kit connects the heating cable bus wires to power in a junction box. Tees and splices accommodate pipe branches to connect two or three heating cables together. An end seal kit is used to terminate the end of the heating cable. These required connection kits are designed and approved to provide a safe and reliable heat-tracing system. For applications requiring tight temperature control, electrical system monitoring, or remote operation, consider a control and monitoring system.

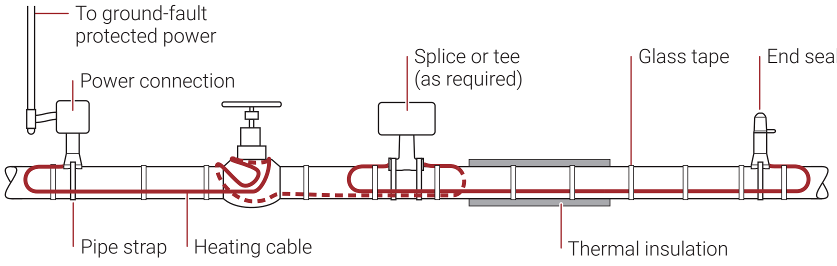


Fig. 2 **Typical power-limiting heating cable system**

Approvals and Certifications

nVent self-regulating systems are approved and certified for use in non-hazardous and hazardous locations by many agencies. Please refer to technical data sheets for more details.

THERMAL DESIGN

The thermal design of a power-limiting heat-tracing system follows the same steps as for a self-regulating system. Refer to Self-Regulating Cables design guide (H56882): Thermal Design section, to determine the pipe heat loss for your application.

The example below can be used to follow the steps for a manual design with VPL power-limiting heating cables.

For an optimized design, use our TraceCalc Pro design software or contact your nVent representative.

HEATING CABLE SELECTION

If your application requires a high maintain temperature up to 455°F (235°C), the heating cable selection process involves three basic steps:

1. Gather the following information:
   - Pipe size and material
   - Insulation type and thickness
   - Maintain temperature (T_M)
   - Minimum ambient temperature (T_A)
   - Minimum start-up temperature
   - Service voltage
   - Chemical environment
   - Maximum intermittent exposure temperature*
   - Electrical area classification**
2. Select the heating cable service voltage.
3. Determine the heating cable power output rating.

* Determines whether a higher exposure temperature heating cable is needed.

** Determines whether special design requirements and connection kits must be used.

For higher maintain temperatures or where more power is required, refer to the Mineral Insulated Cables design guide (H56844) for product selection, or contact your nVent representative.

If your application is in a hazardous location, you must determine the maximum sheath temperature. Power-limiting heating cables do not have an unconditional T-rating as do self-regulating cables. The maximum sheath temperature of the cable must be calculated to ensure that it is compatible with the hazardous location requirements. Use TraceCalc Pro design software or contact your nVent representative.

Heating Cable Catalog Number

Before beginning, take a moment to understand the structure underlying heating cable catalog numbers. You will refer to this numbering convention throughout the product selection process. Your goal is to determine the catalog number for the product that best suits your needs.

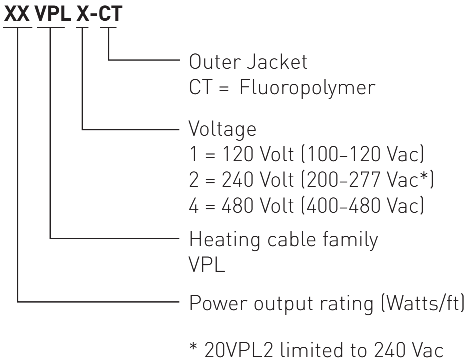


Fig. 3 Heating cable catalog number

Heating Cable Selection

1. Gather information
2. Select service voltage
3. Determine power output rating

Step 1 Gather the necessary information

To select the heating cable, gather and record the following information:

- Pipe size and material ____________________
- Insulation type and thickness ____________________
- Maintain temperature (T_M) ____________________
- Minimum ambient temperature (T_A) ____________________
- Minimum start-up temperature ____________________
- Service voltage ____________________
- Chemical environment ____________________
- Maximum intermittent exposure temperature* ____________________
- Electrical area classification** ____________________

Example: Gather necessary information

Pipe size and material	2 inch, carbon steel
Insulation type and thickness	Fiberglass, 3 inch
Maintain temperature (Tm)	280°F
Minimum ambient temperature (Ta)	–40°F
Minimum start-up temperature	0°F
Service voltage	120 Vac
Chemical environment	Chlorides
Maximum intermittent exposure temperature*	450°F
Electrical area classification**	Non-hazardous

* Determines whether a higher exposure temperature heating cable is needed.

** Determines whether special design requirements and connection kits must be used.

Heating Cable Selection

1. Gather information
2. Select service voltage
3. Determine power output rating

Step ❷ Select the heating cable service voltage

Service voltage options:
1 = 120 volts (100–120 Vac)
2 = 240 volts (200–277 Vac*)
4 = 480 volts (400–480 Vac)

Example: Service voltage selection

Input	120 volts (from Step 1)

Catalog number xVPL1-CT

* 20VPL2 limited to 240 Vac

Heating Cable Selection

1. Gather information
2. Select service voltage
3. Determine power output rating

Step ❸ Determine the heating cable power output rating

Using Graphs 1 and 2 on page 40 or Graph 3 on page 41 locate the heating cable with thermal output greater than the heat loss (Q_T) at the pipe maintain temperature (T_M).

If the pipe heat loss, Q_T is in between the two heating cable power output curves, select the higher-rated heating cable. If Q_T is greater than the power output of the highest-rated heating cable, you can:

- Use two or more heating cables run in parallel.
- Spiral the heating cable.
- Use thicker insulation to reduce heat loss.
- Use insulation material with a lower k factor.

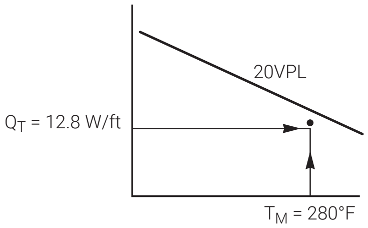


Fig. 4 Heating cable thermal output

Following the thermal design steps described in the Self-Regulating Cables design guide (H56882):

$Q_T = 11.8\ \text{W/ft} + [2/5 \times (14.3 - 11.8)]$

$Q_T = 12.8\ \text{W/ft}$

Spiraling

If spiraling is elected, use the formula below to determine the spiral factor (length of heating cable per foot of pipe):

Spiral factor = Q_T / Heater power output at T_M

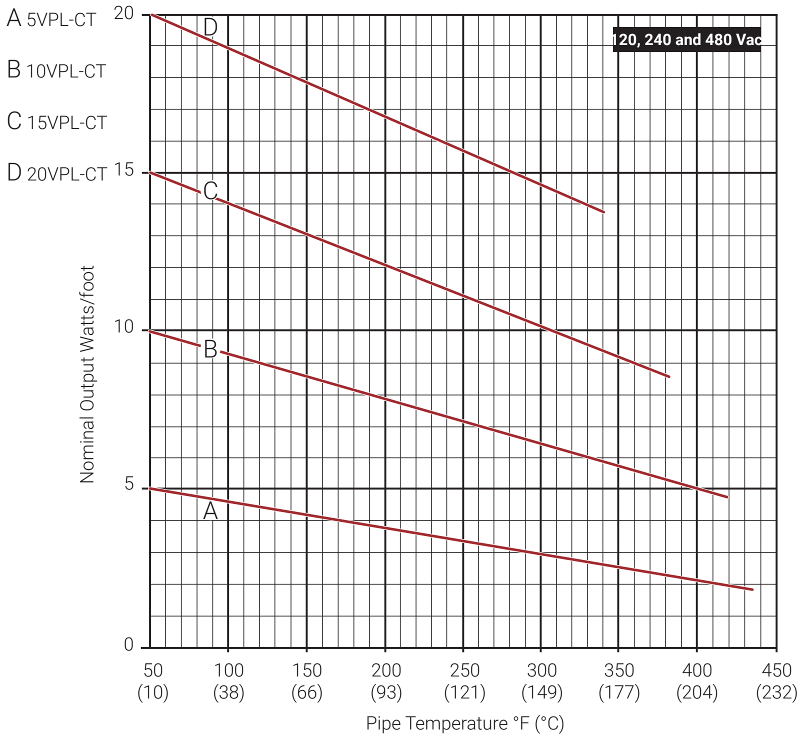
When the spiral factor exceeds 1.6 or the pipe size is less than three inches, consider using two or more heating cables run in parallel rather than spiraling.

Example: Power output selection

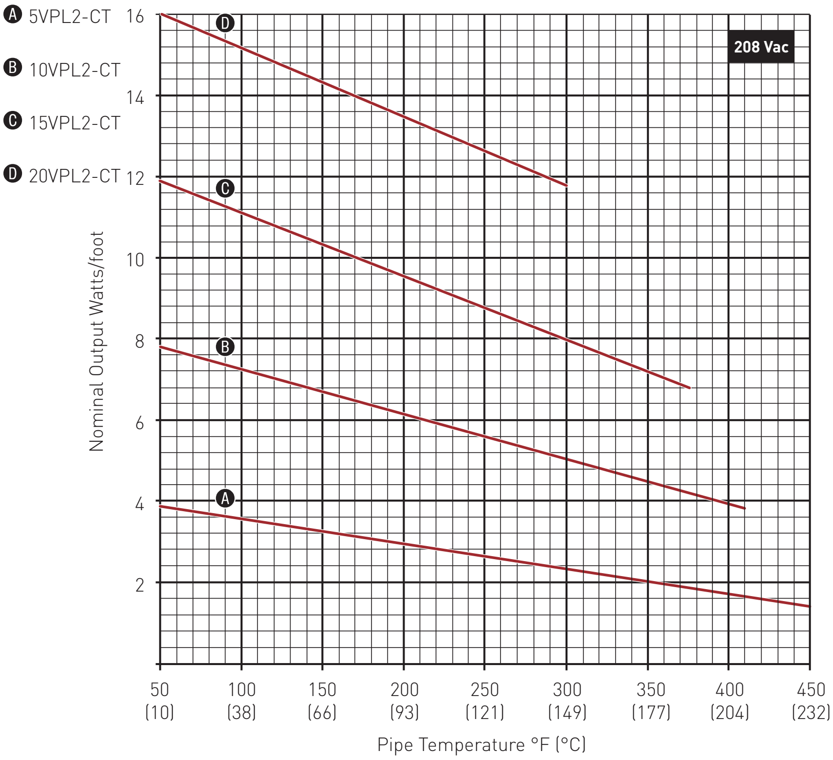
Input	VPL heating cable (determined earlier in this step)
Input	Power output rating = 20 (determined earlier in this step)
Input	Heat loss is 12.8 W/ft (from Self-Regulating Cables)
Input	20VPL output of 15.3 W/ft exceeds 12.8 W/ft at 280°F (Graph 1 page 40)

Catalog number **20VPL1-CT**

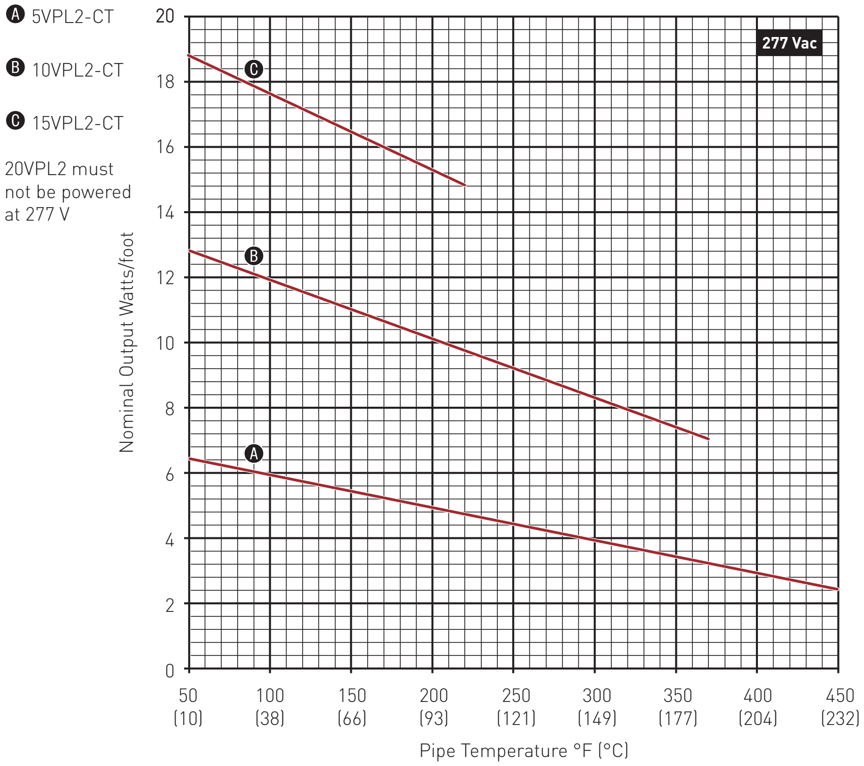
Select one of the following graphs based on the voltage determined in Step 1.



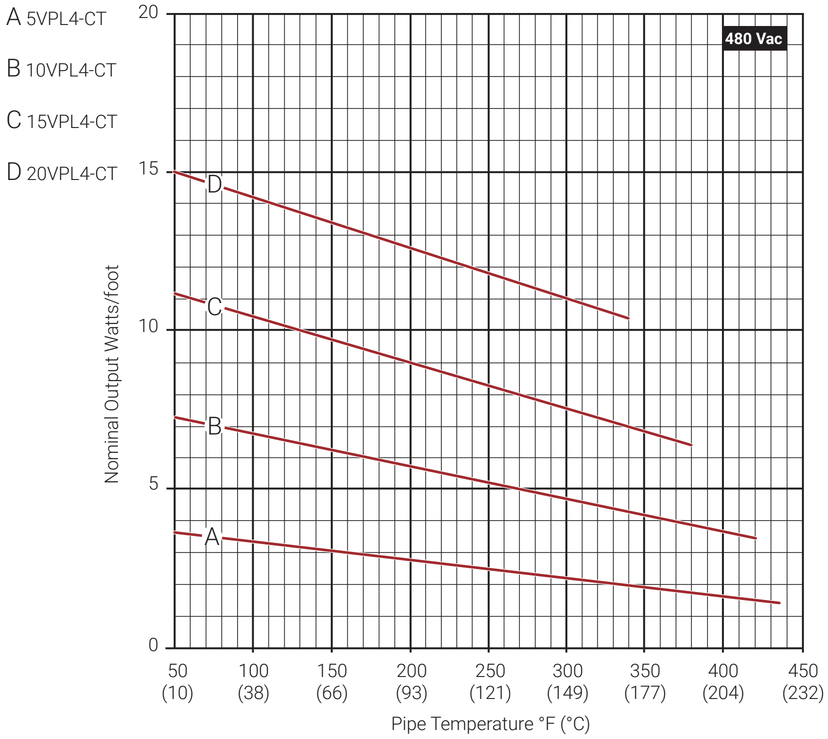
Graph 1 VPL nominal power output at 120 V, 240 V and 480 V



Graph 2 VPL nominal power output at 208 V



Graph 3 VPL nominal power output at 277 V



Graph 4 VPL nominal power output at 480 V

BILL OF MATERIALS

Now that you have selected the correct heating cable for your application, this section helps you to determine:

- Total length of heating cable required.
- Electrical design, including circuit breaker sizing and selection.
- Quantity and type of connection kits and accessories.

Determining the Total Length of Heating Cable

To determine the total length of heating cable, follow the six steps outlined below.

1. Gather the necessary information:
    - Pipe length and diameter
    - Type and number of valves
    - Type and number of pipe supports
    - Start-up temperature
    - Number of circuits and tees in the piping
2. Calculate the total length of heating cable for the piping.
3. Calculate the total length of heating cable for the valves.
4. Calculate the total length of heating cable for the pipe supports.
5. Include additional heating cable for connection kit installation.
6. Add all the lengths together.

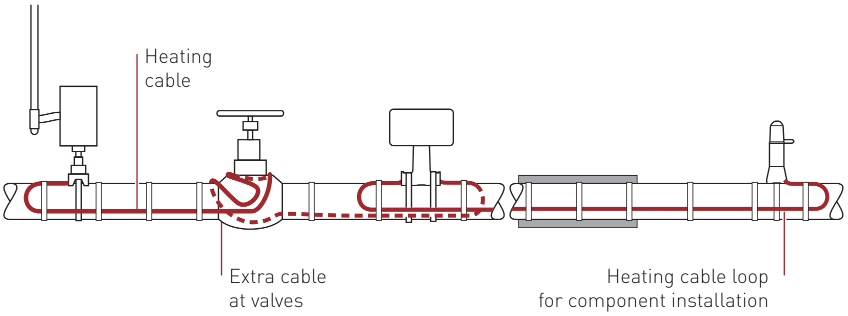


Fig. 5 Typical heating cable layout

Heating Cable Length
1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step 1 Gather the necessary information

- Pipe size and diameter ____________________
- Type and number of valves ____________________
- Type and number of pipe supports ____________________
- Start-up temperature ____________________
- Number of circuits and tees in piping ____________________

Example: Gather necessary information

• Pipe size and diameter	120 feet of 2 inch pipe
• Type and number of valves	Three 2 inch gate valves
• Type and number of pipe supports	Support shoes, thermally insulated: 10
• Start-up temperature	0°F
• Number of circuits and tees in piping	Power connections: 1
	End seals: 3
	Pipe tees: 2

Heating Cable Length

1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step ❷ Calculate the total length of heating cable for the piping

Example: Total length of cable for piping calculation

120 ft of pipe (from Step 1) = 120 ft of cable for single tracing

Heating Cable Length

1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step ❸ Calculate the total length of heating cable for the valves

Use Table 1 to determine the amount of heating cable required for each valve. Multiply by the number of valves to get the total additional footage of heating cable.

RECOMMENDED VALVE ALLOWANCES

Pipe diameter (IPS) (inches)	Heating cable feet (meters)		Comments*
1/4	0.3	(0.09)	These recommendations are limited by the amount of heating cable that can physically be installed on small valves. Heat loss may not be fully compensated under extreme conditions.
1/2	0.8	(0.2)	
3/4	1.3	(0.4)	
1	2.0	(0.6)	
1-1/4	3.3	(1)	
1-1/2	4.3	(1.3)	
2	4.3	(1.3)	
3	4.3	(1.3)	
4	4.3	(1.3)	
6	5.0	(1.5)	
8	5.0	(1.5)	
10	5.6	(1.7)	These numbers represent the minimum amount of heating cable required for a service loop. Additional cable may be required to compensate for total heat loss.
14	7.3	(2.2)	
18	9.4	(2.9)	
24	12.6	(3.8)	

* Use TraceCalc Pro design software to calculate the exact quantity required for the valve.

Example: Total length of cable for valves calculation

From Table 1 for a 2-inch diameter pipe,

Each valve requires:	4.3 ft
Cable needed for three valves:	3 x 4.3 ft
Total cable length needed for valves:	12.9 ft

Heating Cable Length

1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step ❹ Calculate the total length of heating cable for the pipe supports

Support Shoes

For each pipe support shoe, calculate the additional heating cable required as follows:

Determine the heat loss for one support.

- Formula: $Q_{support} = 0.7L \times (T_m - T_a)$, where L = Support length (ft) (assumes a 0.25-inch steel welded shoe partially shielded from winds)
- Multiply that heat loss by the total number of supports.
- Add 10 percent to the total heat loss for added safety.
- Obtain the heating cable power output per foot from Graph 1 or 2.
- Divide the total support heat loss by the heating cable power output per foot to get the number of feet of heating cable needed.

Example: Total length of cable for pipe supports calculation

Input	20VPL1-CT heating cable (from Product Selection, Step 3)
Input	10 thermally-insulated shoe supports (from Bill of Materials, Step 1)

As the pipe supports are thermally insulated, no additional heating cable is required for this example.

Heating Cable Length

1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step ❺ Include additional heating cable for connection kit installation

Estimate the number of power connections, tees, and splices for the system. Allow an additional three feet for each connection kit.

Example: Include additional cable

Input	1 power connection, 3 end seals, 2 tees (from Step 1)
Total number of connection kits	6 (from Step 1)
Cable needed for 6 connection kits	6 x 3 ft of additional cable
Total cable length for 6 connection kits	18 ft of cable

Heating Cable Length

1. Gather information
2. Calculate cable length for piping
3. Calculate cable length for valves
4. Calculate cable length for pipe supports
5. Include cable for connection kits
6. Add all heating cable lengths

Step ❻ Add all the lengths

Example: Final addition

Cable for piping	120 ft (from Step 1)
Cable for valves	12.9 ft (from Step 3)
Cable for supports	0 ft (from Step 4)
Cable for connection kits	18 ft (from Step 5)
Sum of all lengths	120 + 12.9 + 18 = 150.9 ft
Total length of heating cable	151 ft (rounded)

Now that you have the total length of heating cable you can determine the number of electrical circuits you will need.

Electrical Design

⚠ **WARNING**: **Fire hazard**
There is a danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed. To comply with nVent requirements, certifications, and national electrical codes, and to protect against the risk of fire, ground-fault equipment protection must be used on each heating cable circuit. Arcing may not be stopped by conventional circuit breakers.

Determining maximum length of heating cable on one circuit breaker

Using Tables 2, 3, and 4 match the heating cable catalog number at the expected minimum start-up temperature with the total heating cable length and select a circuit breaker trip rating. The circuit breaker trip rating should not exceed the maximum trip rating shown for heating cables. For example, the trip rating of a circuit breaker protecting several circuits should not exceed 50 amps. To maximize fault current protection, use the lowest allowable circuit breaker sizing.

Maximum circuit length per breaker depends on four factors:

1. Heating cable and catalog number
2. Minimum start-up temperature
3. Service voltage
4. Circuit breaker trip rating

TABLE 2 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

120- and 240-volt heating cables applied to metal pipe with glass tape											
nVent RAYCHEM Heating cable	**Start-up temperature**	**120-volt cable**					**240-volt cable**				
		15 A	**20 A**	**30 A**	**40 A**	**50 A**	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
5VPL-CT	50°F(10°C)	260	350	370	370	370	525	685	740	740	740
	0°F (−18°C)	240	325	370	370	370	485	645	740	740	740
	−20°F(−29°C)	235	315	370	370	370	470	625	740	740	740
	−40°F (−40°C)	225	305	370	370	370	455	610	740	740	740
10VPL-CT	50°F (10°C)	130	175	260	260	260	260	350	525	525	525
	0°F (−18°C)	120	165	245	260	260	245	325	490	525	525
	−20°F (−29°C)	120	160	240	260	260	235	315	475	525	525
	−40°F (−40°C)	115	155	230	260	260	230	310	465	525	525
15VPL-CT	50°F (10°C)	85	115	175	215	215	175	230	350	430	430
	0°F (−18°C)	80	110	165	215	215	165	220	325	430	430
	−20°F (−29°C)	80	105	160	215	215	160	215	320	425	430
	−40°F (−40°C)	75	100	155	210	215	155	210	310	415	430
20VPL-CT	50°F (10°C)	65	85	130	175	185	130	175	260	350	370
	0°F (−18°C)	60	85	125	165	185	125	165	250	330	370
	−20°F (−29°C)	60	80	120	160	185	120	160	245	325	370
	−40°F (−40°C)	60	80	120	160	185	115	155	240	320	370

TABLE 3 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

208- and 277-volt heating cables applied to metal pipe with glass tape											
nVent RAYCHEM Heating cable	Start-up temperature	208-volt cable					277-volt cable				
		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
5VPL-CT	50°F (10°C)	589	700	700	700	700	465	620	720	720	720
	0°F (–18°C)	545	700	700	700	700	430	574	720	720	720
	–20°F (–29°C)	530	700	700	700	700	418	557	720	720	720
	–40°F (–40°C)	515	686	700	700	700	406	541	720	720	720
10VPL-CT	50°F (10°C)	291	388	490	490	490	236	315	472	515	515
	0°F (–18°C)	272	362	490	490	490	221	294	441	515	515
	–20°F (–29°C)	265	353	490	490	490	215	286	430	515	515
	–40°F (–40°C)	258	344	490	490	490	209	279	419	515	515
15VPL-CT	50°F (10°C)	191	255	383	400	400	160	213	320	420	420
	0°F (–18°C)	180	240	360	400	400	150	200	300	401	420
	–20°F (–29°C)	176	234	351	400	400	147	196	293	391	420
	–40°F (–40°C)	172	229	343	400	400	143	191	287	382	420
20VPL-CT	50°F (10°C)	142	189	284	340	340	†	†	†	†	†
	0°F (–18°C)	135	180	269	340	340	†	†	†	†	†
	–20°F (–29°C)	132	176	264	340	340	†	†	†	†	†
	–40°F (–40°C)	129	173	249	340	340	†	†	†	†	†

[†] Not permitted (20 VPL must not be powered at 277 V)

TABLE 4 MAXIMUM CIRCUIT LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

400- and 480-volt heating cables applied to metal pipe with glass tape											
nVent RAYCHEM Heating cable	Start-up temperature	400-volt cable					480-volt cable				
		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
5VPL-CT	50°F (10°C)	756	986	1066	1066	1066	1050	1370	1480	1480	1480
	0°F (–18°C)	698	929	1066	1066	1066	970	1290	1480	1480	1480
	–20°F (–29°C)	677	900	1066	1066	1066	940	1250	1480	1480	1480
	–40°F (–40°C)	655	878	1066	1066	1066	910	1220	1480	1480	1480
10VPL-CT	50°F (10°C)	380	511	767	767	767	520	700	1050	1050	1050
	0°F (–18°C)	358	475	715	767	767	490	650	980	1050	1050
	–20°F (–29°C)	343	460	694	767	767	470	630	950	1050	1050
	–40°F (–40°C)	336	453	679	767	767	460	620	930	1050	1050
15VPL-CT	50°F (10°C)	259	340	518	636	636	350	460	700	860	860
	0°F (–18°C)	244	326	481	636	636	330	440	650	860	860
	–20°F (–29°C)	237	318	474	629	636	320	430	640	850	860
	–40°F (–40°C)	229	311	459	614	636	310	420	620	830	860
20VPL-CT	50°F (10°C)	195	263	390	525	555	260	350	520	700	740
	0°F (–18°C)	188	248	375	495	555	250	330	500	660	740
	–20°F (–29°C)	180	176	368	488	555	240	320	490	650	740
	–40°F (–40°C)	173	173	360	480	555	230	310	480	640	740

Example: Determining maximum length of heating cable on one circuit breaker

Input	20VPL1-CT heating cable (from Product Selection, Step 3)
Input	120 volts (from Product Selection, Step 1)
Input	0°F start-up temperature (from Product Selection, Step 1)
Input	Maximum circuit length = 165 feet on a 40-amp breaker (from Table 2)

If the total length of cable exceeds 165 feet, you must use a 50-amp circuit breaker, which allows up to 185 feet.

Determine minimum number of circuits

The number of circuits you need depends on the total length of heating cable you will be using and the maximum circuit length for the heating cable you selected.

Example: Calculating the minimum number of circuits

Input	165 ft allowed per 40-amp circuit (from Table 2)
Input	Total circuit length = 151 ft (from Bill of Materials, Step 6)
Number of circuits	1 circuit

If the total length of heating cable required exceeded 165 feet, you would need to split the total length into two separate circuits (or use a larger circuit-breaker size).

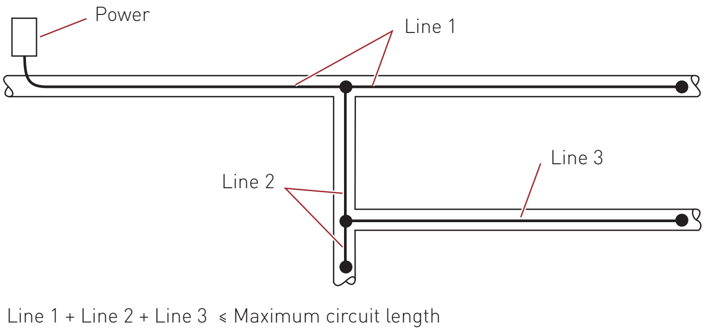


Fig. 6 Maximum heating cable circuit length

Ground-fault protection

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

Connection Kit Selection and Accessories

⚠ **WARNING: Fire hazard**
To prevent fire or shock, nVent RAYCHEM brand specified connection kits must be used. Do not substitute parts or use vinyl electrical tape.

Overview

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

Different power connection, end seal, splice, and tee kits are required depending on the area classification. The data sheets for these connection kits nVent.com or the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalog (H56550).

Non-hazardous and hazardous location connection kits

Figure 7 shows the connection kits and accessories available for typical power-limiting systems.

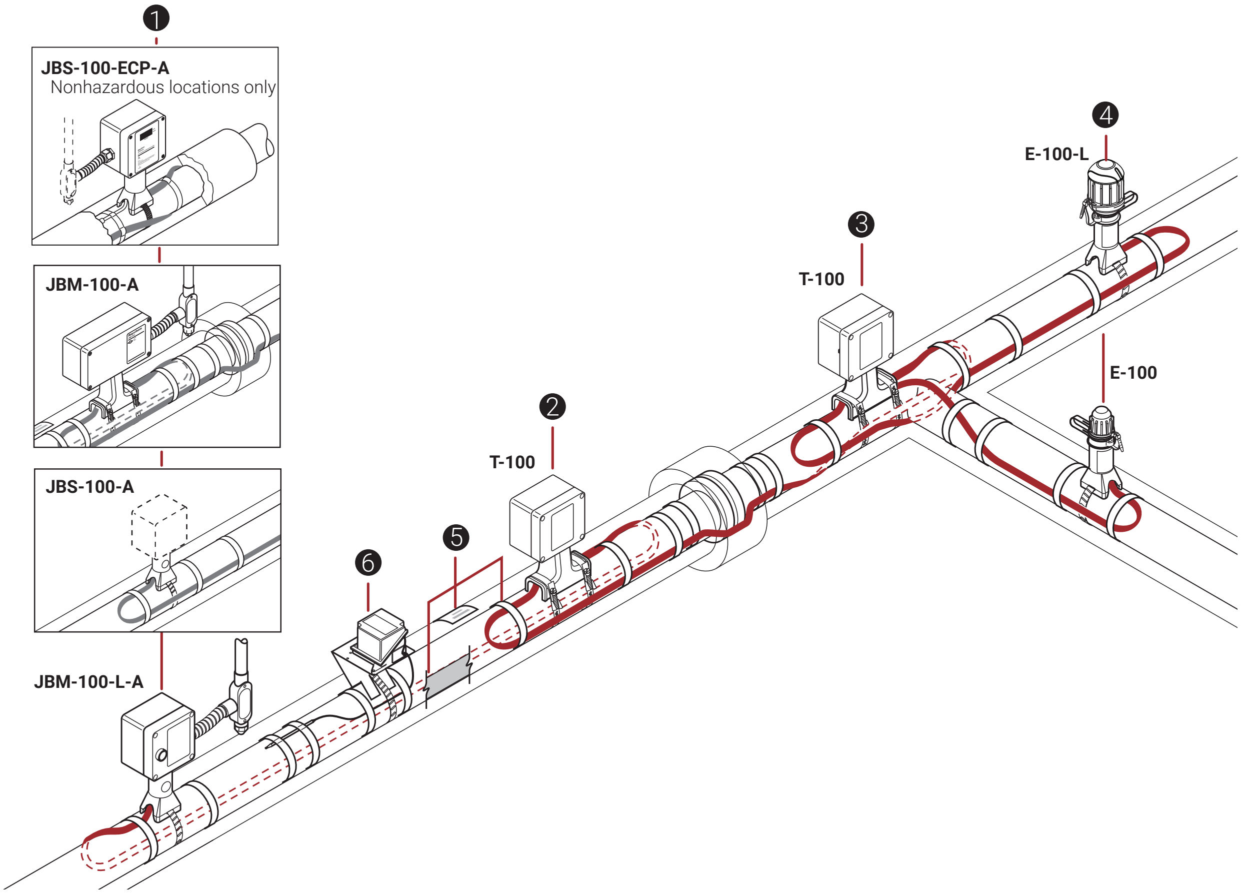


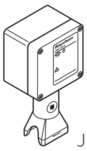
Fig. 7 Power-limiting heating system connection kits and accessories

NON-HAZARDOUS AND HAZARDOUS CONNECTION KIT AND ACCESSORY SELECTION

Description	Catalog number	Quantity
nVent RAYCHEM Connection Kits		
1 Power connection		1 per circuit
Single heating cable	JBS-100-A	
Single heating cable with light	JBS-100-L-A	
Single heating cable with digital electronic controller	JBS-100-ECP-A (non-hazardous locations only)	
Single heating cable (user-supplied junction box)	JS-100-A	
Multiple heating cables (1, 2, or 3)	JBM-100-A	
Multiple heating cable with light	JBM-100-L-A	
2 Splice connection		1 per splice
Above insulation	T-100	
3 Tee connection		1 per tee
Above insulation	T-100	
4 End seal		1 per power connection plus 1 per tee
Above insulation	E-100	
Above insulation with light	E-100-L-A	
Accessories		
5 Attachment tape, labels, and pipe straps		
Controls (optional)		
6 Thermostat — see Control and Monitoring design guide (H56889)		

System connection kits

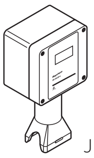
Power Connection Kits for Heating Cable



JBS-100-A

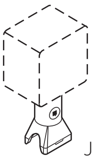
nVent RAYCHEM JBS-100-A Power connection for one heating cable in non-hazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.

With LED indicator light, order JBS-100-L-A



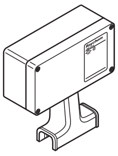
JBS-100-ECP-A

nVent RAYCHEM JBS-100-ECP-A Power connection and digital electronic controller. Requires one pipe strap to be ordered separately. Non-hazardous locations only.



JS-100-A

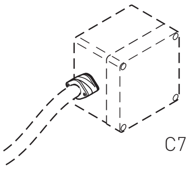
nVent RAYCHEM JS-100-A Junction box stand for one heating cable in non-hazardous and hazardous locations. A separate customer-supplied NEMA 4X junction box is required. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.



JBM-100-A

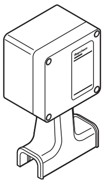
nVent RAYCHEM JBM-100-A Multiple-entry power connection for up to three heating cables. Can also be used as a splice or tee connection. For use in non-hazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires two pipe straps to be ordered separately.

With LED indicator light, order JBM-100-L-A



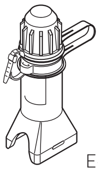
C75-100-A

nVent RAYCHEM C75-100-A A NEMA 4X-rated gland kit (3/4" NPT) used to transition heating cables into a junction box in non-hazardous and hazardous locations. Includes cold-applied heating cable core seal. A terminal block (3 x 12 AWG) is included. This kit does not include the junction box or the conduit.



T-100

nVent RAYCHEM T-100 Tee or splice connection for up to three heating cables in non-hazardous and hazardous locations. Includes cold-applied heating cable core seal. Requires two pipe straps to be ordered separately.

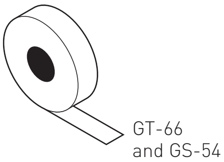


E-100-A

nVent RAYCHEM E-100-A End seal for heating cable in non-hazardous and hazardous locations. Re-enterable. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.

With LED indicator light, order E-100-L-A

Accessories

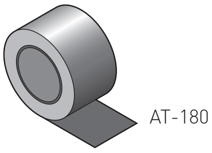


nVent RAYCHEM GT-66 Glass Installation Tape

- For use on pipes other than stainless steel
- 1/2" x 66' roll
- Strap at 1-foot intervals at minimum application temperature of 40°F (5°C)

nVent RAYCHEM GS-54 Glass Installation Tape

- For use on all pipes, particularly stainless steel
- 1/2" x 54' roll
- Strap at 1-foot intervals at minimum application temperature of –40°F (–40°C)



nVent RAYCHEM AT-180 Aluminum Tape

- For use on all pipe materials
- 2-1/2" x 180' roll
- Minimum installation temperature: 32°F (0°C)

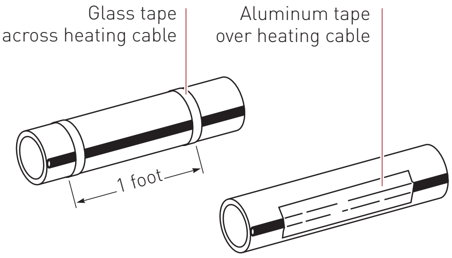
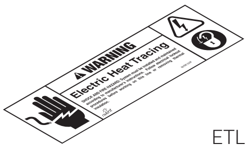


Fig. 8 Tape installation

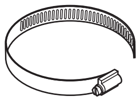
TABLE 6 ATTACHMENT TAPE REQUIREMENTS

nVent RAYCHEM Tape type	Rolls needed per 100 ft of cable Pipe diameter (IPS) in inches						
	1/2	1	2	3	4	6	8
GT-66	0.6	1.2	4	4	6	8	10
GS-54	0.6	1.4	4	6	6	10	12
AT-180	Use one foot of tape per foot of heating						



ETL (Electric Traced Label)

Attach the label to the outside of the thermal insulation weather barrier to indicate presence of electrical heat tracing. Use one label for every 10 feet (3 m) of pipe, alternating on either side of the pipe.



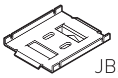
Pipe strap

Pipe Straps

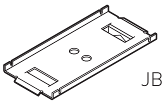
Stainless steel pipe straps to attach connection kits to the heat-traced pipe. Use Table below to assist with pipe strap selection.

TABLE 7 PIPE STRAP SELECTION

Catalog number	Pipe size
PS-01	For conduit ≤ 1"
PS-03	For connection kits on pipes with dimensions <2"
PS-10	For connection kits on pipes with dimensions 2" – 10"
PS-20	For connection kits on pipes with dimensions 10" – 19.5"



JBS-SPA

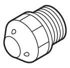


JBM-SPA

Small Pipe Adapters

nVent RAYCHEM JBS-SPA Adapter for mounting E-100, JBS-100, and JS-100-A to small pipe.

nVent RAYCHEM JBM-SPA Adapter for mounting JBM-100 and T-100 to small pipe.



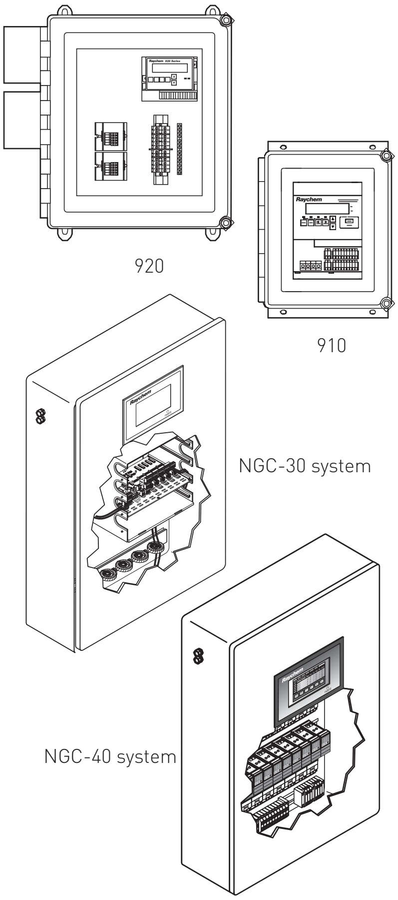
JB-DRAIN-PLUG-3/4IN

Conduit Drain

nVent RAYCHEM JB-DRAIN-PLUG-3/4IN Conduit drain for JBS-100, JBM-100, and JS-100-A.

Controls

For a complete selection of control and monitoring products, including thermostats, see Control and Monitoring design guide (H56889).



920

910

NGC-30 system

NGC-40 system

MINERAL INSULATED HEATING CABLES

This section provides an overview and general design guidelines for nVent RAYCHEM mineral insulated (MI) heat-tracing systems. For complete design assistance, contact your nVent or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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INTRODUCTION

MI heating cable is the ideal choice when an application's temperature or power output requirements exceed the capabilities of self-regulating and power-limiting heating cables. Mineral insulated cables are mechanically robust and durable. They are ideally suited to harsh environments and applications.

mineral insulated heating cables offer a wide variety of solutions for industrial heat-tracing applications. MI heating cables are series-type heating cables and suitable for maintain temperatures up to 1022°F (550°C) and exposure temperatures up to 1200°F (650°C). MI heating cable is the ideal choice when an application's temperature and power output requirements exceed the capabilities of self-regulating and power-limiting heating cables.

MI heating cables can be used for applications with the following requirements:

- Maintain temperature up to 1022°F (550°C)
- Power output to 61 W/ft (200 W/m)
- Maximum heating cable exposure temperature to 1200°F (650°C)

Higher temperature and power capabilities are available; contact nVent for additional information.

Typical Applications

TYPICAL APPLICATIONS FOR MI HEATING CABLES ARE LISTED IN TABLE 1.

TABLE 1 EXAMPLES OF MI HEATING CABLE APPLICATIONS

Refining crude distillation	Chemical and petrochemical	Power generation
Hydrocracking	Phthalic anhydride	High-pressure feedwater
Coking	Benzene	Blowdown lines
Wax	Styrene	Instrument lines
Sulphur	Propylene glycol	Steam lines
Asphalt	Ethylene glycol	De-aerator lines
Heavy residue	Polyethylene	High-pressure condensate
Gas condensate prevention	Polypropylene	
Bitumen	Chlorine	
	Acrylic acid	
	Adipic acid	
	Dimethyl terephthalate	
	Synthetic fiber polymers	
	Nylon monomer	
	Paints and resins	

Mineral Insulated Heating Cable Construction

XMI-A HEATING CABLES

nVent RAYCHEM XMI-A heating cables consist of one or two conductors embedded in a highly dielectric magnesium oxide insulation surrounded by a metal sheath of Alloy 825. This nickel alloy is recognized for its high temperature service and resistance to pitting, acid, salt, and alkali corrosion. In addition, Alloy 825 provides excellent protection against stress corrosion cracking and has a long history of success in heat-tracing applications, particularly at high temperatures.

XMI-A heating cables provide superior strength in dynamic cut-through, crush, and corrosion tests. Special annealing processes maximize flexibility for ease of on-site handling.

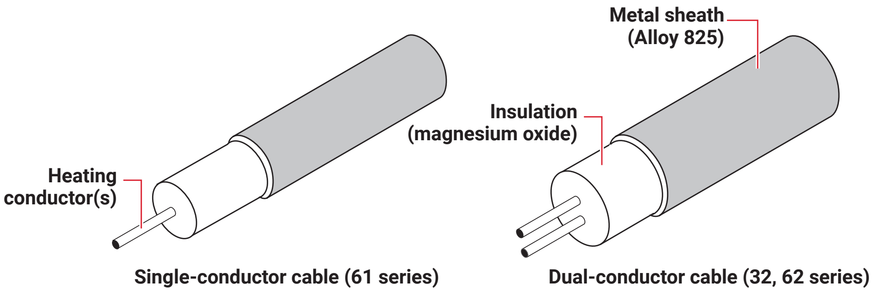


Fig. 1 XMI-A Single- and dual-conductor cables

XMI-L HEATING CABLES

Where Auto Ignition Temperature (AIT) constraints drive heating cable design to multiple passes of cable on equipment due to sheath temperature limitations, this can lead to field construction issues. Insufficient space is available on the equipment to apply the required number of passes.

XMI-L heating cable has been specially developed to mitigate challenging applications of this nature.

Conventional nVent RAYCHEM MI cable is sealed inside a corrugated 316L stainless steel sheath which dramatically increases surface area and results in lower sheath temperatures. This results in a reduction in the number of passes of cable required and correspondingly fewer construction issues.

XMI-L heating cables are supplied in two conductor configurations.

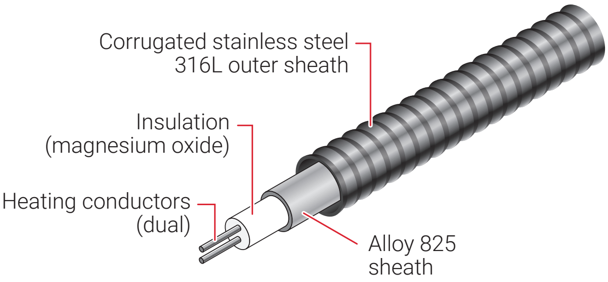
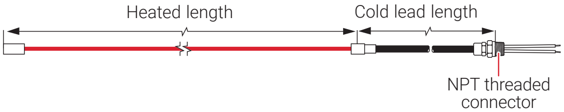


Fig. 2 XMI-L Dual conductor cables

Note: Dual conductor cable (32,62 series)

MI heating cable sets are supplied factory terminated and ready to install. They include a heating section and a nonheating cold lead section.



Design D: Dual conductor cable (32, 62 series only)

Fig. 3 Typical MI heating cable set (dual conductor)

SYSTEM OVERVIEW

Typical Mineral Insulated Heating Cable System

A typical MI heating cable system is shown in Figure 4. Unlike self-regulating or power-limiting cables, MI heating cables are supplied in fixed lengths, so determining and ordering the correct cable length is critical. The heating cable is attached to the pipe with metal banding or tie wire. The cold lead cable is connected to a junction box, which in turn is connected to the power supply.

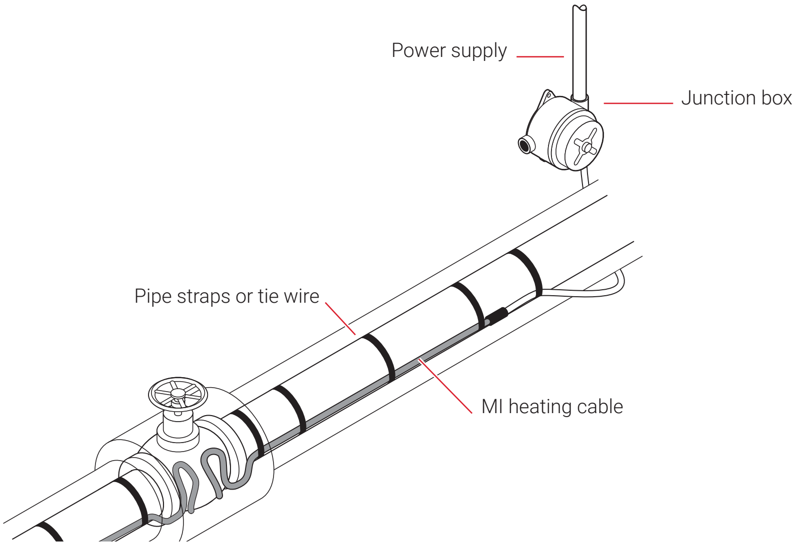


Fig. 4 Typical mineral insulated heating cable system

Ground-Fault Protection

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of , agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

Approvals and Certifications

nVent mineral insulated heating systems meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.

MI heating cable systems are approved for use in nonhazardous and hazardous locations through various approval agencies. Refer to the XMI datasheets for more detailed information XMI-A-H56870, XMI-L-H59079 and Cold lead options-H59126in the Technical Data section The datasheets can be found on the nVent web site, nVent.com, or in the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalog (H56550).

THERMAL DESIGN AND HEATING CABLE SELECTION

The following steps illustrate the process for designing a mineral insulated heat-tracing system. For a complete design, you must use TraceCalc Pro design software or contact nVent for design assistance. nVent RAYCHEM TraceCalc Pro design software may be downloaded after registering at nVent.com/design-tools. Use the Heat-Tracing Design Request Form (H56893) to submit the required data for your application.

1 The heating cable selection process involves four basic steps:

2 Gather the necessary information.

3 Determine the power output and heating cable length.

4 Select the heating cable design configuration.

5 Select the heating cable type, reference, and cold lead.

Example: The example carried through this section shows a simple freeze protection application for a high-pressure condensate line in a power plant.
It is simplified, but shows the basic principles of an MI series resistance heating cable design.

Heating Cable Selection
1. Gather information
2. Determine pipe heat loss and total heating cable length
3. Select heating cable design configuration
4. Select heating cable type, reference, and cold lead

Step **1** Gather the necessary information

- Pipe size and material____________________
- Insulation type and thickness____________________
- Maintain temperature (T_M)____________________
- Minimum ambient temperature (T_A)____________________
- Service voltage (V)____________________
- Maximum exposure temperature____________________
- Area classification____________________
- Pipe length (L)____________________
- Number of pipe supports____________________
- Number and size of valves____________________

Example: Gather information

Pipe size and material:	1-inch steel pipe
Insulation type and thickness:	1/2-inch glass fiber
Maintain temperature:	40°F
Minimum ambient temperature:	0°F
Service voltage:	120 V
Maximum exposure temperature:	680°F
Area classification:	Nonhazardous
Pipe length:	80 ft
Pipe supports:	Thermally insulated (already insulated; excluded from example calculations)
Valves:	2 x 1-inch light valves (threaded)

Heating Cable Selection
1. Gather information
2. Determine pipe heat loss and total heating cable length
3. Select heating cable design configuration
4. Select heating cable type, reference, and cold lead

Step 2 Determine the pipe heat loss and total heating cable length

THERMAL DESIGN (REQUIRED POWER OUTPUT)

To select the proper heating cable, first calculate the pipe heat loss for your application as outlined in Section 1, the nVent RAYCHEM Self-Regulating Cables design guide (H56822). For applications with higher maintain temperatures, use TraceCalc Pro design software or contact your nVent representative.

Example: MI heating cable is required because of the high maximum exposure temperature.

Pipe heat loss: P = 3.5 W/ft x 40/50 = 2.8 W/ft (9.2 W/m)
from the Self-Regulating Cables design guide (H56822)

TOTAL HEATING CABLE LENGTH

The total length of the MI heating cable (L) needs to accommodate pipe length and additional cable required to compensate for heat loss of valves and supports, as well as an installation allowance for field variances (see Table 2).

The length of the heating cable can be determined by using Table 2 and the following worksheet. For small pipes or applications with low power requirements, a single run of two conductor heating cable will often be sufficient. For larger pipes or higher temperatures, multiple runs of single or two conductor heating cable may be required. It is recommended that the design and cable selection process start by assuming a single run of cable and only increase the number of runs if no satisfactory solution can be found.

Depending on the complexity of the application, Steps 2 through 4 can be an iterative process. We recommend using TraceCalc Pro design software. Contact your nVent representative for assistance.

TABLE 2 TYPICAL ALLOWANCES PER RUN OF CABLE (FT)

NPS	Light valve (flanged)	Light valve (threaded or welded)	Heavy valve (flanged)	Heavy valve (threaded or welded)	Typical pipe shoe	150lb Flange (pair)	Field variance
0.5"	1	1	1	1	3	0.6	2%
0.75"	1.5	1	1.5	1	3	0.6	2%
1"	2	1	2	1	3	0.6	2%
1.5"	2.5	1.5	3	1.5	3	0.6	2%
2"	2.5	2	3.5	2	3	0.8	2%
3"	3	2.5	4	2.5	3	0.8	3%
4"	4	3	5	3	3	0.9	3%
6"	5	3.5	6	3.5	3	0.9	3%
8"	7	4	8	4	3	1.0	3%
10"	8	5	10	5	3	1.1	3%
12"	9	6	12	6	3	1.3	3%
14"	10	7	14	7	4.5	1.5	3%
16"	10.5	8	15	8	4.5	1.6	3%
18"	11	9	15.5	9	4.5	1.7	3%
20"	11	10	16	10	4.5	1.8	3%
24"	11.5	12	17	12	4.5	1.9	3%

5. “Light valve” refers to 150 lb valves; “heavy valve” refers to 300 lb valves. For other fittings and support, contact nVent.
6. Allowances above are based on typically available fittings and supports, with insulation that is equivalent to the pipe insulation.
7. For pipes requiring more than two runs of heating cable, apply the full allowance for each run of cable on each fitting or support as long as space allows. However, MI heating cables must not touch or overlap. The minimum spacing between cables is 1" (25 mm). Contact nVent if more than two runs are needed or if cable spacing is less than 1" (25 mm).
8. For some applications, it may be physically impossible to install all of the recommended heating cable directly on the fitting or support. In this case, install the excess heating cable on the pipe, on either side of the fitting or support, or eliminate the additional heater length from your length calculation if a lower local temperature is acceptable. This constraint may be difficult for small pipes and/or multiple cable runs. If required, contact nVent for assistance.

WORKSHEET TO DETERMINE TOTAL HEATING CABLE LENGTH

Example input from Steps 1 and 2.

Pipe size	1"	Pipe length		80 ft	x 1.02 or 1.03*=	81.6 ft
# 2	1"	Valves	@	1 ft	=	2 ft
#	"	Valves	@	ft	=	ft
#	"	Supports	@	ft	=	ft
#	"	Supports	@	ft	=	ft
		Other heat sinks		ft	=	ft
		Sum of the above			=	83.6 ft
		Multiply by no. of runs of heating cable 1 x			=	83.6 ft
Equals total heating cable length (L), rounded:						**84** ft

* Field variance from "Table 2"

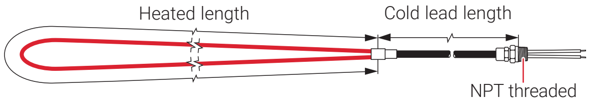
Heating Cable Selection
1. Gather information
2. Determine pipe heat loss and total heating cable length
3. Select heating cable design configuration
4. Select heating cable type, reference, and cold lead

Step 3 Select the heating cable design configuration

The MI heating cable sets are factory terminated in the four design configurations shown below. They are supplied with the heated section joined to a length of nonheating cold lead section, preterminated and ready to fasten in a junction box with an NPT-threaded connector.

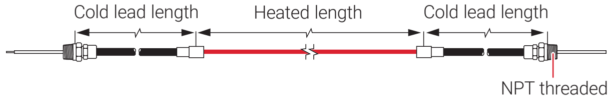
Note: XMI-L available in D or E configurations only.

Design A



Design A: Single conductor cable (61 series only)

Design B

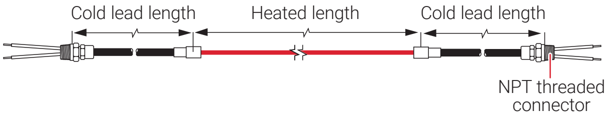


Design B: Single conductor cable (61 series only)

Design D

Design D: Dual conductor cable (32, 62 series only)

Design E



Design E: Dual conductor cable (32, 62 series only)

Fig. 5 XMI-A Heating cable design configurations

For a single run of heating cable, Design D is the most economical solution.

Example: Select Design D for a single run of dual conductor cable.

Heating Cable Selection

1. Gather information
2. Determine pipe heat loss and total heating cable length
3. Select heating cable design configuration
4. Select heating cable type, reference, and cold lead

Step 4 Select the heating cable type, reference, and cold lead

Heating cable types are listed in Table 3.

TABLE 3 MI HEATING CABLE TYPES

Specifications	Series 61	Series 32	Series 62
Number of conductors	1 – single	2 – dual	2 – dual
Maximum operating voltage	600 V	300 V	600 V
Reference table	5	6	7

Note: See datasheet H59079 for XMI-L heating cable types, voltages and conduit sizing options in the event that multiple pass construction issues arise from design using XMI-A.

"Table 5", "Table 6", and "Table 7" list the resistances available for the XMI-A heating cable types.

The naming convention of the heating cables is described in Table 4.

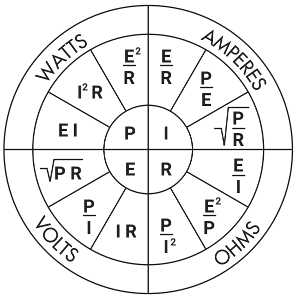
TABLE 4 HEATING CABLE REFERENCE

Digit number	Description	
1	Maximum voltage rating	3 = 300 V, 6 = 600 V
2	Number of conductors	1 or 2
3	Sheath material	S = Alloy 825
4	Conductor material	A, B, C, F, P, Q, or T
5	Move decimal point to left indicated number of places	1, 2, 3, 4, 5, or 6 places
6 to 8	Cable resistance to three whole numbers (use with digit 5)	2200 = 2.00 Ω/cable foot at 20°C

Sample reference:

	6	**2**	**S**	**F**	**2**	**2**	**0**	**0**
Digit	1	2	3	4	5	6	7	8

nVent RAYCHEM Copper-sheathed MI heating cables for low temperature applications are available upon request.



Ohm's Law Formulas

P = Power (W)
I = Current (A)
E = Electromotive Force (V)
R = Resistance (Ω)

To select the heating cable reference, calculate the maximum resistance that the cable can have in order to supply the required power using Ohms law:

R_{max} = $V^2/(P_{min} \times L^2)$

R_{max} : Maximum cable resistance to meet power requirement [Ω/ft or Ω/m]

V : Voltage across heating element [V]

P_{min} : Required power output [W/ft or W/m]

L : Total heating cable length [ft or m]

The minimum required power output (P_{min}) must be at least equal to the heat loss (P) determined in Step 2.

Example: Pmin = P = 2.8 W/ft (from Step 2)
Rmax = (120 V)2 / (2.8 W/ft x (84 ft)2) = 0.7289 Ω/ft (2.39 Ω/m)

Now select a heating cable with a nominal resistance lower or equal to this maximum resistance from to3. . Start by using a 300 V dual conductor cable (32 series) for the most economical solution.

Example: From Table 6 select cable 32SB3700 Rnom = 0.700 Ω/ft (2.30 Ω/m)

Note: Table 5, Table 6, and Table 7 show the nominal conductor resistance; tolerance is ± 10%.

TABLE 5 SERIES 61 MI HEATING CABLE SPECIFICATIONS (600 V, SINGLE CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/ 1000 ft	kg/ 1000 m
61SA2200	2.00	6.56	0.170	4.3	1333	406	50	75
61SA2160	1.60	5.25	0.163	4.1	1452	443	44	66
61SA2130	1.30	4.27	0.160	4.1	1508	460	42	63
61SA2100	1.00	3.28	0.160	4.1	1510	460	43	64
61SA3850	0.850	2.79	0.170	4.3	1338	408	48	72
61SA3700	0.700	2.30	0.160	4.1	1514	462	43	64
61SA3500	0.500	1.64	0.170	4.3	1344	410	49	73
61ST3280	0.280	0.919	0.170	4.3	1337	408	48	72
61SB3200	0.200	0.656	0.180	4.6	1198	365	55	82
61SB3150	0.150	0.492	0.170	4.3	1350	412	51	76
61SQ3118	0.118	0.387	0.175	4.4	1260	384	50	75
61SQ4732	0.0732	0.240	0.170	4.3	1338	410	48	72
61SQ4581	0.0581	0.191	0.172	4.4	1308	399	50	75
61SP4467	0.0467	0.153	0.170	4.3	1337	408	48	72
61SP4366	0.0366	0.120	0.173	4.4	1292	394	50	75
61SP4290	0.0290	0.0951	0.177	4.5	1236	377	53	79
61SP4231	0.0231	0.0758	0.174	4.4	1282	391	52	78
61SP4183	0.0183	0.0600	0.170	4.3	1347	411	50	75
61SP4145	0.0145	0.0476	0.170	4.3	1351	412	51	76
61SP4113	0.0113	0.0371	0.186	4.7	1130	345	61	91
61SC5651	0.00651	0.0214	0.187	4.7	1110	338	60	89
61SC5409	0.00409	0.0134	0.191	4.9	1069	326	64	95
61SC5258	0.00258	0.00846	0.215	5.5	848	259	83	124
61SC5162	0.00162	0.00531	0.268	6.8	546	166	129	192
61SC5102	0.00102	0.00335	0.253	6.4	622	190	124	185
61SC6640	0.00064	0.00210	0.319	8.1	391	119	197	294

Note: All Alloy 825 cold leads are terminated with stainless steel gland and 12-inch tails unless otherwise specified. Other configurations available on request.

TABLE 6 SERIES 32 MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
32SF1180	18.0	59.0	0.174	4.4	1271	387	49	73
32SF1110	11.0	36.1	0.156	4.0	1584	483	40	60
32SF2900	9.00	29.5	0.160	4.1	1507	459	42	63
32SF2750	7.50	24.6	0.157	4	1565	477	41	61
32SA2600	6.00	19.7	0.160	4.1	1507	459	42	63
32SA2400	4.00	13.1	0.146	3.7	1816	554	36	54
32SA2318	3.18	10.4	0.174	4.4	1277	389	50	74
32SA2275	2.75	9.02	0.153	3.9	1657	505	40	60
32SA2200	2.00	6.56	0.169	4.3	1359	414	49	73
32SA2170	1.70	5.58	0.167	4.2	1395	425	48	72
32SB2114	1.14	3.74	0.174	4.4	1279	390	51	76
32SB3914	0.914	3.00	0.162	4.1	1480	451	45	67
32SB3700	0.700	2.30	0.170	4.3	1347	411	50	74
32SQ3472	0.472	1.55	0.177	4.5	1232	376	52	78
32SQ3374	0.374	1.23	0.183	4.6	1153	352	55	82
32SQ3293	0.293	0.961	0.179	4.5	1206	368	53	79
32SQ3200	0.200	0.656	0.161	4.1	1498	457	44	66

TABLE 6 SERIES 32 MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
32SQ3150	0.150	0.492	0.168	4.3	1378	420	49	73
32SQ3100	0.100	0.328	0.185	4.7	1140	348	60	89
32SP4734	0.0734	0.241	0.174	4.4	1284	391	52	78
32SP4583	0.0583	0.191	0.178	4.5	1230	375	55	82
32SP4458	0.0458	0.150	0.188	4.8	1105	337	62	92
32SC4324	0.0324	0.106	0.184	4.7	1145	349	57	85

TABLE 7 SERIES 62 MI HEATING CABLE SPECIFICATIONS (600 V, DUAL CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
62SF1110	11.0	36.1	0.194	4.9	1023	312	61	91
62SF2900	9.00	29.5	0.194	4.9	1024	312	61	91
62SF2750	7.50	24.6	0.205	5.2	916	279	69	103
62SF2600	6.00	19.7	0.230	5.8	728	222	86	128
62SA2414	4.14	13.6	0.240	6.1	669	204	94	140
62SA2275	2.75	9.02	0.225	5.7	762	232	84	125
62SF2200	2.00	6.56	0.245	6.2	644	196	100	149
62SA2170	1.70	5.58	0.240	6.1	671	205	96	143
62ST2115	1.15	3.77	0.215	5.5	834	254	76	113
62SB3914	0.914	3.00	0.232	5.9	718	219	89	132
62SB3700	0.700	2.30	0.265	6.7	550	168	117	174
62ST3505	0.505	1.66	0.215	5.5	837	255	77	115
62SQ3374	0.374	1.23	0.215	5.5	834	254	76	113
62SQ3286	0.286	0.938	0.222	5.6	783	239	81	121
62SQ3200	0.200	0.656	0.227	5.8	750	229	86	128
62SQ3150	0.150	0.492	0.227	5.8	751	229	86	128
62SQ3100	0.100	0.328	0.257	6.5	586	179	111	165
62SP4775	0.0775	0.254	0.250	6.4	618	188	104	155
62SP4561	0.0561	0.184	0.263	6.7	560	171	116	173
62SP4402	0.0402	0.132	0.277	7	505	154	130	194
62SP4281	0.0281	0.0922	0.292	7.4	456	139	147	219
62SC4200	0.0200	0.0656	0.285	7.2	476	145	135	201
62SC4130	0.0130	0.0427	0.304	7.7	419	128	156	233
62SC5818	0.00818	0.0268	0.331	8.4	330	100	187	279
62SC5516	0.00516	0.0169	0.364	9.2	294	90	230	343
62SC5324	0.00324	0.0106	0.402	10.2	242	74	290	432
62SC5204	0.00204	0.00669	0.496	12.6	159	48	438	653
62SC5128	0.00128	0.00420	0.543	13.8	469	143	516	769

Heating Cable Selection
1. Gather information
2. Determine pipe heat loss and total heating cable length
3. Select heating cable design configuration
4. Select heating cable type, reference, and cold lead

The cold lead cable is available in the following sizes:

TABLE 8 ALLOY 825 SHEATHED COLD LEADS

Design A, D, E					
Cold lead code for catalog number	**Maximum voltage (V)**	**Maximum current (A)**	**Gland size (NPT)**	**Gland size reference for catalog number**	**Tail size (AWG)**
S25A	600	25	1/2"	N12	14
LS23A	300	23	1/2"	N12	14
S34A	600	34	3/4"	N34	10
S49A	600	49	3/4"	N34	8
S65A	600	65	3/4"	N34	6
Design B					
S29A	600	29	1/2"	N12	12
S40A	600	40	1/2"	N12	10
S48A	600	48	1/2"	N12	8
S66A	600	66	1/2"	N12	6
S86A	600	86	1/2"	N12	4

Note: All Alloy 825 cold leads are terminated with stainless steel glands and 12-inch tails unless otherwise specified. Other configurations available on request.

ADDITIONAL CONSIDERATIONS

Various materials used in the conductors behave differently. In particular, for heating cables with low resistances, conductor materials may show a significant increase in resistance for increasing maintain temperatures. Use the graph below to adjust resistance as a function of the maintain temperature. For detailed design, use TraceCalc Pro design software or contact nVent.

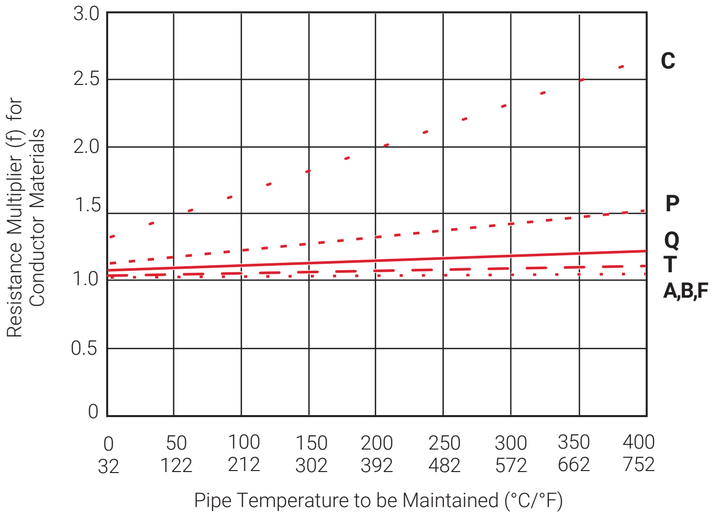


Fig. 6 Resistance correction factor

As the graph shows, the change of resistance can be significant at high temperatures and must not be neglected for cables using conductor materials with a large temperature dependency (see in particular conductor material C).

Adjust the nominal resistance (R_{nom}) with the resistance multiplier (f) based on the graph.

$R_{adj} = R_{nom} \times f$

Example:

Cable reference 32SB3700 uses conductor material B

The graph shows that the resistance change factor is negligible for this cable at a maintain temperature of 40°F (5°C). Therefore, $R_{adj} = 0.700\ \Omega/\text{ft} \times 1.0 = 0.700\ \Omega/\text{ft}$ (2.30 Ω/m).

Now calculate the adjusted power output (P_{adj}) of the heating cable using the following formula:

$P_{adj} = V^2 / (R_{adj} \times L)$, $P_{lin} = P/L$

Example:

$P_{adj} = (120\ V)^2 / (0.7\ \Omega/\text{ft} \times 84\ \text{ft}) = 245\ W$, $P_{lin} = 2.9\ W/\text{ft}$ (9.5 W/m)

Check that the installed linear power, P_{lin} (W/ft or W/m), is equal to or greater than the pipe heat loss (P) determined in Step 2. Adjust formula for multiple runs as required.

Note: If the selected resistance is much lower than the calculated maximum resistance, it can result in a significantly higher power output than required for the application.

The startup current (I) can be calculated using the nominal resistance (Rnom) from Table 5–Table 7:

$I = V / (R_{nom} \times L)$

We typically recommend using a safety factor of 10%.

Example:

$I = 120\ V / (0.700\ \Omega/\text{ft} \times 84) = 2\ A$ (add 10% ≥ 2.2 A)

Canadian and U.S. National Electrical Codes require that circuit breakers must not be loaded above 80% of their nominal rating.

Be sure to also consider the maximum sheath temperature when using MI heating cables. The maximum sheath temperature depends on the power output of the cable, as well as the pipe temperature. It must not exceed the maximum rated temperature of the MI heating cable or the hot-to-cold joint, and must not be in conflict with hazardous area requirements. Sheath temperature calculations can be complex. Use TraceCalc Pro design software or contact your nVent representative for assistance.

Consider the option to select XMI-L heating cables where construction issues are introduced due to the need for multiple passes being balanced with AIT constraints.

BILL OF MATERIALS

Heating Cable Set Catalog Number

To order an MI heating cable set, it is important to understand the format of our catalog number:

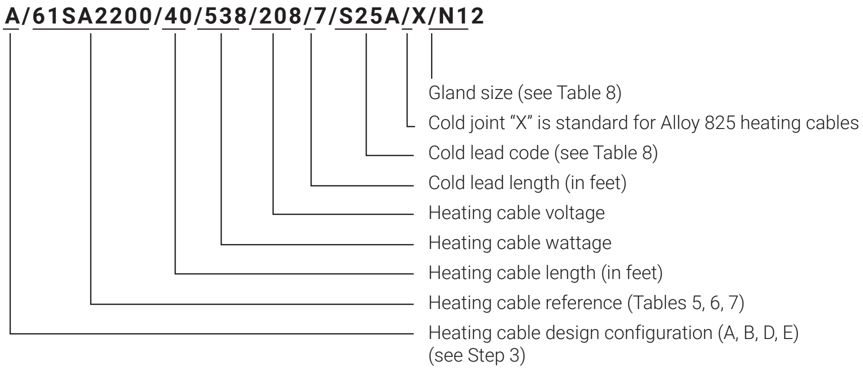


Fig. 7 MI heating cable set catalog number

In the previous heating cable catalog number, the length of the heated section and the cold lead is in feet. For metric lengths, the heating cable catalog number would include a suffix "M" after the length, as follows:

A/61SA2200/12.2M/538/208/2.1M/S25A/X/N12

Conversion from English to Metric units is: L(ft) x 0.3048 = L(m)

Conversion from Metric to English units is: L(m) x 3.2808 = L(ft)

Options

Add suffix "/PE" at the end of the catalog number for pulling eye (Design D cables only).

Add suffix "/RG1" at the end of the catalog number for 1" reverse gland (used to make a watertight seal) for Designs A and D cables. Design D cables also available with 1/2" or 3/4" reverse gland ("/RG34" for 3/4" or "/RG12" for 1/2").

Example:

The catalog number for our simple example would be:

MI heating cable set: D/32SB3700/84/245/120/7/S25A/X/N12

More examples:

D/62SQ3100/200/9920/480/4/S25A/X/N12

- Heating cable configuration is Design D
- 600-V rated dual conductor cable, resistance at 20°C is 0.100 Ω/ft (0.328 Ω/m)
- Heating cable length is 200 ft (61 m)
- Heating cable wattage is 9920 W at 480 V
- Cold lead length is 4 ft (1.2 m)
- Cold lead code is S25A
- 1/2-in NPT gland connector

E/32SQ3200/25.0M/870/120/2.1M/LS23A/X/N12

- Heating cable configuration is Design E
- 300-V rated dual conductor cable, resistance at 20°C is 0.200 Ω/ft (0.656 Ω/m)
- Heating cable length is 25 m (82 ft)
- Heating cable wattage is 870 W at 120 V
- Cold lead length is 2.1 m (7 ft)
- Cold lead code is LS23A
- 1/2-in NPT gland connector

Note: See H59079 for XMI-L nomenclature and catalog number example.

nVent will need the following information to prepare the reference tag supplied with each MI heating cable set:

- Supply voltage and wattage
- Circuit ID (optional, for customer reference only)
- TraceCalc Pro "Series Cable Tag List" report (if heating cable is designed using TraceCalc Pro)

For hazardous locations, also include:

- Area classification (Class, Division, Group)
- Temperature identification number (T-rating) or autoignition temperature (AIT) of flammables handled in the hazardous area
- Appendix I must be completed and returned to nVent for Class I, Division 1 applications
- Maximum sheath temperature of heating cable

The maximum sheath temperature of the MI heating cable depends on the specific application. Contact your nVent representative to provide you with an optimized design for your application.

Selection of Connection Kits and Accessories

nVent RAYCHEM MI heating cables are approved as a complete system only when used with nVent connection kits or any Nationally Recognized Testing Lab (NRTL) enclosure. Any non-approved connection kits may compromise the reliability of the system and will invalidate approvals and warranties.

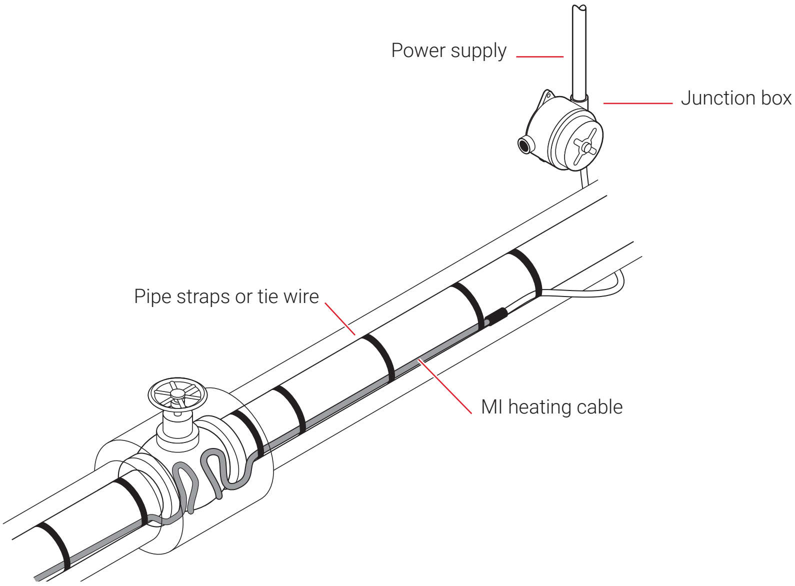


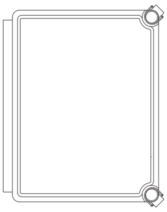
Fig. 8 Typical MI heating system

TABLE 9 CONNECTION KITS AND ACCESSORY SELECTION

Description	Catalog number	Quantity required
Components		
1 Power connection	MIJB	1 per circuit
	or XMI-JB	1 per circuit
	or RMI-JB3, 1–2 heating cables	1 per circuit
	or PT-JB	1 per circuit
	or D1297TERM4 + D1297BRACK	1 per circuit
	or JBS-100-ECP-A + MI-GROUND-KIT (nonhazardous locations only)	1 per circuit
	or JBS-100-ECW-A + MI-GROUND-KIT (nonhazardous locations only)	1 per circuit
Accessories		
2 Attachment material		
Pipe straps	PB... (see "Table 10")	1 every foot
Tie wire	or 051Cupron	See "Table 11"
Prepunched strapping	107826-000	See "Table 11"
Banding (and clips)	BAND100FT	See "Table 11"
	BANDCLIP100	
MIJB mounting bracket	MBRP-B	2 per MIJB
Pipe straps for MBRP-B	PS...	1 per MBRP-B
Electric traced labels	ETL	Every 10 feet
Consider mesh to hold heating cable against awkward shapes HWA-METAL-MESH-SS-50MM-10M		
Temperature controls — see Control and Monitoring design guide (H56889)		

System Components

POWER CONNECTION KITS



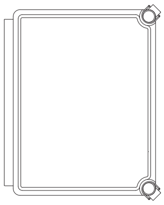
nVent RAYCHEM MIJB-864-A Junction box with pre-drilled earth plate for use with MI heating units.

Typical uses - Power, splice and end box for 3 phase systems

Hazardous locations: CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X.

Entries: Up to 8 x ½” and 3 x ¾”. Power cable gland and hubs not included.
Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation.

Enclosure dimensions: 8” x 6” x 4” (200 x 150 x 100mm)

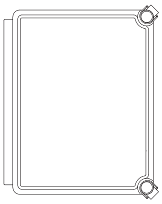


nVent RAYCHEM MIJB-1086-A Junction box with pre-drilled earth plate for use with MI heating units. Accommodates up to 3 power cables.

Typical uses - Power, splice and end box for 3 phase systems
Hazardous locations - CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X.

Entries: Up to 11 x ½” and 8 x ¾”. Power cable gland and hubs not included. Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation. Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG (35A).

Enclosure dimensions: 10” x 8” x 6” (250 x 200 x 150mm)

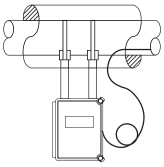


nVent RAYCHEM MIJB-1086-B Junction box with pre-drilled earth plate for use with MI heating units. Accommodates up to 7 outgoing heating cables and one incoming power cable. It can also be used as a marshalling box – one incoming power cable and 5 outgoing power cables.

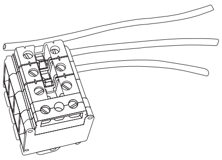
Typical uses - Power or marshalling, splice and end box for 3 phase systems. Hazardous locations: CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X.

Entries: Up to 11 x ½” and 8 x ¾”. Power cable gland and hubs not included. Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation. Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG (35A).

Enclosure dimensions: 10” x 8” x 6” (250 x 200 x 150mm)

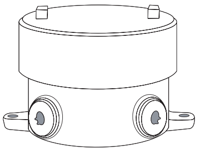


nVent RAYCHEM MBRP-B Enclosure mounting bracket for MIJB series fiberglass enclosures. Mounting bracket enables enclosure installation and connection prior to application of insulation and cladding. Stainless steel pipe support bracket for MIJB-864-A, MIJB-1086-A and MIJB-1086-B fiberglass enclosures. Two brackets are required to support each enclosure. Each bracket requires one pipe strap.



nVent RAYCHEM MIJB-LPWR-KIT Terminal kit to facilitate downsizing of large power cables.

Large power wire kit to downsize #2 or #4 power cable to #6AWG (max 35amps for enclosure terminal blocks). Use with MIJB-1086-A and MIJB-1086-B enclosures as required.



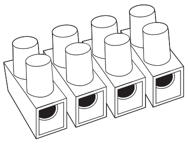
nVent RAYCHEM XMI-JB Aluminum enclosure for CID1 areas.

Typical uses: MI heating units power or splice connection box,
RTD connection box

Hazardous locations - CID1 Groups B, C and D, Maximum operating voltage 600Vac, Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG), NEMA 4X.

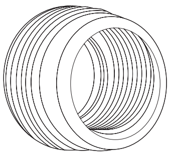
Entries : 5 x 3/4" and includes 3 x 3/4" plugs, two reducer bushings (3/4" x 1/2") and two mounting feet with space to tap hole for bonding wire. Power cable gland should be purchased separately. Additional terminal strips or reducer bushings may also be purchased separately for additional RTD connection.
(4POLETSTRIP and PTRDBH3412)

Enclosure dimensions: 4 ½” x 3 ½” (114 x 89mm).



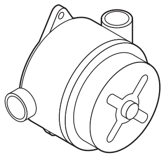
nVent RAYCHEM 4POLETSTRIP Terminal strip for enclosure,

4 pole terminal strip (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG) for use with XMI-JB enclosure. May be used for additional RTD connections.



nVent RAYCHEM PTRDBH3412 Reducer bushing for enclosure,

Zinc plated steel reducer bushing for use with XMI-JB enclosure. Reduces ¾” NPT tapered hole to ½” NPT. Body length 23/32” (18mm), Class I, Div. 1 &2, Groups A, B, C, D. Class I, Zone 1, Groups IIC, IIB, IIA. Class II, Div. 1 & 2, Groups E, F, G.

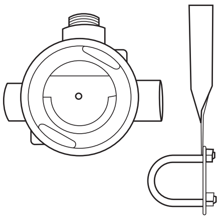


RMI-JB3

nVent RAYCHEM RMI-JB3 Copper-free aluminum alloy box with three entries for use with MI heating cables.

Typical use : power or splice connection box

Includes terminal block (500 Vac, 50 A, 2 x 6 AWG) and three 3/4" x 1/2" reducers and two 3/4" NPT plugs. FM and CSA approved for: Class I, Div. 1 & 2, Groups B, C, D; Class II, Div. 1 & 2, Groups E, F, G; and Class III.
Enclosure dimensions: 6.1" x 5.2" x 3.9" (156 mm x 133 mm x 98 mm).



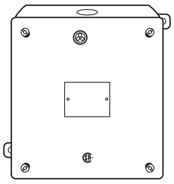
PT-JB

nVent RAYCHEM PT-JB A smaller ferro-alloy junction box with three entries for use with MI heating cables.

Typical use : power or splice connection box

Three 3/4" NPT entries. Provided with one plug and two 3/4" x 1/2" reducers. Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG / UL-300 Vac, 65 A, 18–6 AWG) and stainless steel support bracket (U-clamp). UL and CSA approved for: Class I, Div. 1 & 2, Groups A, B, C, D; Class II, Div. 1 & 2, Groups E, F, G.

Enclosure dimensions: 5.5" x 4.75" x 3" (140 mm x 121 mm x 76 mm).

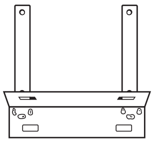


D1297TERM4

nVent RAYCHEM D1297TERM4 A large cast aluminum junction box (NEMA 3R) for installation in nonhazardous and CID2 areas.

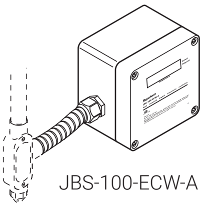
Typical use : power or splice connection box

Three 1/2" NPT entries on bottom, provided with plugs. Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG / UL-300 Vac, 65 A, 18–6 AWG). External mounting feet. CSA approved for Class I, Div 2, Groups A, B, C, and D.
Enclosure dimensions: 6" x 6" x 4" (152 mm x 152 mm x 101 mm).

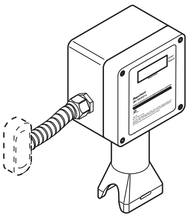


D1297BRACK

nVent RAYCHEM D1297BRACK Optional stainless steel mounting bracket for junction box type D1297TERM4. To be strapped on metal cladding of pipe insulation using metal banding or pipe straps (based on outer dimension of insulation).



JBS-100-ECW-A



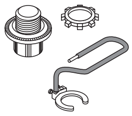
JBS-100-ECP-A

nVent RAYCHEM JBS-100-ECP-A and JBS-100-ECW-A Electronic temperature controllers that provide accurate control of a heating circuit using a RTD sensor.

Adjustable set points between 32°F to 425°F (0°C to 218°C), power input of 120 Vac to 277 Vac, and current switching up to 30 A. c-CSA-us (certified to U.S. and Canadian Standards) for use in nonhazardous locations. Requires MI grounding kit.

The JBS-100-ECP-A is pipe mounted and serves as a power connection kit for both self-regulating and mineral insulated heating cables.

The JBS-100-ECW-A is wall mounted and may be used with all types of heating cables. It can also be used as a power connection kit with MI cables.



MI-GROUND-KIT

nVent RAYCHEM MI-GROUND-KIT Required grounding kit for use with
JBS-100-ECP-A and
JBS-100-ECW-A. Allows for a direct connection to a MI heating cable, eliminating the need for a separate junction box.

Accessories

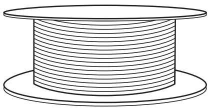
PB

ATTACHMENT MATERIALS

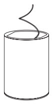
nVent RAYCHEM PB Stainless-steel straps for holding MI heating cables onto pipe. Pliers are the only tool required to pull the pipe strap tight. Allow one pipe strap per foot of pipe (3.3 pipe straps per meter of pipe).

TABLE 10 AVAILABLE PIPE STRAPS

Order Reference	Pipe diameter	Package quantity
PB 125	To 1-1/4"	50 pc
PB 300	1-1/2" to 3"	35 pc
PB 600	3-1/2" to 6"	25 pc
PB 1000	6" to 10"	1 pc
PB 1200	To 12"	1 pc
PB 2400	To 24"	1 pc
PB 3600	To 36"	1 pc



051CUPRON

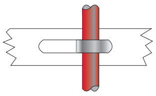


nVent RAYCHEM 051Cupron 16 AWG tie wire for fastening Alloy 825 MI heating cables on pipes. Do not use with copper-sheathed MI heating cables; use PB pipe straps. Particularly good for irregular shaped objects like valves and pumps. Order quantity as required (in ft) as per Table Table 8.

RMI-TW 559600-000 Tie wire for fastening steel heating cables on pipes. Especially suitable for irregular shaped objects such as pumps, valves, flanges. Supplied in 50m reels.

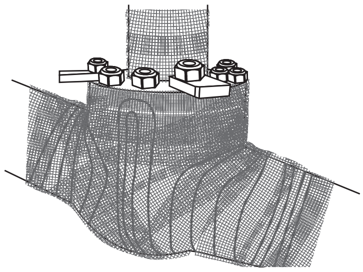
TABLE 11 ALLOWANCE FOR TIE WIRE AND PREPUNCHED BANDING ON PIPES

Pipe size (inches)	1	1.5	2	4	6	8	10	12	14	16	18	20	24	30	36	48
Required length (ft) per ft of pipe	0.8	1.1	1.2	1.6	2.1	2.8	3.5	4.2	4.6	5.2	5.9	6.5	7.9	9.8	11.8	15.7
Required length (m) per m of pipe	0.8	1.1	1.2	1.6	2.1	2.8	3.5	4.2	4.6	5.2	5.9	6.5	7.9	9.8	11.8	15.7



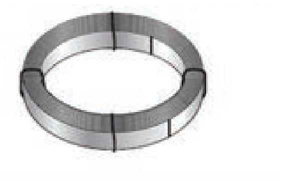
nVent RAYCHEM HARD-SPACER-SS-25MM-25M Stainless steel prepunched strapping to hold MI heating cable in place. Supplied in 82 ft (25.0 m) rolls.

Use on large pipes to simplify installation of multiple heating cables. For quantities, see Table 11 (installation every 1 ft = 0.328 m).



nVent RAYCHEM HWA-METAL-MESH-SS-50MM-10M Stainless steel mesh for fixation of heating cables on valves, pumps or other odd shaped surfaces. This mesh provides optimum contact and heat transfer between heating cables and heated equipment and can be used for exposure temperatures up to 400°C

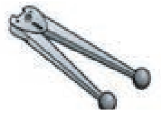
10 m per roll. 50 mm width. Weight: 0.36 kg.



nVent RAYCHEM BAND100FT
Stainless steel banding used to strap MI cables to pipes
Ideal for large OD pipes
100ft roll x ½" wide x 0.020" thick
(30m x 12.5mm wide x 0.5mm thick)
Use with BANDCLIP100 banding clips ordered separately

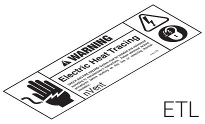
nVent RAYCHEM BANDCLIP100
Stainless steel clips used with stainless steel banding
100 clips per package
Use with BAND100FT ordered separately

nVent RAYCHEM T34P
Ratchet-type tensioning tool tightens stainless-steel banding used to support MI Cables.



nVent RAYCHEM S12P
Crimping tool used to crimp clip onto stainless-steel banding.

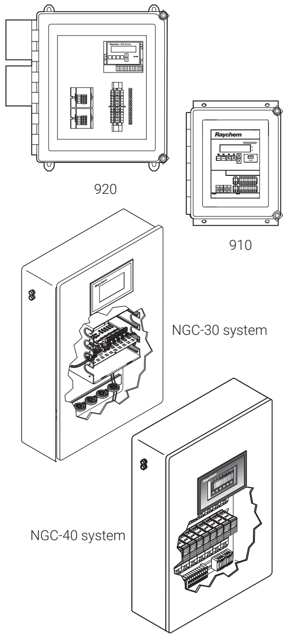
Electric Traced Label



ETL

nVent RAYCHEM ETL - English
ETL - French Attach the label to the outside of the thermal insulation weather barrier to indicate presence of electrical heat tracing. Use one label for every 10 feet (3 m) of pipe, alternating on either side of the pipe. Also install at equipment requiring periodic maintenance (control valves, pumps, instruments, etc.).

Temperature Controls



For a complete selection of control and monitoring products, including line-sensing thermostats, see Control and Monitoring design guide (H56889).

LONGLINE HEATING

This section provides an overview of the longline heat-tracing technologies available from nVent. For complete design assistance, contact your nVent representative or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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INTRODUCTION

nVent provides industry-proven solutions for longline applications.

Heating long pipelines for freeze protection, viscosity control, or temperature maintenance presents special requirements for electrical heat tracing. These applications require long electrical circuit lengths, usually with a single electrical power point. nVent provides a wide range of industry-proven solutions for these applications. Extreme long lines are usually transfer lines between processing plants or to storage or transportation facilities. Tank farms, piers for ocean transport vessels, and pipes between petrochemical facilities are all examples of applications for which longline heat tracing may be used. Even if a processing plant uses steam for in-plant heat tracing, electrical tracing may be beneficial for these transfer lines.

Typical applications for longline heating systems include:

- Water and steam condensate lines
- Water supply and injection lines
- Sewage lines
- Natural gas gathering lines (condensation prevention)
- Crude oil gathering lines (viscosity control)
- Off-site crude and fuel oil lines
- Temperature-sensitive lines
- Product transfer lines

Longline tracing systems can be complex to design and install. For this reason nVent offers several technologies to choose from, thus providing the best cost optimization for your project. These technologies are:

- Self-regulating heating cables
- Mineral insulated heating cables
- Series-resistance heating cables
- Skin-effect heat-tracing systems

All longline heat tracing should be designed with engineering support from nVent. For assistance in selecting the best technology for the application, contact your nVent representative.

SELF-REGULATING HEATING CABLES

LBTV and SLBTV

LBTV cable is especially well suited for tracing pipelines up to 1125 feet (342 m) containing temperature-sensitive fluids, or where high reliability is required.

SLBTV extends the maximum circuit length to 2000 feet (610 m) from one power connection point.

nVent RAYCHEM brand LBTV and SLBTV heating cables can provide temperature maintenance and freeze protection for continuous circuit lengths up to 1125 feet (342 m) and 2000 feet (610 m) respectively powered from a single source. The cable is especially well suited for tracing long pipelines containing temperature-sensitive fluids, or where high reliability is required.

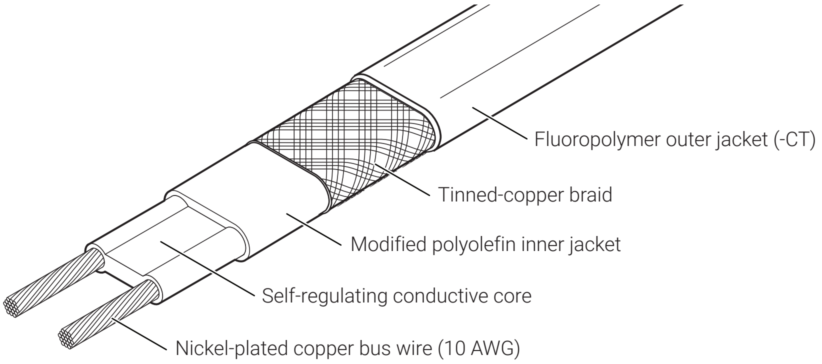

Fig. 1 LBTV and SLBTV heating cable

LBTV and SLBTV heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C). The cable is configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

nVent RAYCHEM LBTV and SLBTV heating cables provide electrical freeze protection and temperature maintenance up to 150°F (65°C) for long piping systems in both nonhazardous and hazardous locations. This single-phase, self-regulating heating cable provides freeze protection and low-temperature maintenance for medium-length applications. The parallel circuit design results in a cable that can be cut to length in the field.

Within the circuit length limitations, the heat output per foot is independent of circuit length. The cable is constructed with 10 AWG copper bus wires, permitting longer circuit length with less voltage drop than the 16 AWG BTV cable bus wires. These heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C). They are approved for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

Refer to the data sheets in the Technical Data section for more detailed information. Data sheets can be found on the nVent web site, nVent.com, or the Technical data sheet section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550).

VLBTV and VLKTV

VLBTV and VLKTV heating cables can be used with piping systems up to 12,000 feet (3660 m) in length and can be used in hazardous locations and where corrosives are present.

The nVent RAYCHEM VLBTV and VLKTV are three-phase heating cables for very long piping systems. Each can be used in hazardous locations and where corrosives are present. They can also be pulled through installation channels when necessary.

VLBTV

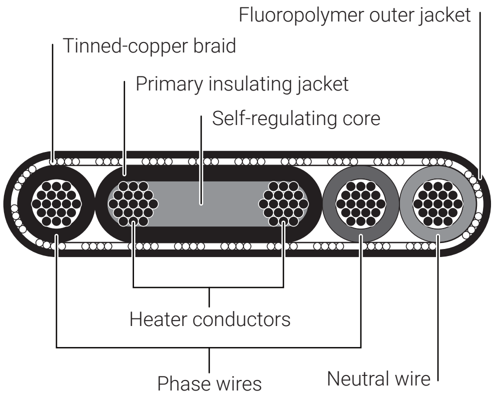

Fig. 2 VLBTV cross section

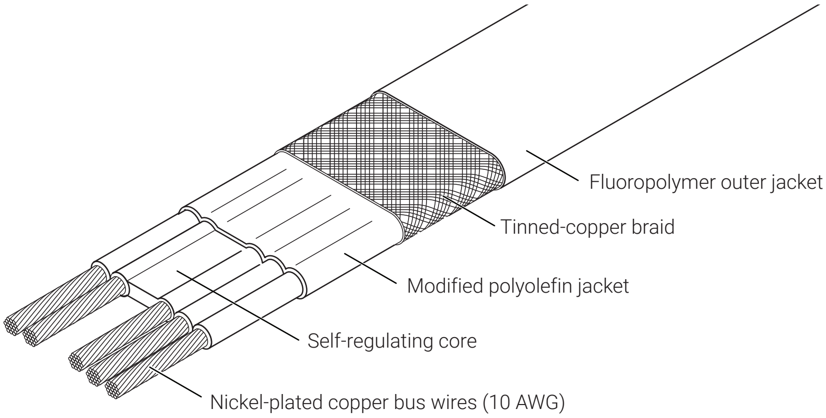

Fig. 3 VLBTV heating cable

VLBTV heating cable can maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C).

VLBTV provides basic freeze protection and low-temperature maintenance for medium-long pipelines. The heating cable can maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C). VLBTV can be used for circuit lengths up to 12,000 feet (3660 m) powered from a single source.

Refer to the data sheet (H52396) in the Technical Data section for more detailed information. Data sheets can be found on the nVent web site, nVent.com, or the Technical data sheet section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550).

VLKTV

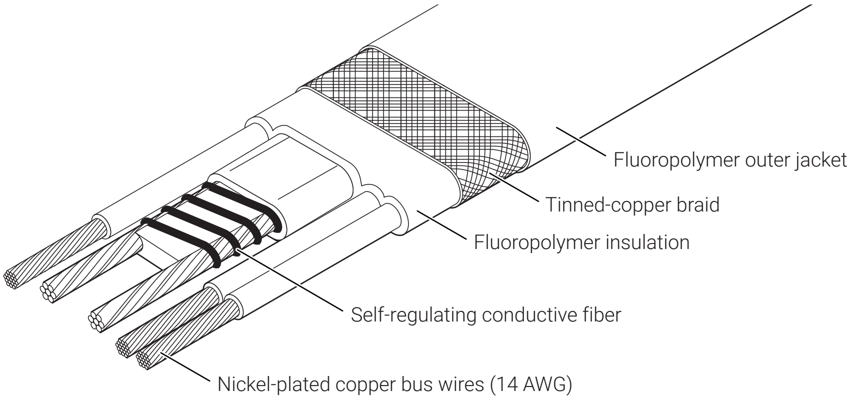

Fig. 4 VLKTV heating cable

VLKTV is especially well suited for tracing long pipelines containing temperature-sensitive fluids, or where extreme heating cable reliability is required.

VLKTV provides high-temperature maintenance for longline applications. VLKTV can also be used to provide low-temperature maintenance for long lines that are exposed to high temperatures. The VLKTV heater can withstand continuous exposure to temperatures up to 300°F (150°C) and intermittent exposure to 420°F (215°C). It can be used for circuit lengths up to 6000 feet (1830 m), powered from a single source. VLKTV is especially well suited for tracing long pipelines containing temperature-sensitive fluids, or where extreme heating cable reliability is required.

Refer to the VLKTV data sheet (H55822) in the Technical Data section for more detailed information. Data sheets can be found on the nVent web site, nVent.com, or the Technical data sheet section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550).

MINERAL INSULATED HEATING CABLES

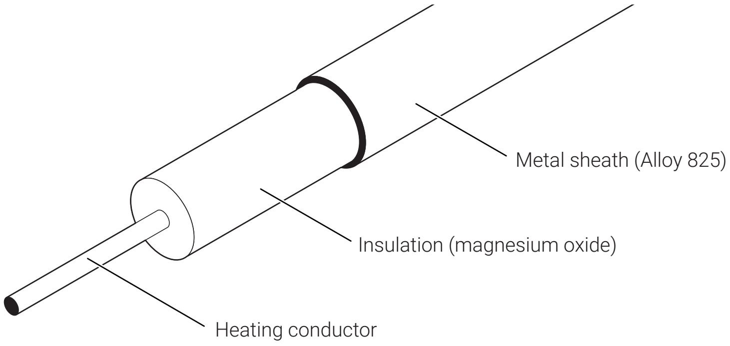

Fig. 5 MI heating cable

MI heating cable is rugged and economical, and can be used for lines up to 5000 + feet (1500 + m).

nVent RAYCHEM brand mineral insulated heating cables are used in longline applications where high temperature maintain and/or high temperature exposures exist, or high power output is required MI heating cable is used in many applications, including transfer lines. It is rugged and economical, and can be used for lines up to 5000+ feet (1500+ m). A 600-Vac Delta or Wye electrical configuration balances the electrical load well. Designs must be done on a case-by-case basis because the total resistance must be matched to the transformer characteristics.

Refer to the Section 3, Mineral Insulated Cables, design guide (H56884) for more detailed information.

SERIES-RESISTANCE HEATING CABLES

SC

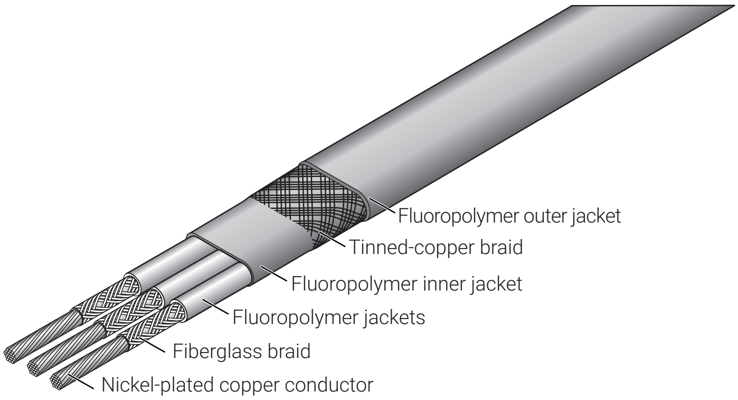

Fig. 6 SC heating cable

Flexible series-resistance heating cables can be used when circuit lengths exceed the ratings of conventional parallel-resistance heating cables and a single power source is needed.

nVent RAYCHEM brand flexible series-resistance heating cables can be used when circuit lengths exceed the ratings of conventional parallel-resistance heating cables and a single power source is needed. Ohmic heating of the conductor provides the heat in this series circuit heating cable. Engineering design by nVent is required since the wattage output depends on the total circuit length and the voltage applied.

SC cables are available in single-, double-, and triple-conductor configurations for single- or three-phase system designs. The resistance conductors are electrically isolated with high-temperature, heavy-wall fluoropolymers; a grounding braid; and a final fluoropolymer jacket. Maximum exposure temperatures are 400°F (204°C) for SC cables, 482°F (250°C) for SC/H cables, and 195°F (90°C) for SC/F cables. SC cables are capable of supporting circuit lengths up to 12,000 feet (3659 m) with one power supply point, and voltages up to 600 Vac.

SKIN-EFFECT HEAT-TRACING SYSTEM

STS

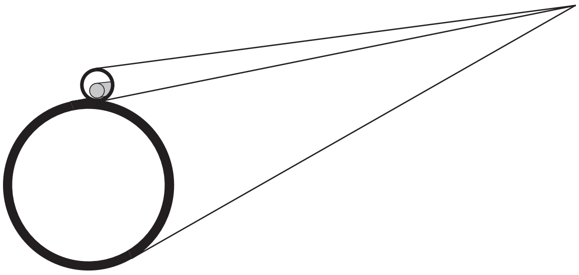

Fig. 7 Skin-effect heat-tracing system (STS)

The STS system is custom engineered for the specific application and is ideally suited for long transfer pipelines up to 15 miles (25 km).

The nVent RAYCHEM brand skin-effect heat-tracing system (STS) is custom engineered by nVent for the specific application and is ideally suited for long transfer pipelines over one mile (1.6 km) in length. Consideration is given to transformer power requirements, control and monitoring designs, conductor wire selection, and the installation of the complete system. In the STS heating system, heat is generated on the inner surface of a ferromagnetic heat tube that is thermally coupled to the pipe to be heat traced. An electrically insulated, temperature-resistant conductor is installed inside the heat tube and connected to the tube at the far end. The tube and conductor are connected in series to an AC voltage source. This method of heating is called skin-effect heating because the return path of the circuit current is pulled to the inner surface (approximately 1 mm) of the heat tube by both the skin effect and the proximity effect between the heat tube and the conductor. The outside surface of the heat tube is at ground potential, while the inner surface of the tube carries full current.

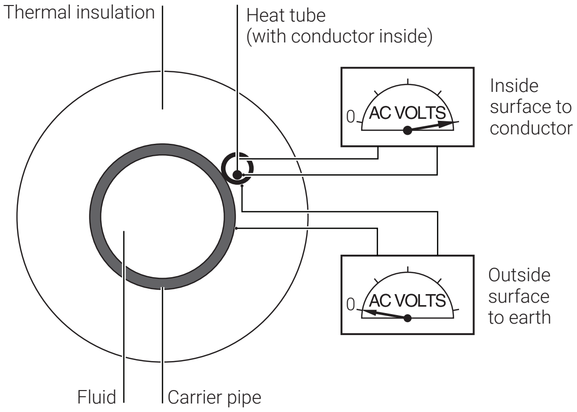

Fig. 8 STS cross section

A skin-effect heat-tracing system minimizes the number of power supply points required by offering the longest circuit lengths available to the industry.

The STS circuit impedance is mainly resistive, generating heat in the heat tube wall and, to a lesser extent, in the insulated conductor. Additional heat results from eddy currents induced in the heat tube wall.

The allowable circuit length is determined by the power output, heat tube size, conductor size, and the carrier pipe temperature. The highest installed cost component in electrical heat-tracing systems is often the power distribution system. This is especially true for long lines where power feeds are unavailable. A STS system minimizes the number of power supply points required by offering the longest circuit lengths available to the industry.

LONGLINE SYSTEM SELECTION

nVent provides a broad range of options for heat-tracing long lines. Decision variables include maintenance temperature, heat-loss circuit length, maximum exposure temperature, power availability, piping system support and construction, thermal insulation k values, and local codes and standards. Use the following table for preliminary cable selection and contact nVent for complete system design and optimization.

Table 1 System Characteristics Matrix

	Maximum circuit length ft (m)		Maximum exposure temperature		Maximum power output* (Watts/ft)	Maximum voltage (Vac)
LBTV2	1125	(343)	185°F	(85°C)	10	277
SLBTV	2000	(610)	185°F	(85°C)	—	277
VLBTV	12,000	(3660)	185°F	(85°C)	20	600
VLKTV	6000	(1829)	420°F	(215°C)	20	600
MI	5000+	(1524+)	1200°F	(650°C)	61	600
SC	12,000	(3659)	250°F	(250°C)	—	600
STS	82,000	(24,993)	200°F	(200°C)	49	2000–5000

* Design dependent

CONTROL AND MONITORING OF LONGLINE SYSTEMS

Control of these heat-tracing systems usually involves significant current switching.

Standard on-pipe sensing and control can be effectively used since the piping system usually has a single flow path. A PASC system should be considered if there are multiple flow paths, or some instrumentation piping involved.

Sensor location is important since flow is usually intermittent and starts from one end of the piping system. Multiple sensors may be used to provide better monitoring of the temperature along the length of the pipe, with the lowest temperature controlling the system turn-on. Current monitoring is effective on all series-heating cable and STS systems and ground-fault protection must be used as required by national electrical codes and standards. Due to high power requirements, these systems typically use dedicated power transformers VLBTV and VLKTV heat-tracing systems need special control and monitoring configurations. Please contact Technical Support for proper design of these systems.

RTB TUBING BUNDLES

This section will help you select and design a complete tubing bundle system for electric heat tracing, steam tracing, or pre-insulated only lines. For other applications or for design assistance, contact your nVent representative or visit our web site at nVent.com.

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BILL OF MATERIALS **91**

INTRODUCTION

Achieve a total solution for heat tracing instrument and small-diameter process lines with tubing bundles.

nVent provides a total solution for heat tracing instrument and small-diameter process lines. nVent RAYCHEM brand RTB tubing bundles are a pre-traced and pre-insulated tubing alternative to field tracing and insulating. RTB systems combine electric or steam heat tracing with tubing and insulation for a single bundle that can be cut to length in the field.

Typical RTB applications include:

- Impulse lines — to flow transmitters, pressure transmitters, level transmitters, and pressure switches
- Sample lines — to analyzers and chromatographs
- Process lines — for steam supply, condensate return, water purge, chemical feed, and air lines

SYSTEM OVERVIEW

An RTB system consists of pre-traced and pre-insulated tubing bundles. Each tubing bundle can be configured as single- or dual-tube, as shown below, and can be constructed in various sizes and materials to meet your small-diameter process needs.

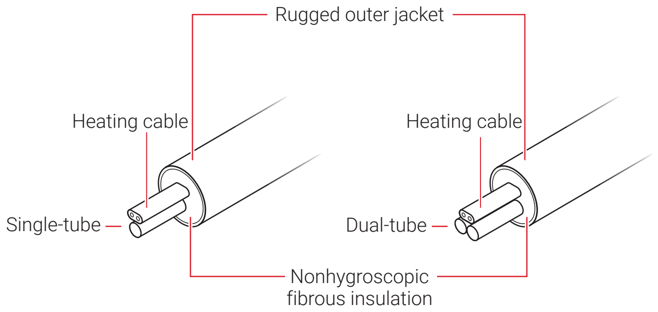


Fig. 1 Tubing bundles, single- and dual-tube construction

RTBs simplify design and significantly reduce installation time.

RTBs are pre-engineered to ensure consistent and repeatable performance for maintenance-free operation. Compared to field fabrication, they simplify design and significantly reduce installation time. The RTB's unique parallel construction allows for a tight bending radius (down to 8 inch) and eliminates possible tube kinking. Each bundle can be cut to length in the field and is powered and terminated with simple RTB connection kits. The insulating material consists of a nonhygroscopic fibrous glass for maximum heat-loss prevention. Finally, each RTB is encased in a high-performance polyurethane outer jacket that provides superior UV resistance and installation capability to –40°C (–40°F).

Contact your nVent representative for design assistance for the following applications:

- The desired maintain temperature range or process tube size does not appear in Table 3 on page 88, or Table 4 on page 89
- The ambient temperature range is different than –30°C to 38°C (–20°F to 100°F)
- Supply voltages of 208 Vac or 277 Vac are used
- Temperature control is critical

Approvals and Certifications

nVent heating cables have agency approvals for use in both nonhazardous and hazardous locations.

The RTB system uses nVent RAYCHEM brand BTV and XTV heating cables that are approved and certified for use in nonhazardous and hazardous locations by many agencies, including FM , CSA, PTB, Baseefa, NEPSI, DNV, ABS and many more. For more details, consult the heating cable data sheets included in the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550) and the Catalogue for Industrial Heat Tracing Products & Services (EN-IndustrialHeatTracingEMEA-SB-DOC2210). Data sheets can be found on the nVent web site, nVent.com.

PRODUCT SELECTION

Overview

The product selection process involves three basic steps:

1. Gather the necessary information.
2. Select the tube type.
3. Select the product / elements based for your application.

Before beginning, take a moment to understand the structure underlying tubing bundle catalog numbers. You will refer to this numbering convention throughout the product selection process. Based on your application: Electric Traced, Steam Traced, or Pre-insulated Only (PIO), your goal is to determine the tubing bundle catalog number for the product that best suits your needs.

Sample applications will be followed throughout the product selection process.

Tubing Bundle Catalog Number

RTB comes in a variety of configurations. The following chart outlines the elements that constitute a bundle configuration and the corresponding catalog number. Other configurations are available on request.

RTB* - X - XXX - X - XXX - XXX-X**

Electric Traced heating options
5B1 = 5BTV1-CT
8B1 = 8BTV1-CT
10B1= 10BTV1-CT
5B2 = 5BTV2-CT
8B2 = 8BTV2-CT
10B2= 10BTV2-CT
5X1 = 5XTV1-CT-T3
10X1= 10XTV1-CT-T3
15X1= 15XTV1-CT-T2
20X1= 20XTV1-CT-T2
5X2 = 5XTV2-CT-T3
10X2= 10XTV2-CT-T3
15X2= 15XTV2-CT-T3
20X2= 20XTV2-CT-T2

Steam Traced heating options
LTS = Low-temperature steam
HTS = High-temperature steam

Preinsulated Only heating option
PIO = Preinsulate only

Process tube wall thickness
030 = 0.030 in
032 = 0.032 in
035 = 0.035 in
049 = 0.049 in
062 = 0.062 in
065 = 0.065 in
10 = 1.0 mm
15 = 1.5 mm

Process tube material
S = Seamless 316 SS
W = Welded 316 SS
M = Monel
C = Copper
P = PFA

Process tubing size
1/8 = 1/8 in
1/4 = 1/4 in
3/8 = 3/8 in
1/2 = 1/2 in
3/4 = 3/4 in
6 = 6 mm
8 = 8 mm
10 = 10 mm
12 = 12 mm

Number of process tubes
1 = Single-tube
2 = Dual-tube

* For optional Arctic PVC jacket add suffix "C" example RTBC
** Requires the selection of tracer tubing, xx = tubing size, -X- tubing, and -XXX- = wall thickness for both LTS and HTS

Examples:

Electric Traced	RTB-2-1/2-S-049-10X1
Steam Traced	RTB-2-1/2-S-049-LTS-3/8-C-035
Preinsulated Only	RTBC-1-1/2-S-049-PIO

Fig. 2 Tubing bundle catalog number elements

Product Selection

1. Gather information
2. Select tube type
3. Select the product / elements

Step 1 Gather the necessary information

First, determine the application that best suits your project, and then go to the respective section that describes the information you will need to gather for that application.

The applications are:

- Electric Traced Lines: For freeze protection and temperature maintenance.
- Steam Traced Lines: For freeze protection and temperature maintenance.
- Pre-insulated Only (PIO) Lines: For steam distribution supply lines, condensate return and personnel protection.

For Electric Traced Lines

To select the tubing bundle for electric traces lines, gather and record the following information:

- Required number of process tubes (one or two) ________________
- Required process tubing size (refer to Table 1 on page 86) ________________
- Required process tube material ________________
- Required process tube wall thickness ________________
- Desired maintain temperature range (for selection of the heating cable)

  ____
- Service voltage for the heating cable ________________
- Process operating temperature (for selection of the appropriate materials and heating cable) ________________
- Maximum exposure temperature (for selection of the appropriate materials and heating cable) ________________
- Temperature class (T-rating) for applications in hazardous locations (for heating cable selection) ________________
- Jacket material (see RTB Electric Traced Bundles data sheet [H58179] for options)

  ____

Example: Electric Traced sample application

Number of process tubes	2
Process tubing size	1/2 inch
Process tube material	Stainless steel 316 (seamless)
Process tube wall thickness	0.049 inch
Maintain temperature	10°C (50°F)
Service voltage for heating cable	120 V
Process operating temperature	38°C (100°F)
Maximum exposure temperature	65°C (150°F)
T-rating	T6
Jacket material	Standard TPU

For Steam Traced Lines

To select the tubing bundle for steam traced lines, gather and record the following information:

- Required number of process tubes (one or two) ________________
- Required process tubing size (refer to Table 1 on page 86) ________________
- Required process tube material ________________
- Required process tube wall thickness ________________
- Desired maintain temperature range________________
- Steam pressure ________________
- Steam tracing tubing size, material and wall thickness ________________
- Process operating temperature ________________
- Maximum exposure temperature ________________
- Jacket material (see RTB Steam Traced Bundles data sheet [H58209] for options) ________________

Example: Steam Traced sample application

Number of process tubes	2
Process tubing size	1/2 inch
Process tube material	Stainless steel 316 (seamless)
Process tube wall thickness	0.049 inch
Maintain temperature	10°C (50°F)
Steam pressure	2 Bar (15 psig)
Steam tracing tubing size	3/8 inch
Steam tracing tubing material	Copper
Steam tracing wall thickness	0.032 in
Process operating temperature	38°C (100°F)
Maximum exposure temperature	65°C (150°F)
Jacket material	Standard TPU

For Pre-insulated ONLY (PIO) Lines

To select the tubing bundles for pre-insulated only (PIO) lines, gather and record the following information:

- Required number of process tubes (only one available) ________________
- Required process tubing size (refer to Table 1 on page 86) ________________
- Required process tube material ________________
- Required process tube wall thickness ________________
- Process operating temperature ________________
- Maximum exposure temperature ________________
- Jacket material (see RTB Pre-insulated Only (PIO) Tubing data sheet [H58210] for options) ________________

Example: Pre-insulated Only sample application

Number of process tubes	1
Process tubing size	1/2 inch
Process tube material	Stainless steel 316 (seamless)
Process tube wall thickness	0.049 inch
Process operating temperature	38°C (100°F)
Maximum exposure temperature	65°C (150°F)
Jacket material	Optional Artic PVC

Product Selection
1. Gather information
2. Select tube type
3. Select the product / elements

Step ❷ Select the tube type

For Electric, Steam and Pre-insulated ONLY (PIO) Lines

The table that follows lists possible RTB combinations of tube size and wall materials. For other configurations, contact your nVent representative.

TABLE 1 NVENT RAYCHEM TUBING BUNDLE OPTIONS

	Tubing size (nominal)							
Tubing wall material and thickness	1/8"	1/4"	3/8"	1/2"	6 mm	8 mm	10 mm	12 mm
Stainless steel 316 (seamless)								
0.035"	•	•	•	•				
0.049"				•				
0.065"				•				
1.0 mm					•	•	•	•
1.5 mm								•
Stainless steel 316 (welded)								
0.035"		•	•	•				
Monel 600 (seamless)								
0.035"		•	•					
0.049"				•				
Copper								
0.030"		•						
0.032"			•					
0.049"				•				
1.0 mm					•	•	•	•
PFA Teflon								
0.030"		•	•					
0.060"				•				
1.0 mm					•	•		

Example: Electric Traced tube number / size / material selection

Number of process tubes	2 (from Step 1)
Process tubing size	1/2 inch (from Step 1)
Process tube material	Stainless steel 316 (seamless) (from Step 1)
Process tube wall thickness	0.049 inch (from Step 1)
Catalog number	RTB-2-1/2-S-049-XXXX

Selection of the heating cable will fill in the one element missing from the catalog number of your RTB tubing bundle.

Product Selection
1. Gather information
2. Select tube type
3. Select the product / elements

Step ❸ Select the product / elements for your application

For Electric Traced Lines

RTB Electric Traced tubing bundles are available with nVent RAYCHEM brand BTV and XTV heating cables. Use BTV heating cables for maintain temperatures up to 32°C (90°F).

For higher maintain temperatures or exposure temperatures above 85°C (185°F), use XTV heating cables. Use Table 2 to identify the cable family that meets your maximum continuous and intermittent temperatures. For maintain and exposure temperatures that exceed the maximum for BTV and XTV, contact your nVent representative.

For more detailed heating cable information, please refer to the Self-Regulating Cables design guide (H56882) of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550) and the Catalogue for Industrial Heat Tracing Products & Services(EN-IndustrialHeatTracingEMEA-SB-DOC2210).

TABLE 2 OVERVIEW OF BTV AND XTV HEATING CABLE CHARACTERISTICS

nVent RAYCHEM Heating cable	Service voltage	Maximum continuous exposure temperature*		Maximum intermittent exposure temperature **		T-rating/ maximum sheath temperature***	
BTV1 all types	110/120 Vac	65°C	(150°F)	85°C	(185°F)	T6 85°C	(185°F)
BTV2 all types	208/277 Vac	65°C	(150°F)	85°C	(185°F)	T6 85°C	(185°F)
5XTV1, 10XTV1	110/120 Vac	121°C	(250°F)	250°C	(482°F)	T3 200°C	(392°F)
15XTV1	110/120 Vac	121°C	(250°F)	250°C	(482°F)	T2D 215°C	(419°F)
5XTV2, 10XTV2, 15XTV2	208/277 Vac	121°C	(250°F)	250°C	(482°F)	T3 200°C	(392°F)
20XTV1	110/120 Vac	121°C	(250°F)	250°C	(482°F)	T2C 230°C	(446°F)
20XTV2	208/277 Vac	121°C	(250°F)	250°C	(482°F)	T2C 230°C	(446°F)

* Heating cable power on (= maximum maintain temperature)
** For 1000 hours intermittent (power on or off)
*** Higher maximum sheath temperatures have been approved by other agencies
Note: All heating cables have a fluoropolymer outer jacket (CT)

Example: Electric Traced selection

Service voltage for heating cable	120 V (from Step 1)
Process operating temperature	38°C (100°F) (from Step 1)
Maximum exposure temperature	65°C (150°F) (from Step 1)
Appropriate heating cable	BTV1

Expected maintain temperature range

Table 3 provides the minimum and maximum expected maintain temperatures of the tubing bundle for ambient temperatures ranging from –30°C to 38°C (–20°F to 100°F).

Go to the column with the tube size you selected and find the heating cable(s) that will maintain the tubing bundle at your minimum temperature requirement or higher. If more than one heating cable will maintain your application's temperature range, choose the cable with the lowest maximum temperature. A thermostat should be used if the maximum temperature in the table exceeds the maximum desired value. Note the heating cable type and the temperature range.

TABLE 3 PROCESS TUBE MAINTAIN TEMPERATURES (MINIMUM–MAXIMUM) FOR AMBIENT RANGE OF –30°C TO 38°C (–20°F TO 100°F) AT 120/240 V

	6 mm or 1/4 in		8 mm		3/8 in		10 mm		12 mm or 1/2 in	
Size	**°C**	**(°F)**	**°C**	**(°F)**	**°C**	**(°F)**	**°C**	**(°F)**	**°C**	**(°F)**
Single-tube										
5BTV1 and 2	19–52	(66–126)	18–52	(64–125)	16–51	(61–124)	15–51	(60–123)	14–50	(58–122)
8BTV1 and 2	32–58	(90–136)	31–57	(88–135)	29–57	(85–134)	28–56	(83–134)	27–56	(81–133)
5XTV1 and 2	31–92	(87–197)	28–90	(82–194)	26–88	(78–190)	23–87	(74–189)	21–84	(70–184)
10XTV1 and 2	63–110	(145–231)	60–108	(139–226)	56–105	(133–222)	53–105	(128–220)	51–101	(123–214)
15XTV1 and 2	84–126*	(184–250)*	81–123*	(177–250)*	78–120	(172–248)	77–120	(170–247)	71–116	(161–240)
20XTV1 and 2	111–151*	(232–250)*	107–148*	(224–250)*	103–145*	(217–250)*	102–144*	(215–250)*	96–139*	(204–250)*
Dual-tube										
5BTV1 and 2	18–52	(64–125)	16–51	(61–124)	14–50	(58–122)	13–49	(56–121)	12–49	(53–120)
8BTV1 and 2	32–58	(89–136)	30–57	(86–135)	28–56	(82–133)	26–56	(79–132)	24–55	(76–131)
5XTV1 and 2	29–91	(85–196)	25–88	(77–190)	22–85	(71–184)	19–84	(66–183)	16–80	(60–176)
10XTV1 and 2	61–109	(142–228)	56–105	(133–221)	52–102	(125–215)	48–101	(119–213)	44–96	(112–205)
15XTV1 and 2	83–124*	(181–250)*	77–119	(171–247)	73–116	(162–241)	71–115	(160–240)	64–110	(148–230)
20XTV1 and 2	109–149*	(228–250)*	102–144*	(216–250)*	97–140*	(206–250)*	95–139*	(203–250)*	87–132*	(189–250)*

The temperatures included in Table 3 are for approximation. For critical services applications contact your nVent representative.
* Requires overtemperature line-sensing thermostat to ensure operation below maximum continuous exposure temperature.

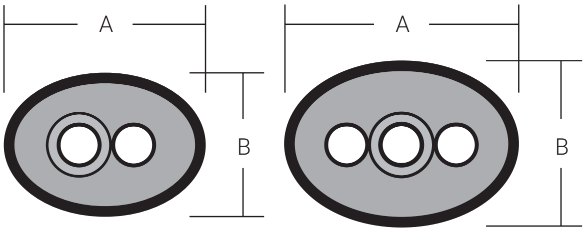
Example: Electric Traced selection

Number of process tubes	2 (from Step 1)
Process tubing size	1/2 inch (from Step 1)
Process tube material	Stainless steel 316 (seamless) (from Step 1)
Process tube wall thickness	0.049 inch (from Step 1)
Maintain temperature	10°C (50°F) (from Step 1)
Service voltage	120 V (from Step 1)
Selected heating cable type	5BTV1 (from previous page)
Min./max. temperature from table	18°C to 51°C (64°F to 125°F) (from Table 3)
Catalog number	RTB-2-1/2-S-049-5B1 (RTB-2-1/2-S-049 is derived from Step 2)

For Steam Traced Lines

RTB Steam Traced tubing bundles are designed to use steam as a heating medium. The performance of each type of product is dictated by construction and positioning of the insulation with the finished product.

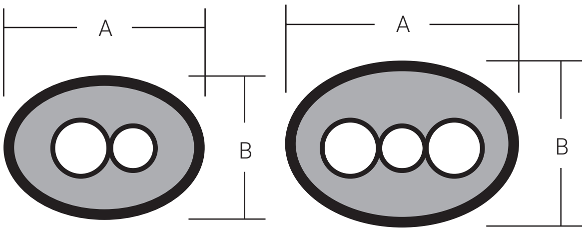
Light Traced Steam (LTS) applications are constructed by separately insulating the nVent TRACER tubing and creating a fixed separation from the process tube(s). The resulting performance characteristics allow LTS to be ideal for freeze protection of small diameter process lines such as instrument impulse lines and can maintain temperatures up to 95°C (200°F).



LTS Single Process
LTS Dual Process

Fig. 3 Light Traced Steam (LTS)

Heavy Traced Steam (HTS) applications are constructed with intimate contact between the TRACER tubing and process tube(s). This construction allows for maximum transfer of heat between the tubes and is ideal for higher maintain applications such as analyzer sample transport and small diameter process lines containing product where temperature maintenance or viscosity control is necessary.



HTS Single Process
HTS Dual Process

Fig. 4 Heavy Traced Steam (HTS)

TABLE 4 PROCESS TUBE MAINTAIN TEMPERATURES (MINIMUM–MAXIMUM) FOR AMBIENT RANGE OF –30°C TO 38°C (–20°F TO 100°F)

	2 Bar (15 psig)		4.4 Bar (50 psig)		9.6 Bar (125 psig)	
	°C	(°F)	°C	(°F)	°C	(°F)
LTS w/ One 1/2" process tube						
3/8" TRACER	17–65	(62–143)	26–74	(78–165)	35–84	(95–193)
1/2" TRACER	29–71	(84–159)	39–83	(102–181)	51–95	(123–203)
LTS w/ Two 1/2" process tubes						
3/8" TRACER	17–65	(62–143)	26–74	(78–165)	35–84	(95–193)
1/2" TRACER	29–71	(84–159)	39–83	(102–181)	51–95	(123–203)
HTS w/ One 1/2" process tube						
3/8" TRACER	118–119	(244–246)	145–146	(293–294)	175–176	(347–348)
HTS w/ Two 1/2" process tubes						
3/8" TRACER	118–119	(244–246)	145–146	(293–294)	175–176	(347–348)

The preceding performance data is typical. Considerations regarding various ambient conditions and maximum run length need to be taken into consideration when selecting TRACER size and pressure.

For additional data on performance and run lengths refer to RTB Steam Traced Bundles data sheet (H58209) or contact nVent.

Example: Steam Traced selection

Number of process tubes	2 (from Step 1)
Process tubing size	1/2 inch (from Step 1)
Process tube material	Stainless steel 316 (seamless) (from Step 1)
Process tube wall thickness	0.049 inch (from Step 1)
Maintain temperature	10°C (50°F) (from Step 1)
Steam pressure	2 Bar (15 psig) (from Step 1)
Steam tracing tubing size	3/8 (from Step 1)
Steam tracing tubing material	Copper (from Step 1)
Steam tracing wall thickness	0.032 inch (from Step 1)
Process operating temperature	38°C (100°F)
Maximum exposure temperature	65°C (150°F)
Catalog number	RTB-2-1/2-S-049-LTS-3/8-C-032

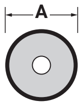
For Pre-insulated ONLY (PIO) Lines

RTB Pre-insulated Only (PIO) tubing bundles are designed specifically for liquid and gas transport lines. These products are used where heat loss, weatherproofing, and personnel protection are important. These are an inexpensive and faster alternative to field insulation of small diameter process lines.

Typical usage includes not only liquid and gas transport lines, but also steam supply lines, condensate return lines, energy conservation, weatherproofing, and personnel protection. Temperature limit is a maximum process temperature: 204°C (400°F). Maximum jacket surface temperature is: 60°C (140°F) @ 27°C (80°F) with 16 km/h (10 mph) wind. Minimum recommended slope for steam line condensate run-off is 1/4 inch per foot.

TABLE 5 INSTALLATION AND DETAILS

	Minimum bend radius cm (in)		Support centers m (ft) Horizontal		Vertical		Nominal weight kg/m (lb/ft)		Nominal dimensions "A" cm (in)	
One 1/4" process line	20	(8)	1.8	(6)	4.6	(15)	0.30	(0.2)	2.5	(1.0)
One 3/8" process line	20	(8)	1.8	(6)	4.6	(15)	0.45	(0.3)	3.2	(1.2)
One 1/2" process line	20	(8)	1.8	(6)	4.6	(15)	0.60	(0.4)	3.4	(1.3)



Example: Pre-insulated Only selection

Number of process tubes	1 (from Step 1)
Process tubing size	1/2 inch (from Step 1)
Process tube material	Stainless steel 316 (seamless) (from Step 1)
Process tube wall thickness	0.049 inch (from Step 1)
Process operating temperature	38°C (100°F)
Maximum exposure temperature	65°C (150°F)
Catalog number	RTBC-1-1/2-S-049-PIO

BILL OF MATERIALS

The creation of a bill of materials involves three basic steps:

1. Determine the total length of tubing bundle and heating cable.
2. Determine the circuit breaker trip rating for bundle.
3. Determine the type and quantity of connection kits, accessories and controllers.

Bill of Materials
1. Determine length of bundle and cable
2. Determine trip rating
3. Select components, accessories and controllers

Step 1 Determine the total length of tubing bundle and heating cable

For electric applications, the length of the heating cable is typically identical to the required length of the tubing bundle. For all applications, be sure the length you order includes an additional one meter (three feet) for each power connection and end seal.

Bill of Materials
1. Determine length of bundle and cable
2. Determine trip rating
3. Select components, accessories and controllers

Step 2 Determine circuit breaker trip rating for bundle

Determine the maximum heating cable length permitted on one circuit breaker. Tables 8 and 9 in the Self-Regulating Cables design guide (H56882) show the maximum heating cable length that may be powered from different-sized circuit breakers for different start-up temperatures. For designs based on European approvals, refer to the "Technical databook" Europe now called Catalogue for Industrial Heat Tracing Products & Services (EN-IndustrialHeatTracingEMEA-SB-DOC2210).

If the length of your tubing bundle exceeds the maximum circuit length, either increase the rating of the circuit breaker or split the bundle into several circuits.

Note: nVent and national electrical codes require ground-fault equipment protection to provide maximum safety and protection from fire.

⚠ WARNING: Fire hazard

There is a danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed. To comply with nVent requirements, certifications, and national electrical codes, and to protect against the risk of fire, ground-fault equipment protection must be used on each heating cable circuit. Arcing may not be stopped by conventional circuit breakers.

Example: Circuit breaker trip rating determination

Catalog number	RTB-2-1/2-S-049-5B1 (from Product Selection, Step 3)
Heating cable type	5BTV1 (from Product Selection, Step 3)
Tubing bundle length	46 m (150 ft)
Start-up temperature	0°C (32°F) Default
Circuit breaker size	15 A
Maximum circuit length	42 m (140 ft)
Number of circuits	2

Bill of Materials
1. Determine length of bundle and cable
2. Determine trip rating
3. Select components, accessories and controllers

Step ❸ Determine the type and quantity of the connection kits, accessories and controllers

Now that you have determined your circuit-breaker rating and number of circuits, use Table 6 on page 92 to determine the number of connection kits and accessories required. BTV and XTV heating cables must be connected and terminated with appropriate power connection and end seal kits (see figure below).

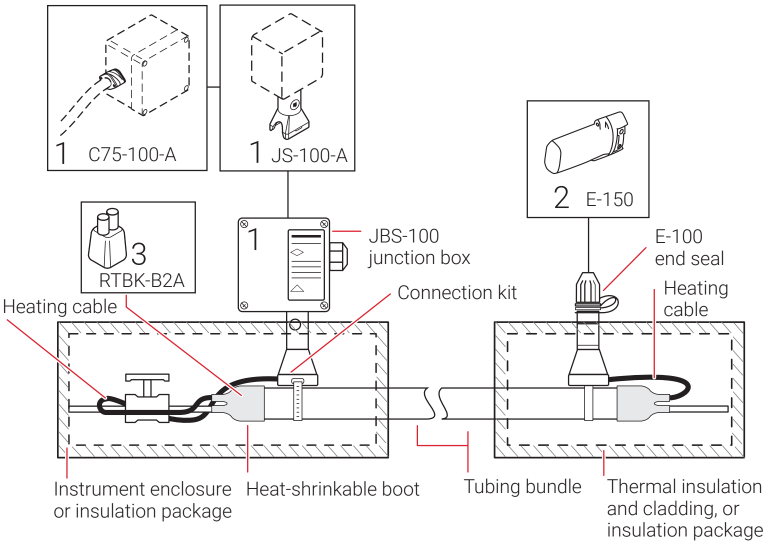


Fig. 5 Tubing bundle connection kits

TABLE 6 RTB CONNECTION KITS AND ACCESSORY QUANTITIES REQUIRED

Description	Catalog number	Quantity
Connection kits for heating cables		
Power connection kits		1 per circuit
Single entry power connection	JBS-100	
Junction box stand	JS-100	
Gland connection	C75-100-A / C25-100	
End seals*		1 per circuit
End seal, above insulation	E-100	
End seal, with light	E-100-L	
End seal kit (low profile)	E-150	
Splice kits (not shown)	S-150, T-100	As required
Tubing bundle accessories		
Heat-shrinkable boots		1 per connection kit
Boot for single tube	RTB-RTBK-B1A	
Boot for single tube with electric trace	RTB-RTBK-B2A	
Boot for dual tubes with electric trace	RTB-RTBK-B3A	
Heat-shrinkable enclosure entry seal (not shown)		1 per enclosure entry
Entry seal for single and dual tubes from 1/8"–3/8" (6mm–10 mm) and 1/2" (12 mm) single tubes	RTB-RTBK-CES4	
Entry seal for 1/2" (12 mm) dual tubes	RTB-RTBK-CES5	
Other		As required
Jacket patch kit	RTB-TPKJP-1	
Silicone sealant	RTB-TPKSK-10	

⚠ **WARNING: Fire hazard**

To prevent fire or shock, nVent RAYCHEM brand specified connection kits must be used. Do not substitute parts or use vinyl electrical tape.

TABLE 7 AVAILABLE SYSTEM COMPONENTS, ACCESSORIES AND CONTROLLERS

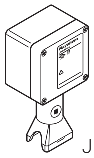
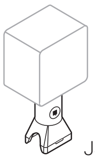
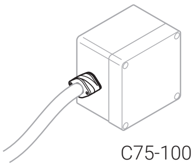
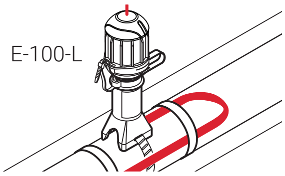
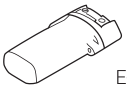
System Components	Power Connection Kits for Heating Cable	Electric Traced	Steam Traced	Pre-insulated Only
 JBS-100	**nVent RAYCHEM JBS-100** Power connection for one heating cable in nonhazardous, Zone 1, 2 and Division 2 hazardous locations. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately. For North America approvals: (H56827) JBS-100-A JBS-100-L-A (with red indicator light) For ATEX Certifications: (DOC 2210) JBS-100-E JBS-100-EP (with internal earth plate) JBS-100-L-E (with green indicator light) JBS-100-L-EP (as above with earth plate)	☑		
 JS-100-A	**nVent RAYCHEM JS-100-A** (H56450) Junction box stand for one heating cable in nonhazardous and Division 2 hazardous locations. A separate customer-supplied NEMA 4X junction box is required. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately.	☑		
 C75-100-A	**nVent RAYCHEM C75-100-A** (North America: H56343) **nVent RAYCHEM C25-100** **(**European: DOC 2210) A gland kit used to transition heating cables into a junction box in nonhazardous and hazardous locations. Includes cold-applied heating cable core seal. A terminal block (3 x 12 AWG) is included. This kit does not include the junction box or the conduit.	☑		
	End Seal Kits for Heating Cable			
E-100-L 	**nVent RAYCHEM E-100** End seal for heating cable in nonhazardous, Zone 1, 2 and Division 2 hazardous locations. Re-enterable. Includes cold-applied heating cable core seal. Requires one pipe strap to be ordered separately. Lighted versions for ease of status monitoring are available. For North America approvals: (H56829) E-100-A E-100-L-A (with red indicator light, 100-120 V) E-100-L-A (with red indicator light, 200-277 V) For ATEX Certifications: (DOC 2210) E-100-E E-100-L-E (with green indicator light, 200-277 V)	☑		
 E-150	**nVent RAYCHEM E-150** (North America: H56835); (European: DOC 2210) Low-profile end seal for heating cable in nonhazardous, Zone 1, 2 and Division 2 hazardous locations. Includes cold-applied heating cable core seal.	☑		

TABLE 7 AVAILABLE SYSTEM COMPONENTS, ACCESSORIES AND CONTROLLERS

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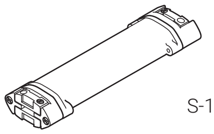
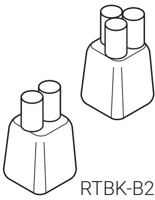
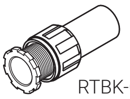
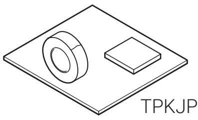
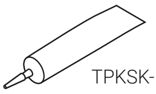
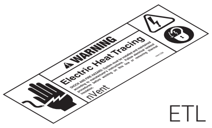
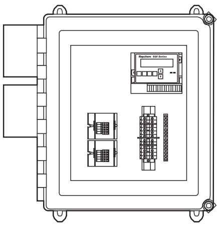
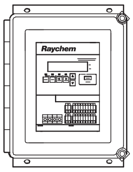
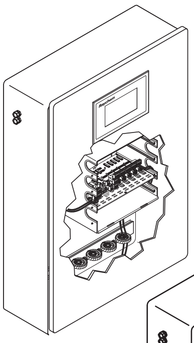
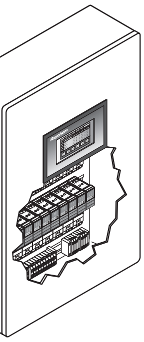
<tr><td>
S-150</td><td>Splice Kits for Heating Cable
nVent RAYCHEM S-150 (North America: H56835); (European: DOC 2210) Splice kit for two heating cables in nonhazardous, Zone 1, 2 and Division 2 hazardous locations. Includes cold-applied heating cable core seal.
Consult the data sheets in the Technical Data section for more specific information. For attachment and other accessories for the heating cables, please refer to Section 1, Self-Regulating Cables of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550) and the Technical Databook for Industrial Heat-Tracing Systems (DOC 2210).</td><td>☑</td><td></td><td></td></tr>
<tr><td colspan="2">Accessories</td><td></td><td></td><td></td></tr>
<tr><td>
</td><td>nVent RAYCHEM Heat-Shrinkable Boots
Used for sealing bundle ends. The boots are designed to provide a weatherproof seal at the end of the tubing bundles. These boots may be used on all electric-traced bundles. For steam-traced bundles, use silicone sealant (TPKSK-10).
Use RTBK-B2A for single-tube bundles with electrical heat tracing
Use RTBK-B3A for dual-tube bundles with electrical heat tracing
Important: Although RTB uses a nonhygroscopic thermal insulation, all bundle ends and jacket penetrations must be sealed to keep the insulation from getting wet.</td><td>☑</td><td>☑</td><td>☑</td></tr>
<tr><td>
RTBK-CES</td><td>nVent RAYCHEM Heat-Shrinkable Entry Seals
May be used to provide a waterproof fitting where the bundle enters an enclosure or penetrates a bulkhead. The thermally stabilized, modified polyolefin entry seal includes an O-ring assembly that seals at the enclosure, and a heat-shrinkable nose that seals to the bundle.
<table>
<tr><th colspan="3">Heat-Shrinkable Sizing Criteria</th></tr>
<tr><th>Tubing size in inches (mm)</th><th>Single-tube bundle</th><th>Dual-tube bundle</th></tr>
<tr><td>1/4"–3/8" (6–10 mm)</td><td>RTBK-CES4</td><td>RTBK-CES4</td></tr>
<tr><td>1/2" (12 mm)</td><td>RTBK-CES4</td><td>RTBK-CES5</td></tr>
</table></td><td>☑</td><td>☑</td><td>☑</td></tr>
<tr><td>
TPKJP-1</td><td>nVent RAYCHEM Jacket Patch Kits
Must be used for sealing around line-sensing thermostat entries. The kit contains thermal insulation, fiberglass tape to hold the insulation in place, and a black, self-sealing rubber patch for weatherproofing the bundle.</td><td>☑</td><td>☑</td><td>☑</td></tr>
<tr><td>
TPKSK-10</td><td>nVent RAYCHEM Silicone Sealant
A black silicone RTV sealant used for sealing the ends of the tubing bundle from moisture. Cure time is approximately 24 hours at 25°C (77°F). The 10-ounce (280 g) tube will seal approximately 10 bundle ends. Silicone sealant can be used for either electric or steam-traced bundles.</td><td>☑</td><td>☑</td><td>☑</td></tr>
<tr><td>

ETL</td><td>nVent RAYCHEM Electric Traced Label
Attach the label to the outside of the thermal insulation weather barrier to indicate presence of electrical heat tracing. Use one label for every 3 meters (10 ft) of pipe, alternating on either side of the pipe.
Also, available in other languages. Refer to the Technical Databook for Industrial Heat-Tracing Systems (DOC 2210) for details.</td><td>☑</td><td></td><td></td></tr>
</table>

TABLE 7 AVAILABLE SYSTEM COMPONENTS, ACCESSORIES AND CONTROLLERS

 920  910  NGC-30 system  NGC-40 system	RTB can be operated uncontrolled or with temperature controls that you are using for other heat-tracing applications. Temperature control will be necessary if the maximum value of the temperature range determined in Step 2 exceeds the maximum maintain temperature for the heating cable. For more detail, see the Control and Monitoring design guide design guide (H56889) in the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550) and the Catalogue for Industrial Heat Tracing Products & Services (EN-IndustrialHeatTracingEMEA-SB-DOC2210).	☑		

TANK HEATING

This step-by-step design guide provides the tools necessary to design a tank heating system for temperature maintenance using electric heating cables or tank heating pads. For design assistance, contact your nVent representative or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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INTRODUCTION

nVent provides a wide selection of heat-tracing solutions for tanks and vessels. Typical applications for electrical heat tracing of tanks and vessels include:

- Freeze protection of low and medium viscosity fluids (e.g., water, ammonia)
- Temperature maintenance for medium viscosity fluids (e.g., oils, resins)
- Crystallization prevention (e.g., caustic soda)
- Condensation prevention (e.g., fly ash in conical bases of silos)

Contact nVent for heat-up applications, hazardous locations, heat tracing of high viscosity fluids (e.g. heavy oils), applications where agitation is used, and other nonstandard applications.

Tank heating applications can be quite varied. For this reason, nVent offers a wide range of technologies to optimize your tank and vessel heat-tracing system.

- Self-regulating heating cables
- Power-limiting heating cables
- Tank heating pads
- Mineral insulated heating cables

A description of the features and benefits of each technology is provided, followed by the design and product selection steps.

Self-Regulating Heating Cables

nVent RAYCHEM brand self-regulating heating cables (BTV, QTVR, XTV, and KTV) are ideal for tank heating when design and installation flexibility are required. The benefits include:

Forgiving technology For over 40 years, these self-regulating heating cables have proven their reliability and remain the premier self-regulating heating cables in the market.

Easy installation Because of parallel circuitry and flat cable design, our self-regulating heating cables are easy to handle and install. They can be cut to any length on site and overlapped without the risk of overheating. The cables readily accommodate design adjustments between specifications and actual on-site installation needs.

Uniform temperatures Heat is evenly distributed over the heat-traced surface. The self-regulating feature of the heating cable responds to actual conditions of the traced surface. Temperature control is simplified, especially for tanks with fill-height variation.

T-ratings Self-regulating heating cables have a T-rating per national electrical codes.

Approvals These self-regulating systems are approved and certified for use in nonhazardous and hazardous locations by many agencies, including FM , CSA, UL, PTB, Baseefa, NEPSI, DNV, ABS and many more.

These self-regulating heating cables can be used for maintain temperatures up to 300°F (150°C). Technical information is provided in the data sheets in the Technical Data section of this catalog.

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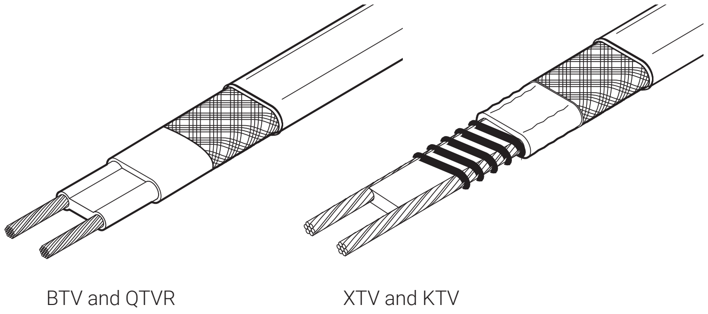

BTV and QTVR XTV and KTV

Fig. 1 Self-regulating heating cables

Power-Limiting Heating Cables

nVent RAYCHEM brand power-limiting heating cables (VPL) feature high power output at high maintain temperatures. These flexible heating cables are rated for maintain temperatures up to 455°F (235°C) and exposure temperatures (power off) to 500°F (260°C). Power-limiting heating cables feature:

Superior temperature capability in a flexible heater These cables are especially suited to applications requiring high power output at elevated temperatures and requiring field installation flexibility to accommodate small tank structure or design modifications.

Easy installation Cables can be cut to length and terminated in the field.

Uniform distribution of heat Heat is evenly and widely distributed over the heat-traced surface.

Approvals nVent power-limiting systems are approved and certified for use in nonhazardous and hazardous locations by many agencies, including FM , CSA, UL, PTB, Baseefa, NEPSI, DNV, ABS and many more.

Additional technical information can be found in the data sheet in the Technical Data section. Data sheets can be found on nVent.com or the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalog (H56550). Refer to the Section 3, Mineral Insulated Cables, design guide (H56884) for more detailed information.

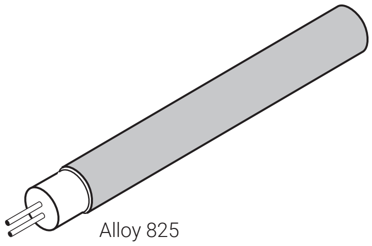


Fig. 2 MI heating cables

Tank Heating Pads

nVent RAYCHEM brand tank heating pads (RHS) are recommended when high wattage density is required. The RHS system provides heat to selected areas on the tank. The heat is then distributed through convection in the fluid (natural or agitated). RHS is built from durable components for use on tanks in industrial applications. The heating pads have a constant power output and are available with two power densities, making them suitable for both metal (lined and unlined) and plastic tanks. RHS tank heating pads have been designed to include the following benefits:

Easy installation The RHS tank heating pads can easily be installed by a single person.

Over-temperature thermostat A sealed, self-resetting, over-temperature thermostat is integrated into the product.

Approvals FM Approvals (FM) and CSA Group (CSA) have approved RHS tank heating pads for both nonhazardous and hazardous locations.

Additional technical information can be found in the RHS data sheet (H56842).

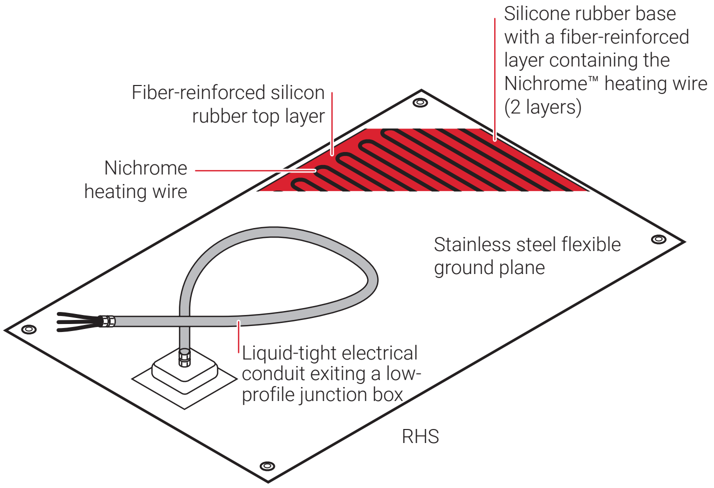


Fig. 3 Tank heating pads

The stainless steel grounding plane is flexible enough to contour to most tank surfaces, and it is oversized to protect the heating elements and maximize contact with the tank.

RHS can be used for maintain temperatures up to 200°F (93°C) and maximum exposure temperatures of 366°F (186°C). For technical details, refer to the RHS data sheet in the Technical Data section. Data sheets can be found on nVent.com or the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalogue (H56550)

TANK TRACING DESIGN AND PRODUCT SELECTION

Overview

Follow the five steps below to select the heating products and create a bill of materials for your tank application. If your tank application requires heat-up or condensation prevention, contact nVent for assistance.

1. Gather the necessary application data.
   - Tank type
   - Tank diameter
   - Tank height
   - Tank support
   - Tank insulation type and thickness
   - Maintain temperature
   - Tank contents
2. Calculate the tank heat loss.
3. Choose the heating technology.
4. Product selection.
5. Select the thermostatic control.

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 1 Gather the necessary data

Gather and record the following information. Alternatively, use the design worksheet in Appendix B to record your application data. You will use this information for the steps that follow.

- Tank type____________________
- Tank diameter____________________
- Tank height____________________
- Tank support____________________
- Tank insulation type and thickness____________________
- Maintain temperature____________________
- Tank contents____________________

Example: Information on three sample applications

Tank type (all)		Vertical cylinder
Tank diameter (all)		3 ft
Tank height (all)		6 ft
Tank support (all)		4 legs
Tank insulation type and thickness (all)		Fiberglass insulation, 2-in
Tank 1	Maintain temperature	100°F at 0°F
	Contents	polyol
Tank 2	Maintain temperature	40°F at 0°F
	Contents	water
Tank 3	Maintain temperature	400°F at 0°F
	Contents	bitumen

TANK HEATING

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 2 Calculate the tank heat loss

The tank's thermal heat loss determines the power needed to maintain the tank at the desired temperature. To determine the heat loss, see "Tank Heat Loss Calculation"section, for formulas and tables. Using these resources, the heat loss of the example tanks was found to be:

Example: Results of tank heat loss calculations

Tank 1: Q_{total} = 458 W (from Tank Heat Loss calculation)

Tank 2: Q_{total} = 178 W (from Tank Heat Loss calculation)

Tank 3: Q_{total} = 2070 W (from Tank Heat Loss calculation)

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 3 Choose the heating technology

nVent offers a range of tank heating solutions.

Table 1 provides a rough guide for the selection of technologies for different applications. The continuing discussion that follows will help you understand and select the appropriate technology when more than one product choice is available or when an application does not easily fit those defined in the table.

Your choice of heating method depends on factors such as:

- Required maintain and exposure temperatures
- Material of the tank wall (metal or plastic)
- Temperature sensitivity and viscosity of the tank contents
- Whether or not the tank is agitated
- Additional requirements such as heat-up or prevention of condensation

TABLE 1 PRODUCT SELECTION GRID

	Self-regulating		Power-limiting	Mineral insulated	Tank pads	
Application or requirement	BTV	QTVR, XTV, KTV	VPL	MI	RHS-L	RHS-H
Flexible field design required	•	•	•			
Plastic tank wall	•	•			•	
Plastic-lined tank wall	•	•			•	
Even heat to all walls needed	•	•	•			
Maintain temperature more than 120°F (49°C)	•	•	•	•		•
Maintain temperature more than 200°F (93°C)		•	•	•		
Maintain temperature more than 300°F (150°C)			•	•		
Low installed cost desired					•	•
High watt density needed		•	•	•		•
Distributed high watt density needed			•	•		
Temperature-sensitive fluids	•	•				
Condensation prevention	•	•	•	•		
Small-diameter stagnant tanks	•	•				
Limited tank surface area available			•	•		•
High heat-loss tanks			•	•		•

Self-Regulating Heating Cables

Uses

- Tanks containing temperature-sensitive fluids
- Tank materials such as PVC or PE
- Applications requiring uniform heating (condensation prevention)
- Tanks with unusual shapes to trace

Advantages

- Very flexible design and installation
  - Cables can be installed on any type of tank surface
  - Cables adapt to any shape or surface
  - Cables allow tracing with more power on high heat loss areas — just reduce the spacing between the heating cables in those areas
  - Cables can be cut to length in the field
- Even heat distribution due to larger heated surface
- Very smooth heating for tank walls with a low withstand temperature

Power-Limiting Heating Cables

Uses

- Tanks containing fluids that are less temperature sensitive
- Tanks with high heat loss, and where flexibility in installation is a premium
- Tanks with a maintain temperature between 250°F (121°C) and 300°F (150°C)

Advantages

- Very flexible design and installation
  - Cables can be installed on any type of tank surface
  - Cables adapt to any shape or surface
  - Cables allow tracing with more power on high heat loss areas — just reduce the spacing between the heating cables in those areas
  - Cables can be cut to length in the field
- Even heat distribution due to larger heated surface
- Very smooth heating for tank walls with a low withstand temperature

Mineral Insulated Heating Cables

Uses

- Maintain temperatures above 300°F (150°C)
- Exposure temperatures above 500°F (260°C)
- Tanks with high heat loss or high power requirements at elevated temperatures

Advantages

- Flexible design and installation
  - Cables can be installed on any type of tank surface
  - Cables can adapt to any shape or surface
  - Cables allow tracing with more power on high heat-loss areas — just reduce the spacing between the heating cables in those areas
- Even heat distribution due to larger heated surface
- Capability for high power output and density

Tank heating pads

Uses

- Tanks containing fluids that are not temperature sensitive
- Tanks where the surface is space-constrained
- Tanks with high heat loss
- Fluids with low viscosity (such as water or light oil)

Advantages

- Lower installation cost
- Capability for high power output and watt density

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 4 Product selection

When you have determined the most appropriate heating technology for your application, proceed to:

Step 4a Product selection for self-regulating and power-limiting heating cables

Step 4b Product selection for mineral insulated heating cables

Step 4c Product selection for tank heating pads

Example:

Tank 1: We recommend the use of self-regulating heating cables.

Tank 2: We recommend the use of RHS tank heating pads.

Tank 3: We recommend the use of MI mineral insulated heating cables.

Step 4a Product selection for self-regulating and power-limiting heating cables

Overview

- Orientation of tank
- Spacing and arrangement of the heating cables
- Traced surface
  - Vertical cylindrical tanks
  - Horizontal cylindrical tanks
  - Conical outlets
- Thermal design for heating cables
  - Determine heating cable compatible with your tank application
  - Select heating cable with the lowest maximum exposure temperature
  - Adjust for aluminum tape attachment
  - Determine minimum required length of heating cable
  - Determine cable distribution
- Electrical design of heating cable
  - Determine maximum allowable circuit length of heating cable
  - Adjust for aluminum tape attachment
  - Ground-fault protection
- Heating cable component selection

The heating cable you select and the length of cable you will need depend on the orientation of the tank and the spacing and arrangement of the heating cables.

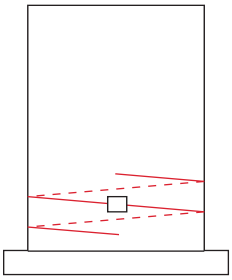


Fig. 4 Heating cable arrangement on a vertical tank

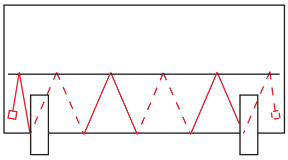


Fig. 5 Heating cable arrangement on a horizontal tank

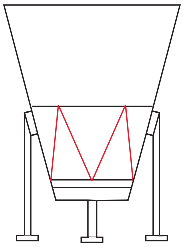


Fig. 6 Heating cable arrangement on a truncated cone

Determination of the traced surface

Vertical cylindrical tanks

Vertical cylindrical tanks are traced on the lower one-third of the side wall (maximum half) and the bottom (if accessible).

Horizontal cylindrical tanks

Horizontal cylindrical tanks are traced on a third of the bottom (maximum half).

Conical outlets

Conical outlets of vessels are often traced to prevent condensation inside. We recommend that the entire surface of the conical outlet be traced and additional tracing is recommended on heat sinks, such as fixings/supports. Heat sinks should be thermally isolated. Because the surface area of the conical outlet is often much smaller than the rest of the vessel, it may be necessary to extend the tracing beyond the conical area in order to fully compensate for the heat loss.

THERMAL DESIGN USING HEATING CABLES

Determine the heating cable families compatible with your tank application

To select a heating cable that is compatible with your application, familiarize yourself with the selection process for pipes as outlined in **Section 1,** Self-Regulating Cables design guide (H56882) and **Section 2,** Power-Limiting Cables design guide (H56883). Considering factors such as exposure temperature, maintain temperature, wall material, hazardous location requirements, etc., list all heating cable families that would be compatible with your tank application — e.g., BTV, QTVR, XTV, KTV, VPL. The power outputs for the different heating cables are found in the Self-Regulating Cables and Power-Limiting Cables design guides.

Select the heating cable with the lowest maximum exposure temperature

Use the heating cable with the lowest possible maximum exposure temperature. Within each heating cable family, start with the cable that has the highest power output.

Example: Heating cable selection

Tank 1

Maintenance temperature	100°F maintain (from Step 1)
Heat loss	458 W (from Step 2)
Recommended cable	nVent RAYCHEM 10BTV2-CR

Adjust for aluminum tape attachment

For optimal heat transfer, the heating cable must be fixed to the tank wall (both metal and plastic) with aluminum tape. For self-regulating cables on metal tanks, this leads to an increase in the power output; on plastic tanks, the much lower thermal conductivity of plastic requires a de-rating of the power output of the cables. Table 2 below provides approximate adjustment factors for the power.

TABLE 3 APPROXIMATE POWER OUTPUT CHANGE FOR HEATING CABLES ATTACHED WITH ALUMINUM TAPE AT-180

Heating cable	Adjustment factor on metal tanks	Adjustment factor on polypropylene tanks	Adjustment factor on fiber-reinforced plastic tanks
BTV	1.20	0.70	0.80
QTVR	1.20	N/R	N/R
XTV/KTV	1.15	N/R	N/R
VPL	1	N/R	N/R

N/R Not recommended due to temperature limitations of tank wall.

Multiply the power output at the maintain temperature (P_{heater}) by the appropriate adjustment factor $ƒ_{adj}$ from Table 2 above.

Formula: $P_{adj} = P_{heater} \times ƒ_{adj}$

Example: Calculating the adjusted power of the heating cable (P_{adj})

Input P_{heater} = 3.7 W/ft (10BTV2-CR power output at 100°F)

Input $ƒ_{adj}$ = 1.20 (from Table 2)

Calculation P_{adj} = 3.7 W/ft x 1.20

P_{adj} = 4.4 W/ft for 10BTV2-CR at 100°F

Divide the total heat loss (Q_{total}) by the adjusted power of the heating cable (P_{adj}) at the desired maintain temperature to obtain the minimum required length (L_{heater}).

$$\text{Formula} \quad L_{heater} = \frac{Q_{total}\ (W)}{P_{adj}\ (W/ft)} \quad \text{(round up)}$$

Example: Calculating the minimum required cable length (L_{heater})

Input Q_{total} = 458 W (from Step 2)

Input P_{adj} = 4.4 W/ft (from previous calculation)

$$\text{Calculation} \quad L_{heater} = \frac{458\ W}{4.4\ W/ft} \quad \text{(round up)}$$

L_{heater} = 104 ft (rounded up)

Next, determine how to distribute cable over the surface you wish to trace. An average spacing of the heating cable ($T_{average}$) can be calculated by dividing the traced surface (S_{traced}) by the total length of the heating cable (L_{heater}).

$$\text{Formula} \quad T_{average} = \frac{S_{traced}\ (ft^2)}{L_{heater}\ (ft)} \quad \text{(round up)}$$

Example: Determining cable distribution

For our vertical cylinder tank (3 ft diameter, 6 ft high), tracing the lower one-third of the wall of the tank:

Input S_{traced} = 3 ft x 3.14 x 2 ft (as determined in Step 4a)

Input L_{heater} = 104 ft (from previous calculation)

$$T_{average}\ (ft) = \frac{(3\ ft \times 3.14 \times 2\ ft)}{104\ ft} = \frac{(18.8\ sq\ ft)}{104\ ft} = 0.18\ ft\ (2.2\ in)$$

In this case, the result is close to the minimum spacing interval, so some of the tracing may be placed on the bottom of the tank. The spacing should be reduced locally to bring more power to areas that require more heat, such as supports and fixings. The maximum spacing should typically not be more than 12 inches (~300 mm). Do not space adjacent heating cable closer than two inches (50 mm), because interaction will occur and power output will decrease.

By changing the heating cable and the spacing in the calculation, you can obtain the solution that best fits the specific requirements of your tank application.

ELECTRICAL DESIGN OF HEATING CABLE

Determine maximum allowable circuit length

To determine the maximum allowable circuit length of your heating cable, refer to the data sheet **in the Technical Data section**nVent for that heating cable. For metal tanks, however, the maximum circuit length needs to be reduced by the appropriate factor shown in Table **3** because of the use of the aluminum tape and the increased power. For plastic tanks, the maximum circuit length need not be adjusted.

Adjust for aluminum tape

⚠ WARNING: Fire hazard
There is a danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed. To comply with **nVent** requirements, certifications, and national electrical codes, and to protect against the risk of fire, ground-fault equipment protection must be used on each heating cable circuit. Arcing may not be stopped by conventional circuit breakers.

TABLE 3 APPROXIMATE ADJUSTMENT FACTORS FOR MAXIMUM CIRCUIT LENGTH OF SELF-REGULATING HEATING CABLES ON METAL SURFACES ATTACHED WITH AT-180 ALUMINUM TAPE

Heating cable	Circuit length adjustment factor on metal tanks
BTV	0.8
QTVR	0.8
XTV/KTV	0.83

Simply multiply the allowed footage shown on the heating cable data sheet in the Technical Data sectionnVent by this factor to determine the footage that can be installed on a given breaker size.

Ground-fault protection

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

CONNECTION KIT SELECTION FOR SELF-REGULATING AND POWER-LIMITING CABLES

Now that you have determined your heating cable type and length, use the following chart to select the proper connection kits.

Note: nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

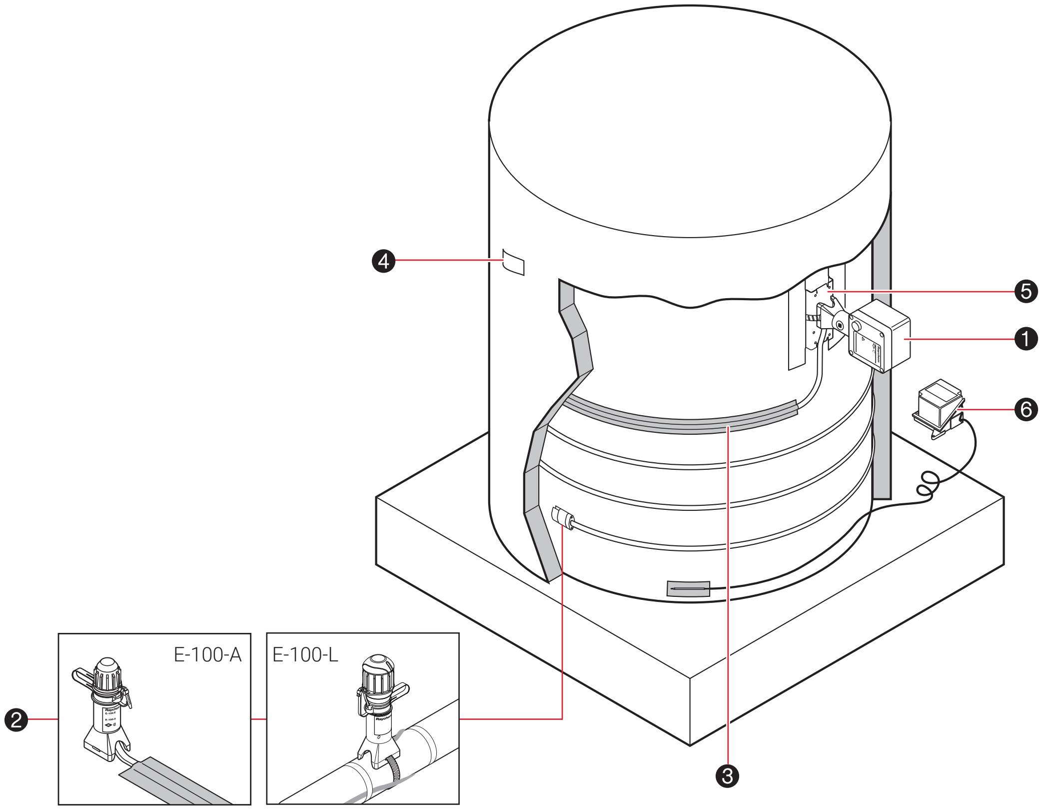


Fig. 7 Tank-tracing system connection kits and accessories

⚠ WARNING: Fire hazard
To prevent fire or shock, nVent RAYCHEM brand specified connection kits must be used. Do not substitute parts or use vinyl electrical tape.

TABLE 4 CONNECTION KIT AND ACCESSORY SELECTION FOR SELF-REGULATING AND POWER-LIMITING CABLES

Description	Catalog number
Connection kits	
❶ Power connection kit (not shown)	JBS-100-A
Power connection kit with light	JBS-100-L-A
Splice connection (not shown)	S-150 (not for use with VPL)
❷ End seal	
Below insulation	E-150 (not for use with VPL)
Above insulation	E-100-A
Above insulation, with light	E-100-L-A (100-277 V)
Accessories	
❸ Aluminum tape	AT-180
❹ Labels	ETL
❺ Support bracket	SB-100-T
Controls	
❻ Thermostat (see Control and Monitoring design guide (H56889))	

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 4b Product selection for mineral insulated heating cables

For MI product selection and design, refer to Mineral Insulated Heating Cables design guide (H56884) or contact your nVent representative.

Step 4c Product selection for tank heating pads

Tank material and power density determine which RHS tank heater series to select. The number of heaters required depends on the amount of heat distribution the application requires. A large number of low-power pads will disperse the heat better than a few high-power heaters. nVent recommends distributing the heat over as much wall surface as is economically feasible.

Note: nVent does not recommend the use of tank heating pads for applications with:

- Highly temperature-sensitive fluids
- High-viscosity fluids
- Double-wall tanks
- Tank diameters of less than four feet
- A requirement for uniform heating
- A location where an installation temperature above 0°F (–18°C) cannot be assured.

TANK MATERIAL

"Table 1" on page 102, indicates the heater to select based on tank type, heat loss, and surface area available.

METAL TANKS

nVent RAYCHEM RHS-H series heaters are used for metal tanks. RHS-H heaters have a power density of 1.9 W/in^2 at the specified voltage with integrated thermostatic over-temperature protection.

Table 5 lists the RHS-H configurations available. To determine the number of heaters required, divide the final design heat loss for the tank by the heater's power output.

TABLE 5 RHS-H SPECIFICATIONS (NOMINAL)

Catalog number	Overall dimensions	Voltage (Vac)	Power output (W)	Current draw (A)
RHS-H-500-1	14" x 24" (356 mm x 610 mm)	120	500	4.2
RHS-H-1000-1	24" x 26" (610 mm x 660 mm)	120	1000	8.3
RHS-H-1400-1	24" x 36" (610 mm x 914 mm)	120	1400	11.7
RHS-H-500-2	14" x 24" (356 mm x 610 mm)	240	500	2.1
RHS-H-1000-2	24" x 26" (610 mm x 660 mm)	240	1000	4.2
RHS-H-1400-2	24" x 36" (610 mm x 914 mm)	240	1400	5.8

POLYPROPYLENE, FRP, AND METAL TANKS

nVent RAYCHEM RHS-L series heaters are for plastic or metal tanks. RHS-L heaters have a power density of 0.6 W/in^2 at the specified voltage with integrated thermostatic over-temperature protection. The available RHS-L configurations are shown in Table 6.

TABLE 6 RHS-L SPECIFICATIONS (NOMINAL)

Catalog number	Overall dimensions	Voltage (Vac)	Power output (W)	Current draw (A)
RHS-L-150-1	14" x 24" (356 mm x 610 mm)	120	150	1.3
RHS-L-300-1	24" x 26" (610 mm x 660 mm)	120	300	2.5
RHS-L-420-1	24" x 36" (610 mm x 914 mm)	120	420	3.5
RHS-L-150-2	14" x 24" (356 mm x 610 mm)	240	150	0.6
RHS-L-300-2	24" x 26" (610 mm x 660 mm)	240	300	1.3
RHS-L-420-2	24" x 36" (610 mm x 914 mm)	240	420	1.8

Considerations for plastic tanks

When designing heating systems for plastic tanks, be sure to keep the wall temperature below the recommended maximum material temperature. Common plastic tank walls are polyethylene and FRP. This section provides the algorithms you may use to determine the temperature generated by RHS tank heating pads.

Determine the power density of the RHS-L heater, Q_A.

1. Q_A = 295 Btu/ft^2-hr equal to 0.6 W/in^2 for nominal voltages of 120 Vac and 240 Vac
2. For voltages other than 120 Vac and 240 Vac,(Q_A) adjusted = $(Q_A) \times (V/V_{nominal})^2$

Determine the maximum fluid maintain temperature, T_f. Enter this data on the design worksheet found in Appendix B.

Determine the fluid gradient, ΔT_f. The fluid gradient will depend on fluid type and temperature. For applications not involving temperature-sensitive fluids, the following values may be used for simplicity.
ΔT_f = 10°F (6K) for fluids similar to water
ΔT_f = 30°F (16K) for fluids similar to warm light oils
ΔT_f = 100°F (56K) for fluids similar to warm heavy oils

Calculate the tank wall gradient, ΔT_w. The gradient depends on wall thickness, t (inches), and material conductivity, k. $\Delta T_w = Q_A \times t/k$

Wall thickness is expressed in inches. Typical conductivity values for high-temperature plastics are:
k = 1.7 Btu-in/hr-ft2 -°F for polypropylene (PE)
k = 2.1 Btu-in/hr-ft2-°F for fiber-reinforced plastic (FRP)

Calculate the maximum outer wall temperature, $T_{out\text{-}max}$
$T_{out\text{-}max} = T_f + \Delta T_f + \Delta T_w$

Contact the tank manufacturer to determine the type and temperature capability of the tank material. The maximum temperature for polypropylene and FRP is typically 220°F (104°C). Other plastics, like PVC and polyethylene, have much lower temperature capabilities and are more suitable for use with nVent RAYCHEM self-regulating heating cables.

Example:

Tank Checklist

Fluid:	Water	Maintain temperature:	50°F
Tank material:	FRP	Tank wall thickness:	1/2-in
RHS heater:	RHS-L-XXX	Voltage:	277 Vac

Calculate adjusted heater power density:

(Q_A) adjusted = $(295) \times (277/240)^2 = 393$ Btu/ft2-hr

Determine fluid maintain temperature: $T_f = 50°F$

Determine fluid gradient for water: $\Delta T_f = 10°F$

Calculate wall gradient for a FRP tank with 1/2" wall thickness:

$\Delta T_w = (393 \times 0.5) / 2.1 = 94°F$

Calculate maximum outer wall temperature:

$T_{out\text{-}max} = 50°F + 10°F + 94°F = 154°F$

The maximum material temperature for FRP is approximately 220°F. Therefore, the application is compatible with the tank material.

POWER ADJUSTMENT FACTORS

For all heating pads with catalog number X-XXX2, power output is calculated at 240 Vac. If the source voltage is either 208 Vac or 277 Vac, the following power output adjustment factors should be used.

208 Vac: Power output adjustment factor = 0.75
277 Vac: Power output adjustment factor = 1.33

LOCATION AND ARRANGEMENT OF HEATING PADS

For vertical tanks, locate the heater on the lower one-third of the tank wall. Arrange the heaters on vertical, horizontal, and truncated cone tanks as shown in Fig. 8 through 10.

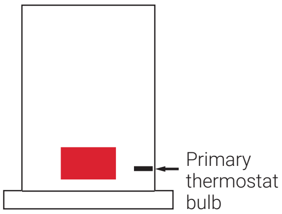


Fig. 8 Vertical tanks with RHS heaters

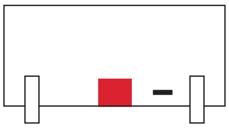


Fig. 9 Horizontal tanks with RHS heaters

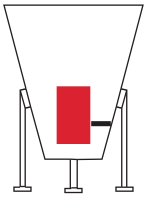


Fig. 10 Truncated cones with RHS heaters

⚠ **WARNING: Fire hazard**
There is a danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed. To comply with nVent requirements, certifications, and national electrical codes, and to protect against the risk of fire, ground-fault equipment protection must be used on each heating cable circuit. Arcing may not be stopped by conventional circuit breakers.

TANK HEATING PAD — ELECTRICAL DESIGN

Size your circuit breaker according to the load of the heating pad(s). If your tank requires several heating pads, these can be grouped to one electrical circuit as long as the circuit breaker rating allows.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating pad is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating pad branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HEATING PAD — ACCESSORY SELECTION

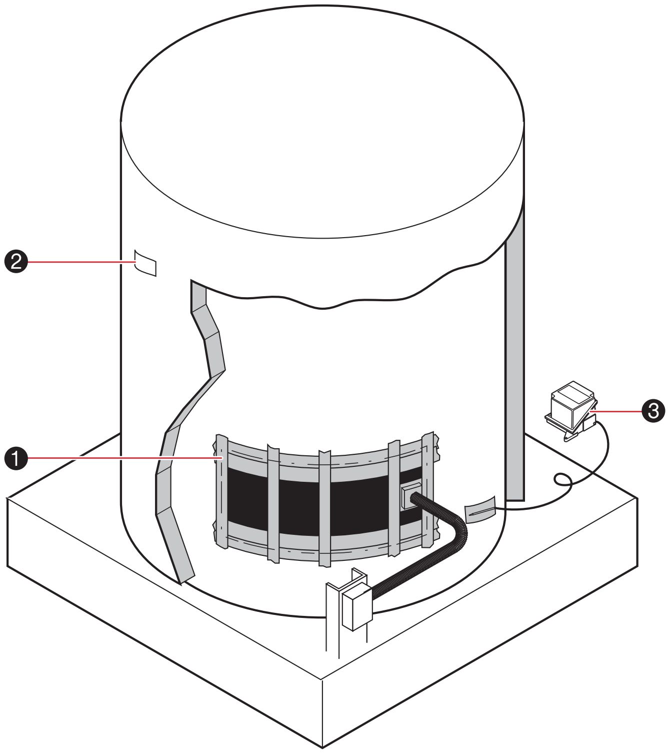


Fig. 11 Tank pad system components

⚠ **WARNING: Fire hazard**
To prevent fire or shock, nVent RAYCHEM brand specified components must be used. Do not substitute parts or use vinyl electrical tape.

TABLE 7 ACCESSORY SELECTION FOR TANK PAD HEATERS

Description	Catalog number
Components	
❶ Installation kit	RHS-INSTALLATION-KIT
❷ Labels	ETL
❸ Thermostat (see Control and Monitoring design guide (H56889))	

Tank Tracing
1. Gather information
2. Calculate tank heat loss
3. Choose heating technology
4. Product selection
5. Select thermostatic control

Step 5 Select the thermostatic control

There are two kinds of sensors for indicating temperature: “in-fluid” and “on-surface.”

The “in-fluid” approach typically uses a thermowell protruding through the tank wall and into the fluid. Control of the heater is achieved by using a solid-state control device that receives its input from an RTD inside the thermowell.

The “on-surface” approach uses RTDs or bulb and capillary thermostats to control tank heaters by sensing temperatures on the outside surface of the tank wall. Sensors should be located midway between heating cables or heating pads. If your application has high heat-loss supports or accessories, place the primary sensor midway between the heating pad or cable and the support or accessory. The primary temperature sensor should be placed horizontally on the tank, refer to "Fig. 9", "Fig. 10", "Fig. 11", and "Fig. 12".

RHS tank heaters have integrated, resettable thermostats that provide over-temperature protection in the event of a primary thermostat failure. The RHS integrated thermostat **must not** be used as the primary means of temperature control.

For more details regarding the many options in control devices see Control and Monitoring design guide (H56889).

TANK HEAT LOSS CALCULATION

The Tank Tracing Design and Product Selection section presented a general approach to selecting a heat-tracing system for a tank or vessel. The tank heat loss can be calculated by using the graphs and equations on the following pages. The approach for the calculation is based on those in the TraceCalc Pro design software.

The overall heat loss (Q_T) of an insulated tank can be expressed as:

$Q_T = Q_V + Q_S + Q_A$

where:

Q_V = Heat loss through the insulated body of the tank

Q_S = Heat loss through the tank support mechanism (slab, legs, saddle, or other base support)

Q_A = Heat loss through accessories such as manholes, handholds, ladders, or handrails

To calculate the tank's overall heat loss (Q_t), follow these six steps:

1. Calculate the surface area of the tank.
2. Calculate the Q_V (heat loss through the insulated body of the tank).
3. Calculate the Q_S (heat loss through the base support).
4. Calculate the Q_A (heat loss through the accessories).
5. Calculate the Q_T (overall heat loss).
6. Calculate the final-design heat loss.

The heat-loss rates for insulated tank bodies (see "Table 9" and "Graph 1") are based on the following IEEE 515 provisions:

- Fiberglass insulation
- Tank located outdoors
- No insulating airspace between the tank surface and insulation

The tank body heat loss rates in Table 9 and Graph 1 assume a tank that is completely full and insulated with a minimum of one inch of fiberglass. However, Table 10 provides factors for adjusting the tank body heat loss for insulations other than fiberglass.

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step 1 Calculate the surface area of the tank

CYLINDER SURFACE AREA

The surface area of the cylindrical tank is equal to the area of the body (A_{body}) plus the area of both ends of the tank (A_{end}), or, in the case of a vertical cylinder resting on a slab, the area of the tank body (A_{body}) plus the area of the top (A_{end}). If the tank is a vertical cylinder resting on a slab, do not add in the bottom area at this point.

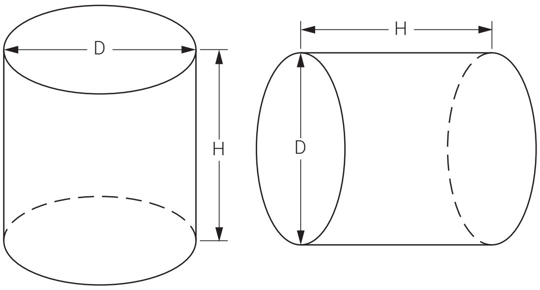


Fig. 12 Cylinder surface areas

To calculate the total surface area (A_V) of the tank cylinder:

- Calculate the surface area of the body:

$(A_{body}) = \pi DH$

- Calculate the surface area of one or both ends:

$(A_{end}) = \pi D^2/4$ or $(A_{end}) = (\pi D^2/4) \times 2$

- Add the results.

Table 8 below provides both the end and body areas of cylindrical tanks 6 to 20 feet in diameter and 8 to 25 feet high.

TABLE 8 CYLINDRICAL TANK SURFACE AREAS

		A_{body} (ft^2)																	
		H (ft)																	
D (ft)	A_{end} (ft^2)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
6	29	151	170	189	208	227	245	264	283	302	321	340	359	311	396	415	434	453	471
7	39	176	198	220	242	264	286	308	330	352	374	396	418	440	462	484	506	528	550
8	51	202	227	252	277	302	327	352	377	403	427	452	478	503	528	553	579	604	629
9	64	227	255	283	311	340	368	396	425	453	481	509	538	566	594	622	650	679	707
10	79	252	283	315	346	377	409	440	472	503	535	565	597	629	660	692	723	754	786
11	95	277	311	346	381	415	450	484	519	553	588	622	657	692	726	761	795	830	864
12	114	302	340	377	415	453	491	528	566	604	641	679	717	754	792	830	868	905	943
13	133	327	368	409	450	491	531	572	613	654	695	736	776	817	858	899	940	981	1021
14	154	352	396	440	484	528	572	616	660	704	748	792	836	880	924	968	1012	1055	1100
15	177	377	425	472	519	566	613	660	707	754	802	849	896	943	990	1037	1084	1131	1179
16	202	403	453	503	553	604	654	704	754	805	855	905	955	1006	1056	1106	1157	1207	1257
17	227	427	481	535	588	641	695	748	802	855	908	962	1015	1069	1121	1175	1229	1282	1336
18	255	452	509	565	622	679	736	792	849	905	962	1018	1075	1131	1188	1244	1301	1357	1414
19	284	478	538	597	657	717	776	836	896	955	1015	1075	1135	1194	1254	1314	1373	1433	1493
20	315	503	566	629	692	754	817	880	943	1006	1069	1131	1194	1257	1320	1383	1446	1508	1571

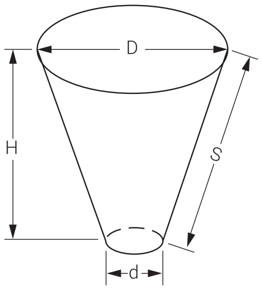
Note: For the area of a horizontal tank, add the area of both ends.

TRUNCATED CONE SURFACE AREA

The total surface area (A_V) of a truncated cone tank (Fig. 14) is calculated as follows:

$(A_V) = (A_{body}) + (A_{top}) + (A_{bottom})^*$

* Do not include (A_{bottom}) if the bottom of the tank is resting on a slab.



$$A_{body} = \frac{\pi}{2}(D+d)\,S$$

$$= \frac{\pi}{2}(D+d)\sqrt{\frac{(D+d)^2}{4} + H^2}$$

$$A_{top} = \frac{\pi D^2}{4}$$

$$A_{bottom} = \frac{\pi d^2}{4}$$

Fig. 13 Truncated cone surface areas

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step ❷ Calculate the Q_V (heat loss through the insulated tank body)

PREPARATION

Calculating the Q_V requires the following tank information:

- Maintain temperature (T_M)
- Minimum ambient temperature (T_A)
- Insulation thickness

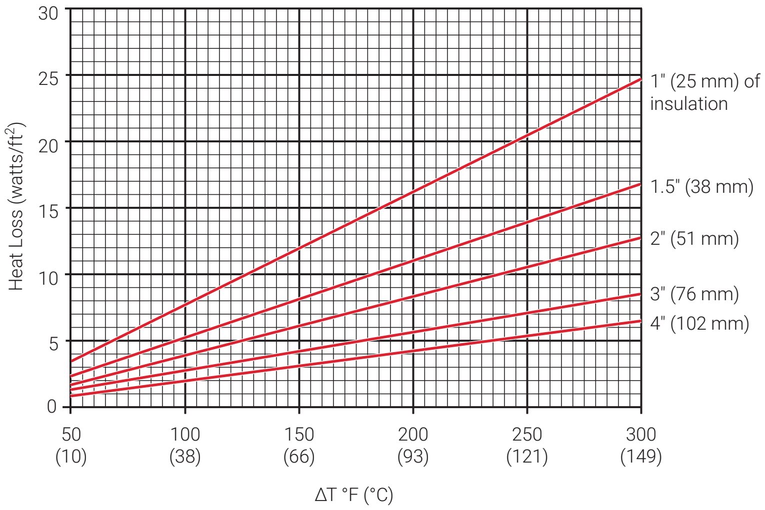
CALCULATION

Use the maintain and minimum ambient temperatures to arrive at the temperature differential. With the ΔT and the insulation thickness, calculate the Q_V:

- Obtain ΔT by subtracting the minimum ambient temperature (T_A) from the maintain temperature (T_M):
  $\Delta T = (T_M) - (T_A)$
- Determine the heat loss rate (q_V) for the application. Table 9 shows the heat-loss rates (q_V) for typical temperature differentials and insulation thicknesses.
- Determine the f insulation adjustment factor. Table 10 provides insulation factors for the most commonly used tank insulations.
- Calculate the total heat loss through the tank body:
  $Q_V = A_V \times q_V \times f$ (insulation adjustment factor)

TABLE 9 HEAT LOSS RATE (Q_V) PER SQUARE FOOT (WATTS/FT²)

	Insulation thickness				
ΔT °F (°C)	1" (25 mm)	1.5" (38 mm)	2" (51 mm)	3" (76 mm)	4" (102 mm)
50 10)	3.4	2.3	1.7	1.2	0.9
100 (38)	7.1	4.8	3.6	2.4	1.8
150 (66)	11.0	7.5	5.6	3.7	2.8
200 (93)	15.3	10.3	7.7	5.2	3.9
250 (121)	20.0	13.5	10.2	6.8	5.1
300 (149)	24.9	16.8	12.7	8.5	6.5



Graph 1 Heat loss rate per square foot (watts/ft^2)

TABLE 10 INSULATION ADJUSTMENT FACTORS FOR TYPICAL INSULATIONS

Insulation types	Insulation adjustment factor	k factor*
Fiberglass	1.00	0.270
Cellular glass	1.46	0.395
Calcium silicate (Type 1)	1.48	0.400
Expanded perlite	1.85	0.499
Flexible elastomer	1.15	0.311
Mineral fiber blanket	1.26	0.340
Polyisocyanurate	0.67	0.180
Rigid polyurethane, W	0.60	0.161
Rigid polyurethane, spray	0.60	0.161
Rock wool/mineral wool	1.06	0.287

* Based on a 50°F (10°C) mean temperature with units Btu/hr–°F–ft^2/in

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step ❸ Calculate the Q_S (heat loss through the base support)

The following heat loss tables and accompanying graphs (Graph 2–Graph 5) provide typical base-support heat losses (Q_S) through the following types of base supports:

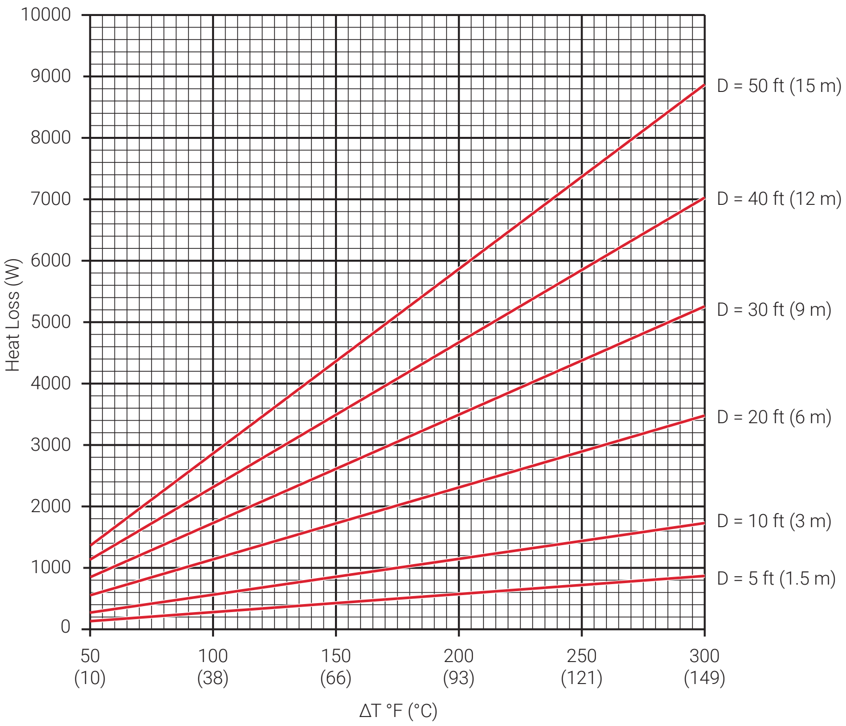
- Concrete slab or earth foundation
- Legs
- Concrete saddles
- Uninsulated skirt

CONCRETE SLAB OR EARTH FOUNDATION

Based on the ΔT and tank diameter, select the Q_S from Table 11 or Graph 2 below.

TABLE 11 HEAT LOSS (W) FOR A CONCRETE SLAB OR EARTH FOUNDATION

	ΔT °F (°C)					
Tank diameter ft (m)	50 (10)	100 (38)	150 (66)	200 (93)	250 (121)	300 (149)
5 (1.5)	137	278	451	566	711	857
10 (3)	283	573	864	1154	1452	1703
20 (6)	566	1163	1760	2325	2922	3488
30 (9)	848	1767	2616	3535	4383	5231
40 (12)	1131	2388	3518	4649	5906	7037
50 (15)	1374	2945	4320	5891	7265	8836



Graph 2 Heat loss (W) for a concrete slab or earth foundation

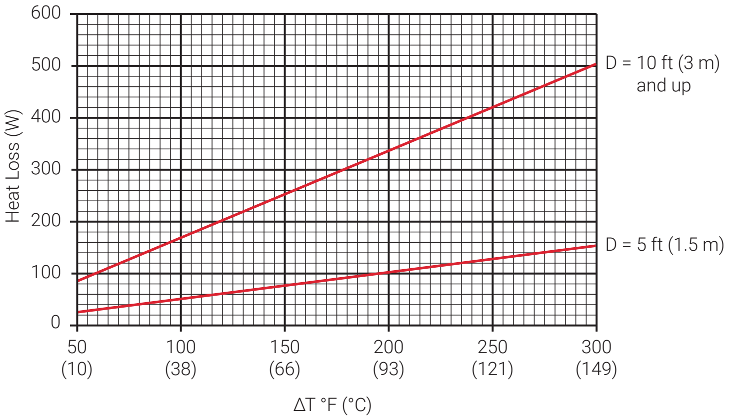
LEGS

Determine the heat loss for legs (Q_S) as follows:

- Based on the ΔT and tank diameter, select the heat loss from the Table 12 or Graph 3.
- Multiply the heat loss by the number of legs.

TABLE 12 HEAT LOSS (W) FOR A LEG SUPPORT

		ΔT °F (°C)					
Tank diameter ft (m)		**50 (10)**	**100 (38)**	**150 (66)**	**200 (93)**	**250 (121)**	**300 (149)**
5	(1.5)	26	52	77	103	129	155
10	(3) and above	85	169	351	336	420	505



Graph 3 Heat loss (W) for leg support

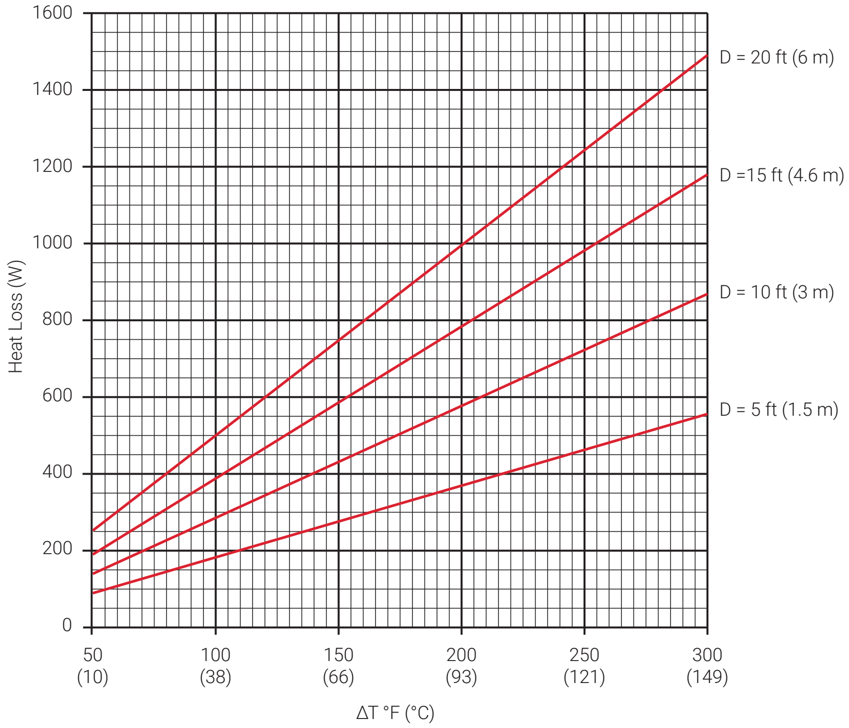
CONCRETE SADDLES

Determine the heat loss for saddles (Q_S) as follows:

- Based on the ΔT and tank diameter, select the heat loss (Q_S) from Table 13 or Graph 4.
- Multiply the heat loss by the number of saddle supports.

TABLE 13 HEAT LOSS (W) FOR A CONCRETE SADDLE

Tank diameter ft (m)	ΔT °F (°C) 50 (10)	100 (38)	150 (66)	200 (93)	250 (121)	300 (149)
5 (1.5)	93	186	275	368	461	553
10 (3)	145	290	430	576	721	866
15 (4.6)	198	395	586	783	981	1179
20 (6)	250	500	741	991	1241	1491



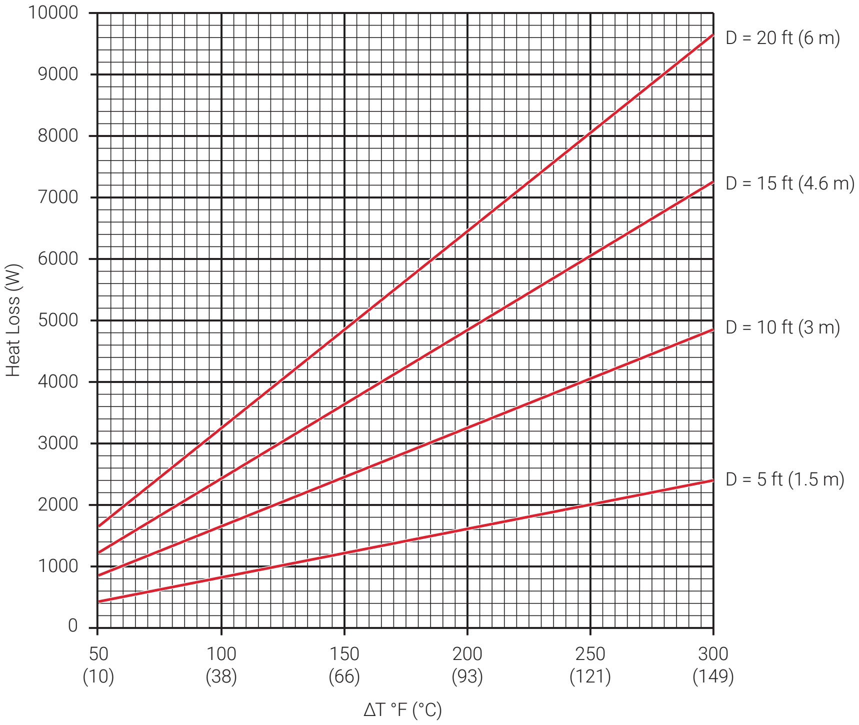
Graph 4 Heat loss (W) for a concrete saddle

UNINSULATED SKIRT

Based on the ΔT and tank diameter, select the Q_S from Table 14 or Graph 5.

TABLE 14 HEAT LOSS (W) FOR AN UNINSULATED SKIRT

Tank diameter ft (m)	ΔT °F (°C) 50 (10)	100 (38)	150 (66)	200 (93)	250 (121)	300 (149)
5 (1.5)	402	805	1193	1595	1998	2400
10 (3)	806	1612	2389	3195	4000	4806
15 (4.6)	1209	2419	3585	4794	6003	7212
20 (6)	1613	3225	4780	6393	8006	9619



Graph 5 Heat loss (W) for an uninsulated skirt

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step 4 Calculate the Q_A (heat loss through the accessories)

The following heat loss tables and accompanying charts provide typical accessory heat losses (Q_S) through the following types of accessories:

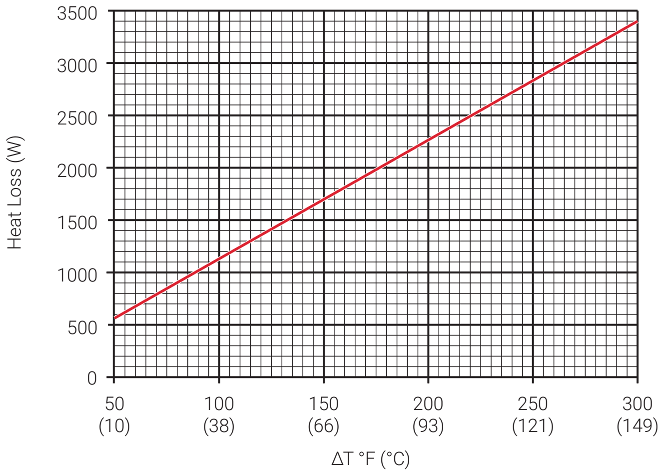
- Manholes
- Handholes
- Ladders
- Handrails

MANHOLES

Select the heat loss for a manhole from Table 15 or Graph 6. The heat loss is based on a 2-foot diameter cover and a 1-foot tall base. The base and cover are uninsulated.

TABLE 15 HEAT LOSS (W) FOR A MANHOLE

	ΔT °F (°C)					
	50 (10)	100 (38)	150 (66)	200 (93)	250 (121)	300 (149)
Heat loss (W)	564	1120	1680	2237	2807	3401



Graph 6 Heat loss (W) for a manhole

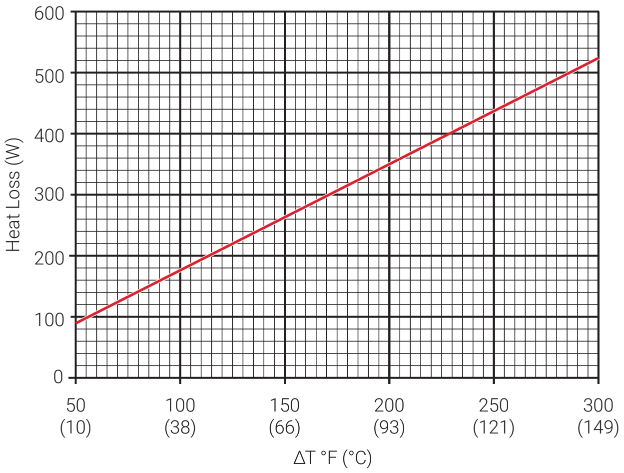
HANDHOLES

Calculate the heat loss for handholes as follows:

- Select the heat loss from Table 16 or Graph 7 based on the ΔT. Heat loss is based on a 0.5 foot diameter, uninsulated surface.
- Multiply the heat loss you select by the number of handholes.

TABLE 16 HEAT LOSS FOR A HANDHOLE

	ΔT °F (°C)					
	50 (10)	100 (38)	150 (66)	200 (93)	250 (121)	300 (149)
Heat loss (W)	90	178	265	351	437	526



Graph 7 Heat loss (W) for a handhole

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step ❺ Calculate the Q_T (overall heat loss)

Add the heat-loss rates (Q_V, Q_S, and Q_A) from Steps ❷, ❸, and ❹.

Outdoor application:

$Q_T = Q_V + Q_S + Q_A$

Indoor application:

$Q_T = 0.9 \times (Q_V + Q_S + Q_A)$

Tank Heat Loss Calculation
1. Calculate surface area of tank
2. Calculate Q_V
3. Calculate Q_S
4. Calculate Q_A
5. Calculate Q_T
6. Calculate final design heat loss

Step ❻ Calculate the final design heat loss

nVent recommends that the final design heat loss should include a 20 percent safety factor.

QF (Final design heat loss) = QT x 1.20

Note that this same heat-loss calculation approach should be used for insulated polypropylene and fiber-reinforced plastic (FRP) tanks.

SNOW MELTING AND DE-ICING

This section provides an overview of nVent RAYCHEM Snow Melting and De-Icing systems. For detailed information on snow melting design, refer to the nVent RAYCHEM MI Surface Snow Melting Design Guide (H57045) or the nVent RAYCHEM ElectroMelt Surface Snow Melting Design Guide (H53393). For detailed information on roof and gutter de-icing design, refer to the nVent RAYCHEM IceStop Roof and Gutter De-icing Design Guide (H56070). For additional information, contact your nVent representative or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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IceStop Self-Regulating Heating Cables 129

IceStop System 130

INTRODUCTION

Snow and ice can create many problems for the industrial marketplace including delayed shipments due to frozen loading docks and safety hazards due to icicle formation. nVent provides several snow melting and de-icing solutions for these problems. Typical benefits served by these products include:

- Reduced liability
- Fewer costly repairs
- Reduced potential for lost business
- Increased safety
- Enhanced appearance

A description of typical nVent RAYCHEM snow melting and de-icing applications and details on the appropriate system offerings follows.

SNOW MELTING

APPLICATIONS

In winter, snow and ice can accumulate on surfaces and create hazards to people and vehicles. nVent's snow melting systems can be used to melt snow in a variety of areas, such as sidewalks, stairways, driveways, ramps, and helicopter landing pads, avoiding expensive vehicle repairs, delayed shipments, and increasing personnel safety.

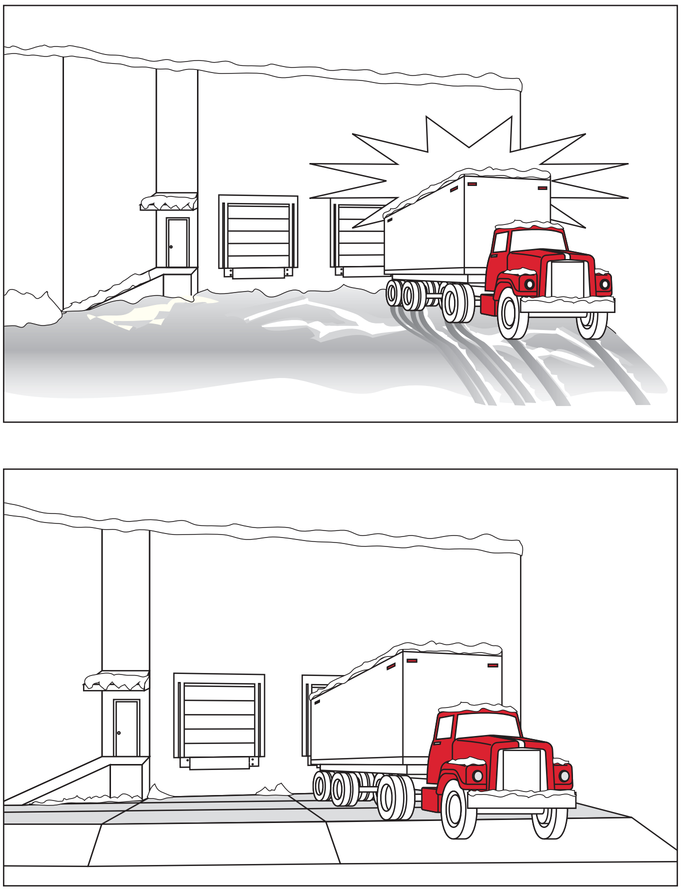

Fig. 1 **Examples of a typical snow melting application**

PRODUCT OFFERINGS

Snow melting applications can be quite varied. For this reason, nVent offers two products utilizing different technologies to provide an optimized system for your snow melting needs. Both technologies are proven and reliable.

- Mineral Insulated (MI) heating cables
- ElectroMelt self-regulating heating cables

To determine which product suits your application, contact your nVent representative or phone nVent at 800-545-6258.

APPROVALS

All snow melting systems meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code. All snow melting systems are approved for use in hazardous and nonhazardous locations through various approval agencies. Refer to the product-specific data sheet for more detailed information.

Mineral Insulated Heating Cables

Standard surface snow melting MI heating cables are comprised of a single conductor surrounded by magnesium oxide insulation, a solid copper sheath, and an extruded high density polyethylene (HDPE) jacket. The nVent RAYCHEM HDPE jacket protects the copper sheath from corrosive elements that can exist in surface snow melting applications.

Single-conductor cable

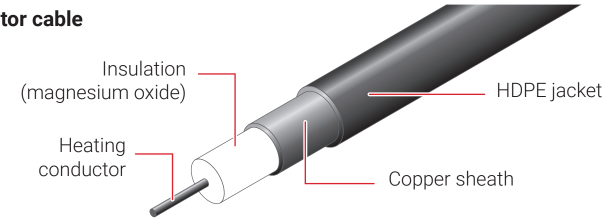

Fig. 2 MI heating cable construction

MI Snow Melting System

A typical MI snow melting system includes the components shown below. For detailed design information, refer to the MI Surface Snow Melting Design Guide (H57045).

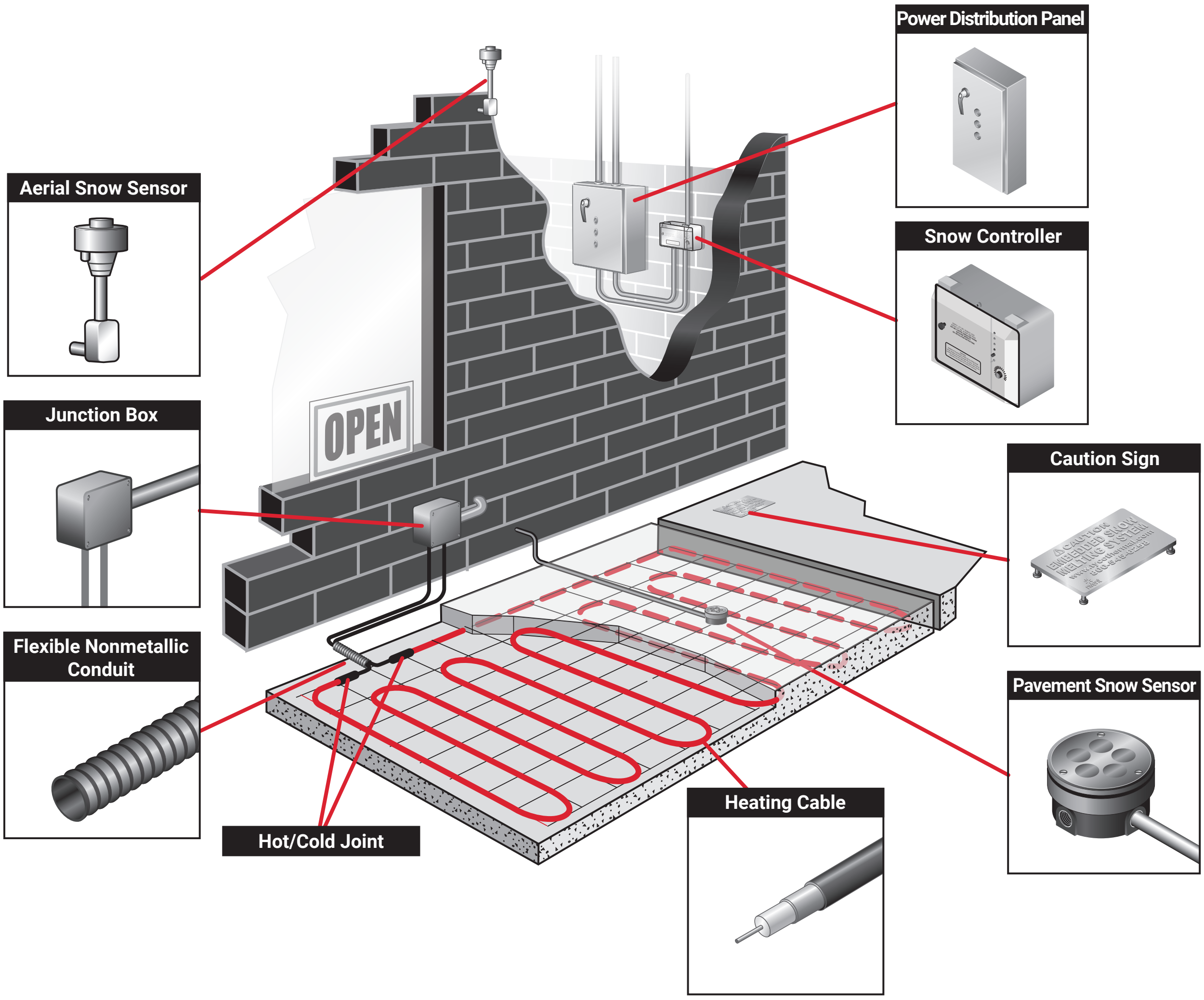

Fig. 3 Typical MI snow melting system

ElectroMelt Self-Regulating Heating Cables

The ElectroMelt self-regulating heating cable is embedded in concrete pavement to melt snow and ice that might otherwise accumulate on the surface. The heating cable responds to the local concrete temperature, increasing heat output when concrete temperature drops and decreasing heat output when concrete temperature rises. The self-regulating heating cable cannot overheat and destroy itself, even if overlapped in the concrete, and therefore does not require the use of overlimit thermostats.

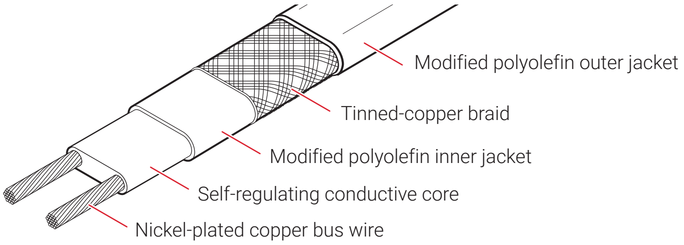

Fig. 4 ElectroMelt heating cable construction

ElectroMelt Snow Melting System

A typical ElectroMelt system includes the components shown below. For detailed design information, refer to the ElectroMelt Surface Snow Melting System Design Guide (H53393).

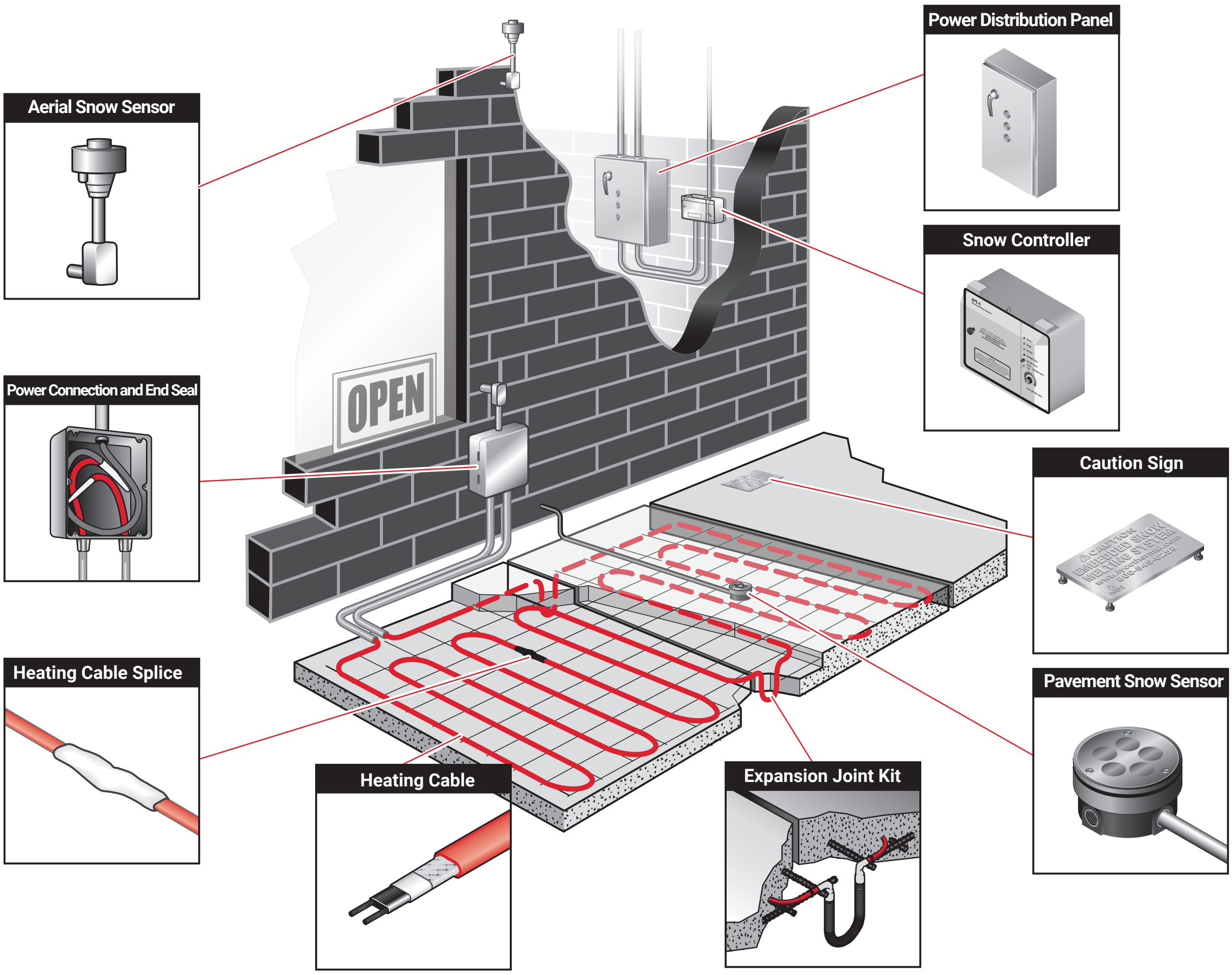

Fig. 5 Typical ElectroMelt snow melting system

ROOF AND GUTTER DE-ICING

APPLICATIONS

Industrial administrative buildings, warehouses, storage facilities, and production buildings benefit from roof and gutter de-icing systems. After melting, ice and snow can refreeze and form ice dams that prevent water from draining to the gutter. On rooftops this often leads to standing water, which can cause severe damage by draining into the building. The water can also flow over the ice-filled gutter and form icicles, which can be a serious safety hazard.

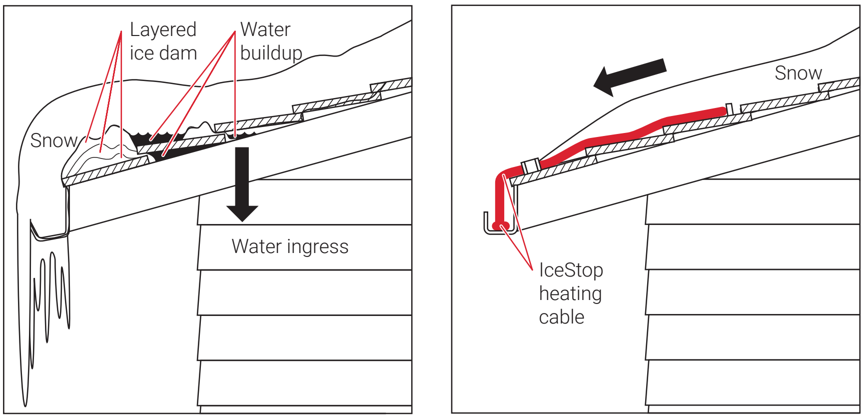

Fig. 6 Examples of a typical roof and gutter de-icing application

PRODUCT OFFERINGS

The IceStop system can prevent ice dams and icicles by maintaining a continuous path for melt water to drain from the roof. The IceStop system uses a self-regulating heating cable which reduces heat output automatically as the cable warms to above freezing, resulting in lower energy use, and eliminating the possibility of overheating.

Approvals

nVent roof and gutter de-icing systems meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.

IceStop is approved for use in hazardous and nonhazardous locations through various approval agencies. Refer to the data sheet in the Technical Data section for more detailed information. Data sheets can be found on nVent.com or the Technical data sheet section of the Industrial Heat Tracing Products & Services Catalog (H56550).

IceStop Self-Regulating Heating Cables

IceStop self-regulating heating cables are comprised of two parallel nickel-coated bus wires in a cross-linked polymer core, a tinned copper braid and a fluoropolymer or polyolefin outer jacket. These cables are cut to length simplifying the application design and installation.

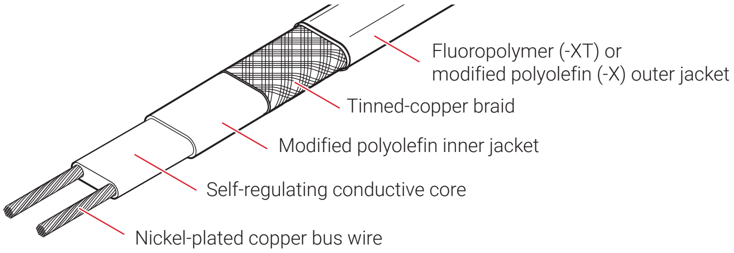

Fig. 7 IceStop heating cable construction

IceStop System

A typical IceStop roof and gutter de-icing system includes the components shown below.

For detailed design information, refer to the IceStop Roof and Gutter De-icing design guide (H56070).

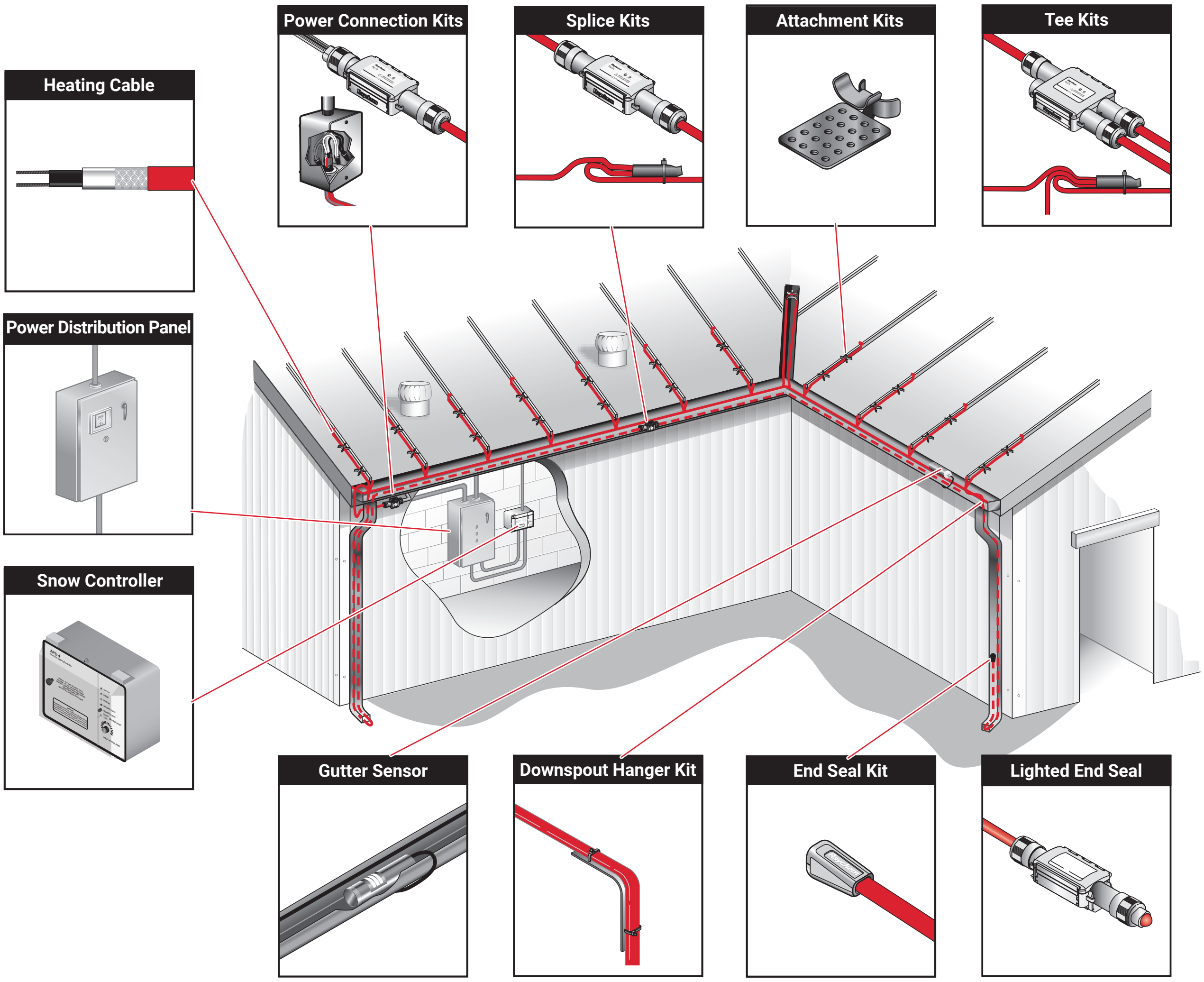

Fig. 8 Typical IceStop roof and gutter de-icing system

CONTROL AND MONITORING

This section provides complete information for the design and selection of heat-tracing control and monitoring systems. Part 1 identifies control and monitoring options for use with heat-tracing applications. Part 2 details each nVent control and monitoring product. For additional information contact your nVent representative or visit our web site at nVent.com.

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Part 1: Control and Monitoring Options

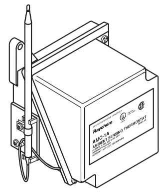
INTRODUCTION

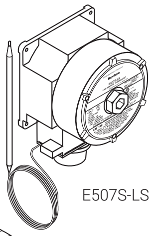
nVent provides a wide variety of control and monitoring products, from simple mechanical thermostats and signal lights to sophisticated digital controllers and control and monitoring systems designed specifically for use with our heat-tracing products. This section will help you select and specify the right control and monitoring products for your application. For details on nVent RAYCHEM panel products such as the nVent HTPG and HTPI, refer to Heat-Trace Panels (H56890).

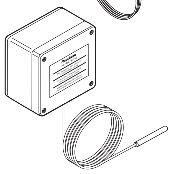
PRODUCT OVERVIEW

nVent RAYCHEM control and monitoring products include thermostats, controllers, and control and monitoring systems. Following are descriptions of some of our most common control and monitoring products.

THERMOSTATS


AMC-1A


E507S-LS


RAYSTAT-EX-03-A

Mechanical Thermostats

Mechanical thermostats, such as the ambient-sensing AMC-1A and line-sensing E507S-LS, provide cost-effective control for self-regulating and constant-wattage heat-tracing applications in both nonhazardous and hazardous locations.

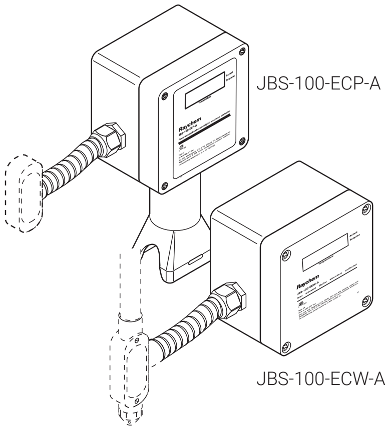
Electronic Thermostats

Electronic thermostats, such as the nVent RAYCHEM RAYSTAT-EX-03-A, offer additional features, including precise set points and long-lasting switches.

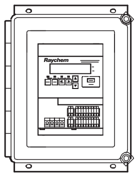
CONTROLLERS

Electronic Controllers

Electronic controllers include the nVent RAYCHEM JBS-100-ECP-A, JBS-100-ECW-A, and the nVent RAYCHEM 910 and 920 controllers.


JBS-100-ECP-A

JBS-100-ECW-A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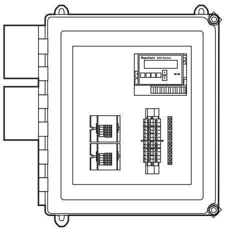

920

JBS-100-ECP-A and JBS-100-ECW-A

The nVent RAYCHEM JBS-100-ECP-A and JBS-100-ECW-A are electronic temperature controllers that provide accurate control of a heating circuit using a RTD sensor.
The JBS-100-ECP-A is pipe mounted and serves as a power connection kit for both nVent RAYCHEM self-regulating, power-limiting, and nVent RAYCHEM mineral insulated heating cables. The JBS-100-ECW-A is wall mounted and may be used to control all types of heating cables. The JBS-100-ECW-A can only be used as a power connection with mineral insulated cables. Combining the power connection and controller into one single unit will significantly reduce installation cost. Both the JBS-100-ECP-A and JBS-100-ECW-A have adjustable set points between 32°F to 425°F (0°C to 218°C), power input of 120 Vac to 277 Vac, and switches current up to 30 A. A local display allows for monitoring of set point, actual temperature, and also indicates alarm conditions (high/low temperature and sensor failure). A form C contact allows for remote annunciation of alarms. These units are c-CSA-us (certified to U.S. and Canadian Standards) for use in nonhazardous locations.

910 and 920

The nVent RAYCHEM 910 and 920 controllers are microprocessor-based, single-point and dual-point controllers for heat-tracing circuits located in nonhazardous or Class I Division 2 (and Zone 2) hazardous locations. These controllers combine the temperature control of a thermostat with integral ground-fault protection, while providing alarms for low and high temperatures, line current, and ground-fault current. Operation, programming, circuit status, currents, and temperatures are provided at the control panel and remotely by means of a network connection to the plant DCS or a PC with nVent RAYCHEM Supervisor software.

CONTROL AND MONITORING SYSTEMS

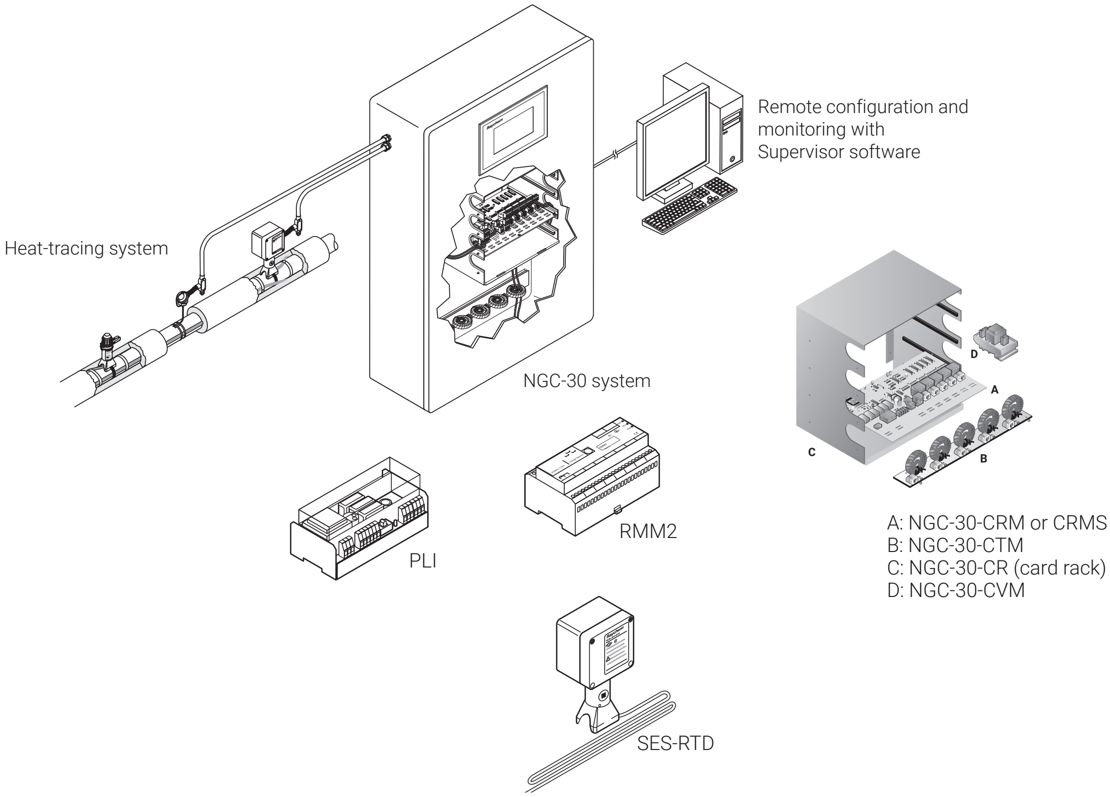
Multipoint Control And Monitoring Systems

Multipoint control and monitoring systems include the nVent RAYCHEM NGC-30, and NGC-40 systems.

NGC-30

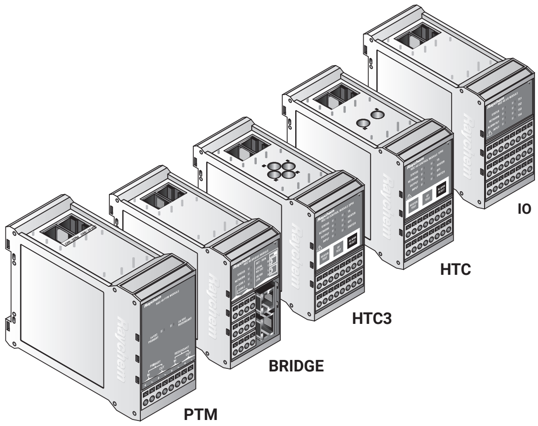
The nVent RAYCHEM NGC-30 is a distributed architecture control and monitoring system that can manage up to 260 heat-tracing circuits. Approved for use in both hazardous and nonhazardous areas, it allows user selection of several control modes, temperature setpoints and all alarm thresholds of individual heat-tracing circuits. During operation it monitors temperatures, ground-fault currents, operating currents and voltages and provides alarms via local indicators and remotely using dry contact relay outputs or through the Supervisor software. The NGC-30 system utilizes a touch screen-based user interface terminal for programming and monitoring at the panel. This user interface terminal provides an intuitive interaction with the control and monitoring system which allows users to quickly and easily access heat-tracing system information. Alarm information is communicated in plain language rather than codes.

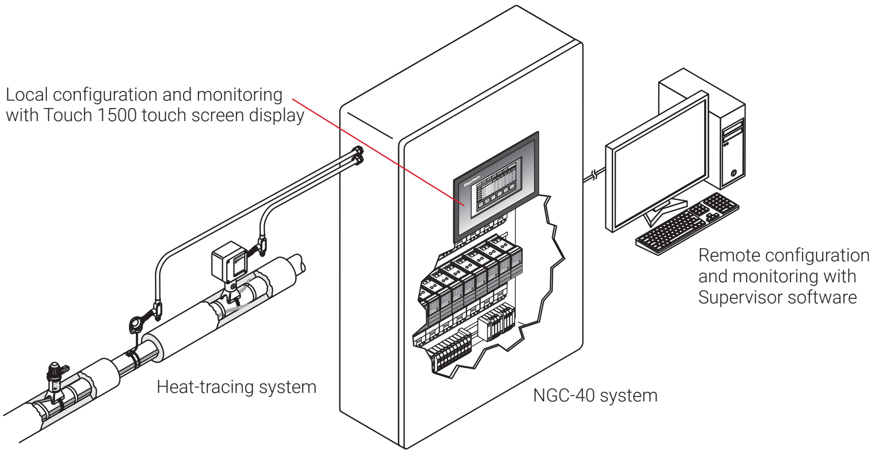
Temperature inputs are provided through directly connected RTDs, through a Remote Monitoring Module (RMM2) or through a Power Line Carrier Interface (PLI) Module with special transmitters. Operation, programming, circuit and RTD status and alarm reporting are provided at the control panel or remotely via a network connection to the plant DCS or the Supervisor software.



NGC-40

The nVent RAYCHEM NGC-40 control and monitoring system differs from the NGC-30 in that it dedicates a single control module to each individual heat-trace circuit. It provides the highest reliability for heat tracing applications based on single controller architecture. The NGC-40 control system offers a truly modular heat-tracing control, monitoring and power distribution system. NGC-40 modules are packaged in DIN Rail housing and are installed in an NGC-40 panel that can manage up to 80 heat tracing circuits. Operation, programming and easy intuitive access to the heat tracing data can be achieved locally at the control panel from a 15" touch screen (TOUCH 1500) or remotely from a central location using the Supervisor software. The system is fully flexible from a configuration point of view and offers individual single-phase and three-phase electrical heat-tracing control and monitoring.





CONTROL SOLUTIONS

Control products vary the output of the heating source to keep pipes from freezing or to maintain process piping at elevated temperatures. The choice of control product depends on whether the system is controlled on the basis of ambient temperature or pipe temperature.

Most heat-tracing systems use a control element.

Applications that may benefit from a control element are those:

- Requiring a narrow operating temperature range.
- With temperature-sensitive fluids or equipment.
- For which energy consumption is a key concern.

CONTROL CONSIDERATIONS

The most important step in providing a reliable control system is to design the heat-tracing system properly for the specific application.

Heat-tracing systems maintain the temperature of stagnant fluids in pipes and tanks by replacing the heat lost through the thermal insulation. Overall performance of the heat-tracing system is highly dependent on the integrity of the thermal insulation, the heat-tracing design, and the installation. Therefore, the most important step in providing a reliable control system is to properly design the heat-tracing system for the specific application, as detailed in other nVent design guides.

When designing your heat-tracing system, consider these factors:

- Adding control elements increases the installation and maintenance costs of the system, but should result in tighter temperature control, energy savings and more efficient use of plant maintenance personnel's time.
- Electronic controllers increase initial system costs, but offer reliability and feedback superior to that provided by mechanical thermostats. The monitoring and alarm information available from electronic controllers can help maintenance personnel react to heat-tracing problems more quickly, before pipe freeze-up or process temperature issues cause a plant or process shutdown.
- The thermal environment of a heat-tracing system varies greatly — especially at valves, pipe supports, and other heat sinks — so it is seldom possible to achieve very tight temperature control.
- The temperature of a heat tracing system is based on ambient temperature and can vary by as much as 20°C when the system is uncontrolled. However, pipe temperature sensing will provide tighter temperature control than is possible with ambient sensing.
- TraceCalc Pro, nVent design software, estimates the temperature range of your heat-tracing system, both with and without control. If an uncontrolled self-regulating heating cable provides an acceptable range, consider choosing this approach for its high reliability and low installed cost.

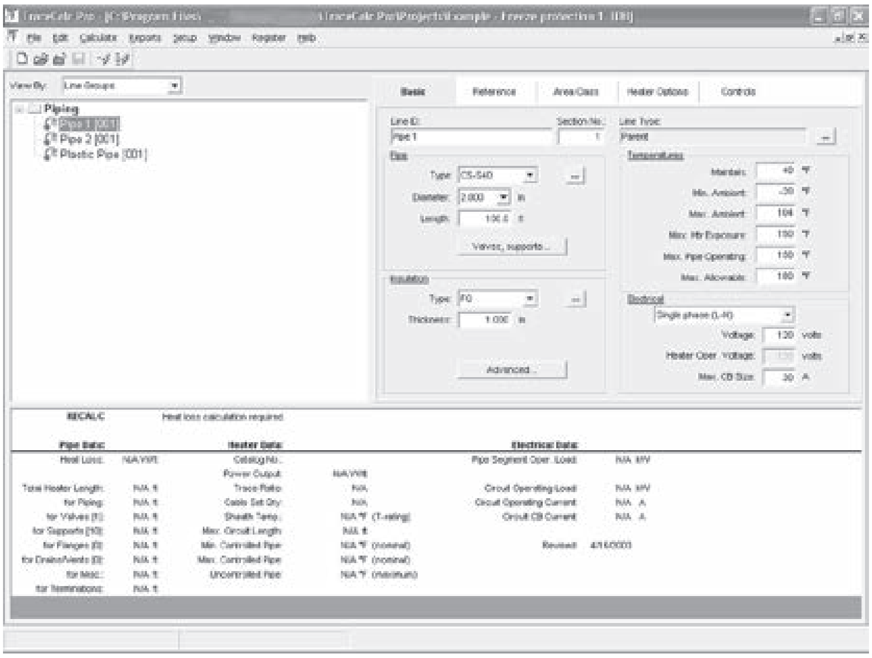


Fig. 1 TraceCalc Pro heat-tracing design software

APPLICATION TEMPERATURE RANGE

The options for control depend on the expected temperature range for the application. Ranges are grouped into three categories, as follows:

Freeze Protection

Freeze protection applies to fluids that must be kept above a minimum temperature, typically 32°F (0°C) for water lines. Moderate overheating of the fluid (30°F to 40°F; 17°C to 22°C) is not a major concern. (IEEE 515-2011, Process Type I)

Broad temperature maintenance

Broad temperature maintenance is appropriate when the process temperature must be controlled within a moderate range; e.g., set point plus approximately $\Delta T = \pm 35°F \pm (19°C)$. This is generally used for viscosity control to keep process fluids flowing, such as in fuel oil and cooking oil lines. (IEEE 515-2011, Process Type II)

Narrow Temperature Maintenance

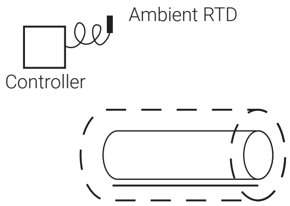
Narrow temperature maintenance applies to fluids that must be kept within a narrow temperature range to maintain viscosity and prevent fluid or pipe degradation. Examples include sulfur and acrylic acid lines, as well as food syrup and sugar solutions. (IEEE 515-2011 Process Type III)

CONTROL OPTIONS

The control method you select will be driven by your application. Table 1 summarizes the recommended control options for each application type. Following the table is an overview of the three basic control types: ambient-sensing, proportional ambient-sensing (PASC), and line-sensing control.

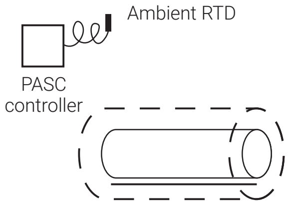
TABLE 1 RECOMMENDED CONTROL METHODS

Application	Control methods recommended
Freeze protection	Ambient-sensing control to reduce energy consumption Proportional ambient-sensing control (PASC) for lowest energy consumption
Broad temperature maintenance	Proportional ambient-sensing control (PASC) for tighter temperature control
Narrow temperature maintenance	Line-sensing control



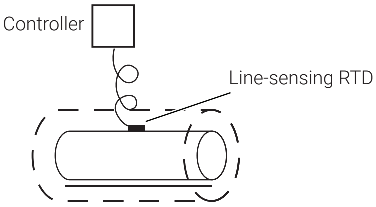
Ambient-Sensing Control

Ambient-sensing control uses an on-off thermostat that senses ambient temperature. It is more energy efficient than self-regulating control because the heating circuit is energized only when the temperature drops below the setpoint. This type of control is most suitable for freeze-protection applications. The control device can be either a mechanical thermostat or an electronic controller. Mechanical thermostats are more commonly used since they are less expensive and are sufficiently accurate and reliable. However, they do not provide the monitoring and alarm functions that are available from an electronic controller.



Proportional Ambient-Sensing Control (PASC)

Proportional ambient-sensing control (PASC) uses an electronic controller that senses ambient temperature and continuously matches the heat-tracing power applied to the pipe to the predicted heat loss that occurs due to changing ambient conditions. A preprogrammed algorithm calculates the cycle time that the heating circuits will be energized in order to maintain the desired temperature. This control method results in tighter temperature range control and lower energy usage than the ambient-sensing method. PASC control is suitable for all broad temperature-control and some narrow temperature-control applications, as well as freeze-protection applications.



Line-sensing Control

Line-sensing control is based on pipe temperature. With this option, each flow path must have a separate circuit controlled by a mechanical line-sensing thermostat or electronic controller. When the pipe temperature falls below the desired maintain temperature, the control unit turns on the heating circuit. The same cost-benefit trade-offs between electronic and mechanical controllers should be made for line-sensing applications. An electronic controller with monitoring and alarm features is recommended for critical pipes.

CONTROL SELECTION

Selecting a control system suitable for your application involves four steps:

1 Select the nVent heat-tracing solution.

2 Identify the control application.

3 Choose the control method.

4 Review the specifications for your control selection.

The selection process outlined on the following pages results in a reliable, cost-effective control system optimized for simplicity. If you are installing multiple heat-tracing circuits, a more detailed analysis of the application may yield a different result with lower installed and operating costs. Contact your nVent representative for assistance.

Control Selection
1. Select nVent heating solution
2. Identify control application
3. Choose control method
4. Review specifications for control selection

Step 1 Select the nVent heating solution

This is the most important step in designing a heat-tracing system. Use the heat-tracing product selection sections in this publication to select the heating system and components for your application. Assistance is available on-line (nVent.com), in nVent TraceCalc Pro design software, or from your nVent representative.

Control Selection
1. Select nVent heating solution
2. Identify control application
3. Choose control method
4. Review specifications for control selection

Step 2 Identify the control application

For the pipes and tanks to be heated, identify the specific control application in Table 2.

TABLE 2 CATEGORIES OF CONTROL

Control application	Temperature range/goal
Freeze protection	To keep water lines above 32°F (0°C)
Broad temperature control	For viscosity control to keep process fluids flowing
Narrow temperature control	To keep process fluids within a narrow temperature band to maintain viscosity and prevent fluid degradation

If your project includes multiple heat-tracing circuits and a combination of applications, or monitoring and alarm reporting capability is desired, use the NGC-30 or NGC-40 control and monitoring system and contact your nVent representative for design assistance. Otherwise, continue to Step 3 to select your control method.

Step 3 Choose the control method

For freeze-protection applications

Use Table 3 to select the appropriate control solution for your application. Base your selection on the number and type of heat-tracing circuits to be installed, the type of control you need, and the area classification. Other nVent products that include monitoring and ground-fault protection are discussed later under "Monitoring Solutions."

TABLE 3 CONTROL SELECTION FOR FREEZE PROTECTION

nVent heating solution: individual circuits[1]	Control options	nVent RAYCHEM control product	Quantity required
Self-regulating heating circuits on pipes	Ambient-sensing control	AMC-1A, AMC-1H, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
Constant-wattage/ power-limiting heating circuit(s) on pipes (includes MI and VPL cables)	Line-sensing control	AMC-1B, E507S-LS, 910, 920, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
Any heating circuit(s) on tanks	Line-sensing control	AMC-1B, E507S-LS, 910, 920, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
Multiple circuits[1] grouped in panels			
Self-regulating heating circuits on pipes	Ambient-sensing control for main contactor in panel	HTPG, HTPI	One per system
	Energy-saving electronic proportional control for main contactor in panel	NGC-30, NGC-40, 920	One per system
Constant-wattage/ power-limiting heating circuits on pipes	Proportional control for each contactor in panel	NGC-30, NGC-40, 920	One per system
Any heating circuits on tanks	Multicircuit line-sensing control	NGC-30, NGC-40, 920	One per system

1. A heat-tracing circuit is defined as one circuit breaker with its associated branch wiring, heat-tracing cable, and components.

For broad temperature control applications

Use Table 4 to select the appropriate control solution for your application. Base your selection on the number and type of heat-tracing circuits you will use in your application, the desired control option, and the area classification. Other nVent products that include monitoring and ground-fault protection are discussed later under "Monitoring Solutions."

TABLE 4 CONTROL SELECTION FOR BROAD TEMPERATURE CONTROL

nVent heating solution: individual circuits[1]	Control options	nVent RAYCHEM control product	Quantity required
Self-regulating heating circuits on pipes	Line-sensing control	AMC-1B, E507S-LS, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
Constant-wattage/power-limiting heating circuits on pipes (includes MI, SC and VPL cables)	Line-sensing control for each circuit; maintain temperature less than 300°F (150°C)	AMC-1B, E507S-LS, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
	Line-sensing control for each circuit; maintain temperature greater than 300°F (150°C)	RAYSTAT-EX-03-A, JBS-100-ECP-A, or JBS-100-ECW-A 910, 920	One per circuit
Any heating circuit(s) on tanks	Line-sensing control	AMC-1B, E507S-LS, JBS-100-ECW-A or 910, 920	One per circuit
Multiple circuits[1] grouped in panels			
Any heating circuits on pipes	Multicircuit proportional ambient-sensing control (PASC)[2]	NGC-30, NGC-40	One per system
	Multicircuit line-sensing control	NGC-30, NGC-40, 920	One per system
Any heating circuits on tanks	Multicircuit line-sensing control	AMC-1B,E507S-LS, NGC-30, NGC-40, 920	One per system

1. A heat-tracing circuit is defined as one circuit breaker with its associated branch wiring, heat-tracing cable, and components.
2. The NGC-30, NGC-40, 920 and 910 controllers include approved ground-fault protection, so a ground-fault circuit breaker in the panel is not required.

For narrow temperature control applications

Use Table 5 to select the appropriate control solution for your application. Base your selection on the number and type of heat-tracing circuits you will use in your application, the desired control option, and the area classification. Other nVent products that include monitoring and ground-fault protection are discussed later under “Monitoring Solutions.”

TABLE 5 CONTROL SELECTION FOR NARROW TEMPERATURE CONTROL

nVent heating solution: individual circuits[1]	Control options	nVent RAYCHEM control product	Quantity required
Heating circuits on pipes or tanks	Line-sensing control for each circuit; maintain temperature less than 300°F (150°C)	AMC-1B, E507S-LS, 910, 920, JBS-100-ECP-A, or JBS-100-ECW-A	One per circuit
	Line-sensing control for each circuit; maintain temperature greater than 300°F (150°C)	RAYSTAT-EX-03-A, JBS-100-ECP-A, JBS-100-ECW-A or 910, 920	One per circuit
Multiple circuits[1] grouped in panels			
Any heating circuits on pipes	Multicircuit line-sensing control	NGC-30, NGC-40 or 920,	One per system
Any heating circuits on tanks	Multicircuit line-sensing control	NGC-30, NGC-40, 920	One per system

1. A heat-tracing circuit is defined as one circuit breaker with its associated branch wiring, heat-tracing cable, and components.

Control Selection
1. Select nVent heating solution
2. Identify control application
3. Choose control method
4. Review specifications for control selection

Step 4 Review the specifications for your control selection

You will find descriptions of each of the control products in Control and Monitoring, Part 2; data sheets for these products are available on the nVent web site. Review the technical specifications of each product you have selected to ensure the product meets the needs of your application.

MONITORING SOLUTIONS

While you may select only one method of control for each heat-tracing circuit, you may incorporate a variety of monitoring options into the system design. The use of monitoring increases overall system reliability because failures in the heating and power distribution systems get reported to operations personnel.

nVent recommends always using, at a minimum, ground-fault monitoring. For the small additional cost, you get a monitoring system that reliably reports physical damage to the heat-tracing system, which is a common failure mode.

For critical applications, add temperature and/or current monitoring. This technique gives the most direct feedback on system performance. Multiple sensors can be placed at critical components.

To bring monitoring and alarm reporting from all heat-tracing circuits, use the Supervisor software located in the control or operations room.

Types of Monitoring

Monitoring increases system reliability by detecting faults before they become a major problem.

There are several methods available for monitoring heat-tracing systems. Local and remote feedback can be provided on ground-fault levels, pipe temperatures, heating cable current, and continuity.

Ground-fault monitoring

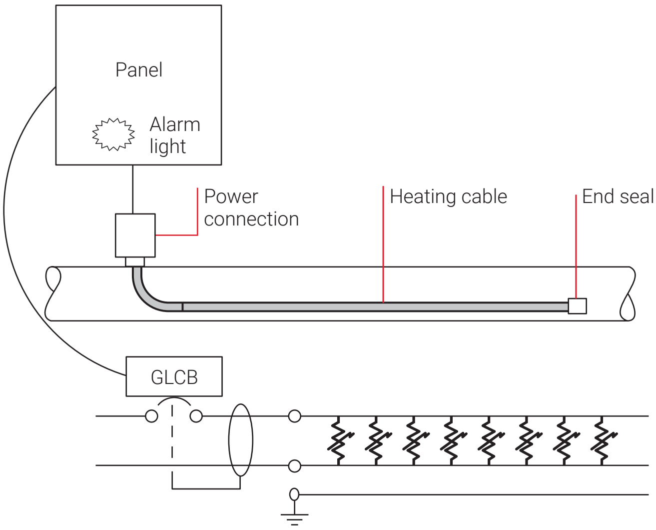


Fig. 2 Ground-fault monitoring: GLCB status

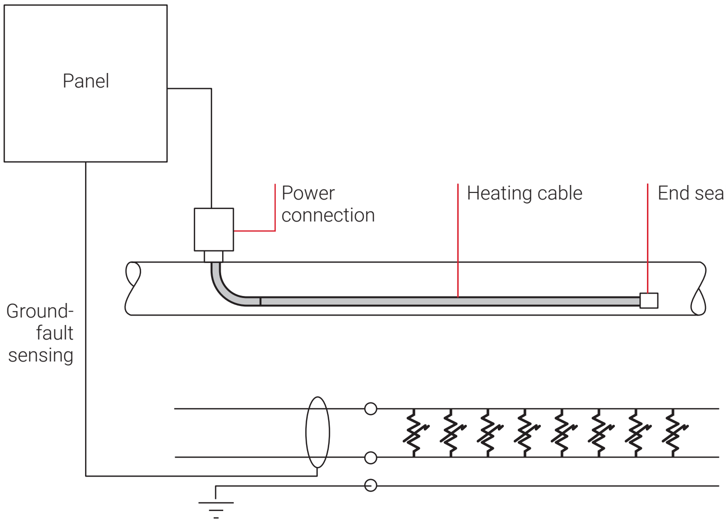


Fig. 3 Ground-fault monitoring of actual G-F current

A ground-fault monitoring system monitors the current leakage from the heating system (heating cable, power wiring, and components) to ground, using ground-leakage circuit breakers and/or current-sensing devices that measure the current. Standard circuit breakers do not provide adequate protection because they are not designed to detect the low-level ground-fault currents that may be produced as a result of improper installation or mechanical damage.

National electrical codes and other local codes require ground-fault equipment for heat-tracing circuits. These protective devices are designed to reduce the risk of fire and to safeguard equipment, rather than personnel. Ground-fault interrupters (GFIs) specified for personnel protection normally have a 4-mA to 6-mA trip setting that may lead to frequent nuisance tripping in heat-tracing applications.

When a heat-tracing circuit's current leakage exceeds the trip setting, the protective device trips, shutting off the circuit. If the protective device is a Ground Leakage Circuit Breaker (GLCB), it may have an auxiliary (bell alarm) contact to trigger a common remote trip alarm. Other protective devices can also trigger alarms, as well as interrupt the circuit.

Alarms and trips are usually caused by improper installation, mechanical damage to the heating cable or power wiring, or moisture in junction boxes or end seals. Since these are typically accompanied by ground-fault current, ground-fault detection provides a significant monitoring function for electrical heat tracing.

Strengths of ground-fault monitoring

Strengths of ground-fault monitoring include:

- Quick detection of potentially dangerous fault conditions due to improper installation, mechanical damage, or water ingress.
- Easy grouping and wiring of alarms to a remote location.

nVent provides a range of ground-fault sensors and equipment-protection GFCIs, which provide CSA and UL-approved ground-fault current protection for heating circuits.

Temperature monitoring

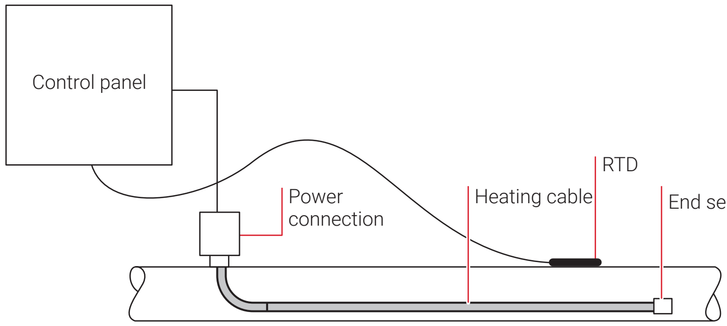


Fig.4 Temperature monitoring

Temperature monitoring systems continuously measure the pipe or tank temperature and signal an alarm if preset limits are exceeded. A digital controller uses an RTD temperature sensor placed on the pipe or tank to check the pipe temperature against the low and high limits, which are typically set 20°F (10°C) above and below the normal control range of the circuit.

Low-temperature alarms

One or more of the following conditions can cause a low-temperature alarm:

- Loss of power to the heating cable.
- Wet or missing thermal insulation.
- Heating cables with insufficient power output.
- Control failure, or controller left in OFF position.
- Heating cable failure.

High-temperature alarms

High-temperature monitoring is typical in applications such as safety showers, plastic pipes and tanks, and processes in which an overtemperature condition can adversely affect the fluid properties. Any of the following conditions can cause a high-temperature alarm:

- Fluid temperature that exceeds the alarm limit, such as during steam-cleaning operations.
- Controller failure or controller left in the ON position.
- A site installation condition that differs from the design parameters; e.g., oversized insulation.

Strengths of temperature monitoring

Following are the primary advantages of temperature monitoring:

- Dedicated to monitoring pipe temperature, the most critical aspect of heat tracing.
- Effective for monitoring failures in other systems, including thermal insulation, design, and process.
- Relatively simple to apply in any environment, with any heating system, and at any location.
- Provides timely indication of fault condition allowing repairs to be implemented before costly shutdowns or catastrophic mechanical failures occur.

Current Monitoring

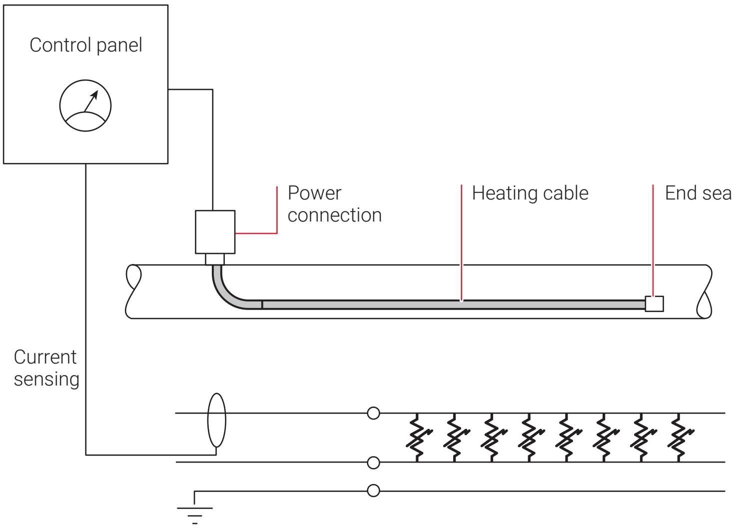


Fig. 5 Current monitoring

Current monitoring uses a heat-tracing controller or current-monitoring relay to signal an alarm when electrical current in the circuit is too low or too high. This monitoring method is especially effective for constant-wattage heating products because their current usually does not vary over time or temperature.

The current flowing in self-regulating cables will vary significantly based on the heating requirements of the pipe at a particular moment in time. Therefore, current monitoring is only effective at identifying short or open conditions for self-regulating cable.

The following conditions typically cause an alarm from a current-monitoring system:

- Loss of power to the heating cable, or a tripped circuit.
- Damage to the heating cable bus wires or branch-circuit wiring.
- Splices or tees left open after repair or maintenance.

Strengths of current monitoring

- Strengths of current monitoring include the following:
- Alarms from current monitors can be grouped in a central location.
- Power loss to the heating system is reported.
- Unpowered sections of heat-tracing cables will result in low-current alarms.

nVent RAYCHEM 910 single-point controller, 920 dual-point controller, NGC-30, and NGC-40 systems offer current monitoring with low and high alarm settings and remote annunciation.

Continuity monitoring

Continuity monitoring is a technique used to verify that the heating-cable circuit has voltage present at the far end (termination end). Continuity monitoring is often provided by a signal light installed as part of the end seal, which provides a local visual indication of voltage presence at the end of the heating-cable circuit. This equipment is called an end-of-circuit light (E-100-L-A). For remote or centralized verification that voltage is present, a transmitter can be incorporated as part of the end termination. The transmitter communicates with a centralized receiver at the near end of the circuit and confirms continuity. This equipment is called an end-of-line transmitter (SES).

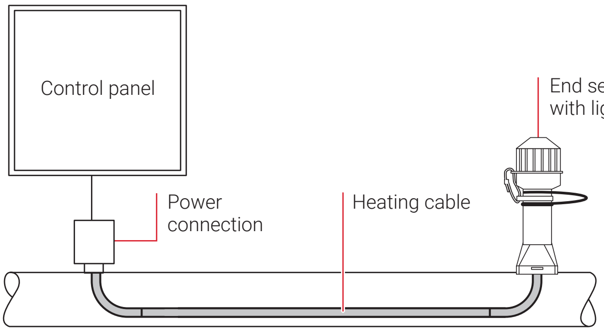


Fig. 6 Continuity monitoring with a signal light (end-of-circuit light)

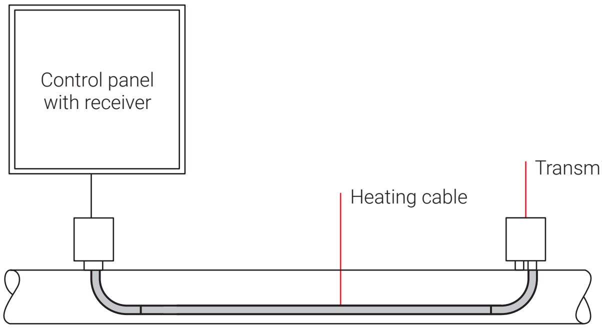


Fig. 7 Continuity monitoring with power line signal transmitter (end-of-line transmitter)

When continuity is not confirmed — either the signal light is off, or the message at the central receiver is negative — it can be due to:

- Loss of heating cable continuity; e.g., cable damaged, splice left open.
- Loss of power to the heating circuit; e.g., tripped breaker, failed thermostat, tripped ground-fault protection device.
- No call for heat from the control unit or thermostat.
- A defective light or transmitter.

Since a defective end-of-circuit light can lead to a false warning, all nVent products use long-lasting, maintenance-free LED signal lights.

Strengths of continuity monitoring

Lighted End Seals have several key advantages:

- Low installed cost; adding a light to an end seal is inexpensive.
- Upgradable critical lines; lights can be retrofitted to existing end seals.
- Heat-tracing failure detection, including damaged cables and tripped breakers.
- Simplified troubleshooting; there is no need to open junction boxes or use contact test tools.
- Used in parallel circuits with good results.

The nVent RAYCHEM lighted end seal, the E-100-L-A, provides bright LED indication at a low installed cost.

An nVent RAYCHEM end-of-line transmitter product — Smart End Seal (SES) system — can provide power line signal transmission, giving centralized continuity confirmation at an attractive cost when used with the NGC-30 panels with PLI option.

MONITORING SELECTION

Selecting a monitoring method suitable for your application is a three-step process:

1. Select the control method.
2. Identify the monitoring application.
3. Choose the monitoring method.

As with heat-tracing control, monitoring is not always required. Choose the level of monitoring appropriate to the level of criticality of your process.

Monitoring Selection
1. Select control method
2. Identify monitoring application
3. Choose monitoring method

Step 1 Select the control method

Although control and monitoring choices can be made independently, in practice, the type of control solution you select influences your monitoring choice. For example, using the nVent RAYCHEM NGC-30 or NGC-40 system for control allows easy addition of temperature monitoring.

Monitoring Selection
1. Select control method
2. Identify monitoring application
3. Choose monitoring method

Step 2 Identify the monitoring application

The sophistication of the monitoring technique generally depends on the type of heat-tracing application. Choose your application from Table 6 as you did for control selection.

TABLE 6 CATEGORIES OF HEAT-TRACING APPLICATIONS

Application	Temperature range/goal
Freeze protection	To keep water lines above 32°F (0°C) (IEEE 515-2011 Process Type I)
Broad temperature control	For viscosity control to keep process fluids flowing (IEEE 515-2011 Process Type II)
Narrow temperature control	To keep process fluids within a narrow temperature band to maintain viscosity and prevent fluid degradation (IEEE 515-2011 Process Type III)

Monitoring Selection
1. Select control method
2. Identify monitoring application
3. Choose monitoring method

Step 3 Choose the monitoring method

Freeze-protection applications

Use Table 7 to select the appropriate monitoring solution for your application. Base your selection on the number of heat-tracing circuits to be installed, the control method you've chosen, and the criticality of the process being protected. Examples of critical freeze-protection lines include process water feed lines, safety showers, and fire water lines.

TABLE 7 MONITORING SELECTION FOR FREEZE PROTECTION

Number of heat-tracing circuits	Control method	Criticality	nVent RAYCHEM monitoring method[1]	Quantity required
One or more individual heating circuits	Self-regulating (no control), ambient-sensing or line-sensing thermostat	Not critical	Ground-fault monitoring via GLCB	One GLCB per circuit
		Critical	Current temperature and ground-fault monitoring via 910[2] and 920[2]	One per every one (910) or two (920) circuits
Multiple circuits	Ambient-sensing, line-sensing, or energy-saving proportional control	Not critical	Ground-fault monitoring via GLCB	One GLCB per circuit with one common alarm for panel
		Critical	Current, temperature and ground-fault monitoring via NGC-30 or, NGC-40[2]	One per system

1. Add the E-100-L-A lighted end seal to any choice for easier troubleshooting.
2. Replace the mechanical or electronic thermostat you selected under “Control Selection” with this unit.

Broad temperature control applications

Use Table 8 to select the appropriate monitoring solution for your application. Base your selection on the number of heat-tracing circuits to be installed, the control method you've chosen, and the criticality of the process being traced. Criticality for broad temperature control generally means the system should alarm when pipe or tank temperature drops below a predetermined limit.

TABLE 8 MONITORING SELECTION FOR BROAD TEMPERATURE CONTROL

Number of heat-tracing circuits	Control method	Criticality	nVent RAYCHEM monitoring method[1]	Quantity required
One or more individual heating circuits	Self-regulating (no control), or line sensing thermostat	Not critical	Ground-fault monitoring via GLCB	One GLCB per circuit
		Critical	Current temperature and ground-fault monitoring via 910[2] and 920[2]	One per circuit
Multiple circuits	PASC or multicircuit line sensing control	Not critical	Ground-fault monitoring via GLCB with common alarm to controller	One GLCB per circuit
		Critical	Current, temperature and ground-fault monitoring via NGC-30 or NGC-40[2]	One per system

1. Add the E-100-L-A lighted end seal to any choice for easier troubleshooting.
2. Replace the mechanical or electronic thermostat you selected under "Control Selection" with this unit.

Narrow temperature control applications

Use Table 9 to select the appropriate monitoring solution for your application. Base your selection on the number of heat-tracing circuits to be installed and the control method you've chosen. All narrow control applications are considered critical.

TABLE 9 MONITORING SELECTION FOR NARROW TEMPERATURE CONTROL

Number of heat-tracing circuits	Control method	Criticality	nVent RAYCHEM monitoring method[1]	Quantity required
One or more individual heating circuits	Line sensing thermostat	Critical	**Temperature monitoring** via 910[2] or 920[2]	One per circuit
Multiple circuits	Multicircuit line sensing control	Critical	**Temperature monitoring** via NGC-30 or NGC-40[2]	One per system

1. Add the E-100-L-A lighted end seal to any choice for easier troubleshooting.
2. Replace the mechanical or electronic thermostat you selected under "Control Selection" with this unit.

Additional Considerations

The selection tables in this section provide control and monitoring solutions for the majority of heat-tracing applications. Review the following additional considerations and discuss any unusual applications or requirements with your nVent representative.

If your design selection includes a mechanical thermostat and ground-fault circuit breaker for each heat-tracing circuit, consider instead using the 910 single-point controller or 920 multipoint controller. These replace both the mechanical thermostat and the ground-fault circuit breaker, and provide temperature, ground-fault, and current monitoring in a rugged industrial package.

If multiple heat-tracing circuits are to be installed at the same time, there are significant opportunities for installation, operation, and maintenance cost savings. nVent representatives can help optimize your system by choosing the best combination of heat-tracing products and control and monitoring systems.

If you plan to connect your heat-tracing control and monitoring equipment to a host computer or DCS in your facility, consider the 910, 920, NGC-30 or NGC-40. All offer extensive networking capabilities, as well as computer-based Supervisor software.

If your application requires long runs of temperature-sensor cable or conduit, consider a NGC-30 system with power-line interface modules (PLIs) or the NGC-30 with the RMM2. The NGC-30 line sensing control and temperature monitoring system with the PLI transmits temperature data over the heating cable bus wires and branch circuits, significantly reducing the cost of temperature sensor cable or conduit runs.

The RMM2 is an 8-point RTD module located in the field. Up to 16 RMM2 modules can be connected together via RS485 twisted pair cable back to the NGC-30 or NGC-40 controller.

PART 2: CONTROL AND MONITORING SYSTEMS

NVENT CONTROL AND MONITORING SYSTEMS

Compare features of nVent control and monitoring systems in Table 10.
For additional information on each product, see the descriptions that follow and the data sheets.

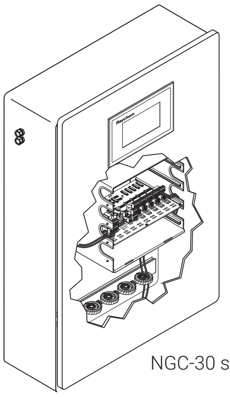
TABLE 10 NVENT CONTROL AND MONITORING PRODUCTS

	Thermostats		Controllers				
	Ambient	Line	nVent RAYCHEM NGC-30	nVent RAYCHEM NGC-40	nVent RAYCHEM 910 / 920	nVent RAYCHEM JBS-100-ECP-A / JBS-100-ECW-A	nVent RAYCHEM RAYSTAT EX-03-A
Control							
Ambient-sensing	•		•	•	•	•	
Line-sensing		•	•	•	•	•	•
PASC			•	•	•		
RTD input			•	•	•	•	•
Monitoring							
Ambient temperature			•	•	•	•	
Pipe temperature			•	•	•	•	•
Ground fault			•	•	•		
Continuity			•				
Current			•	•	•		
Location							
Local	•	•	•	•	•	•	•
Remote			•	•		JBS-100-ECW-A only	
Hazardous	•	•	•	•	•		•
Communication							
Local display			•	•	•	•	
Remote display			•	•	•		
Network DCS			•	•	•	•	
Supervisor			•	•	•		

MICROPROCESSOR-BASED CONTROLLERS

These electronic systems are designed to control heating-cable circuits used in freeze protection and process-temperature maintenance applications. Each has unique features that provide cost-effective temperature control and extensive heat-tracing circuit integrity monitoring. All offer digital displays, simple push-button configuration, and intelligent communications to remote PCs or a DCS. Choose the 910 for single heat-tracing circuits, the 920 for dual heat-tracing circuits, NGC-30 or NGC-40 for multiple heat-tracing circuits.

Multipoint Control and Monitoring Systems



NGC-30 system

NGC-30 System

The NGC-30 system is a next generation heat-tracing control and monitoring system using state-of-the-art electronics and a touch screen user interface terminal to reduce training and greatly increase ease of use. Able to control up to 260 heat-tracing circuits, the NGC-30 provides independent circuit monitoring, programming and fault reporting for maximum system flexibility. Faults and alarms are communicated in plain text via the touch screen user interface terminal, enhancing usability and reducing troubleshooting time.

Compatible with Ethernet, RS-485 and RS-232 communications, the NGC-30 system can be easily integrated into existing plant networks. Supervisor software can be used to provide remote or centralized access to the NGC-30 System and establish a stand-alone heat-tracing control point. The NGC-30 communicates to external systems via the Modbus protocol if compatibility with existing DCS systems is desired.

The NGC-30 is available with both electromechanical or solid-state relays and is approved for both hazardous and nonhazardous locations.

Control

The NGC-30 measures temperatures with 3-wire, 100-ohm platinum RTDs. The temperature information can be transferred to the NGC-30 control panel through an RTD directly connected to the NGC-30 panel, through an optional nVent RAYCHEM Remote Monitoring Module (RMM2) or through an optional PLI Module with special transmitters: nVent RAYCHEM SES (Smart-End-Seal), nVent RAYCHEM SPC (Smart Power Connection). Each RMM2 aggregates up to 8 RTDs in the field. The RMM2 and PLI modules communicate temperature data back to the NGC-30 system via a single RS-485 twisted wire pair.

Power Line Carrier Interface Technology

The nVent RAYCHEM Power Line carrier Interface Module (PLI) is an optional part of the NGC-30 heat-tracing control and monitoring system. When using Power Line Interface Technology (PLI), the RTD temperature information and the continuity confirmation are sent back through special transmitters, SES/SPC, to the PLI Module and the NGC-30 controller along the heat-tracing bus wires and the AC power line, meaning the heating able is also the data cable. Since no additional wiring is required to bring RTD temperature and continuity data back to a central location, installation and maintenance costs of the heat-tracing system are significantly reduced.

Monitoring

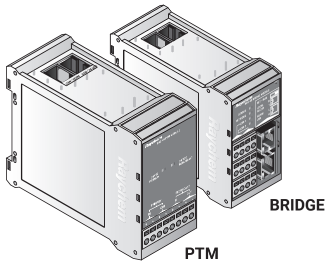
The NGC-30 system measures 12 parameters including ground-fault, temperature and current variables to ensure system integrity. The NGC-30 units can monitor up to 16 RMM2s that each have inputs for eight temperature sensors (RTD). The RMM2s can be connected by a single RS-485 cable to the NGC-30, thus reducing wiring costs for temperature sensors. Power line carrier communication can further reduce wiring costs because the heat-tracing bus wires and the AC power lines carry the temperature information signal back to a PLI, which interfaces with the NGC-30 controller. This eliminates the need for RTD wiring or field RS-485 cable. Three (3) dry contact alarm relays are provided for remote alarm indications if desired. The system allows configuration of what fault types cause relay state change. For example, one relay could be configured to indicate only when a ground-fault alarm exists, another only in response to a temperature alarm and the third for over current and communications and RTD sensor failures. The system can be set to periodically check for heating cable faults when conditions do not require the heat tracing to be energized for extended periods. If a problem occurs, maintenance personnel will be notified and the issue can be repaired before it effects plant operation.

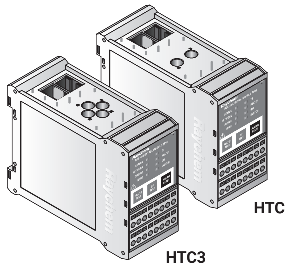
Benefits and Features

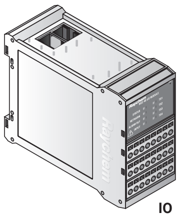
- Optimized control mode for each individual heat-tracing circuit. Each of the 260 heat-tracing circuits can be set to one of five control algorithms independently of the setting of any other heat-tracing circuits. There are no global settings at the circuit level.
- Central status overview and access to all parameters of the entire heat-tracing installation through the touch screen user interface terminal. This intuitive interface reduces training time and provides simple and easy navigation so that maintenance and operations personnel can retrieve the information they need quickly and without bulky reference manuals.
- Faults are communicated in plain language eliminating the need to remember or decipher fault codes.
- Alarms for temperatures, ground-fault currents, operating currents, communications, RTD status and others are all logged in an Events file to track system history. Information is easily accessible through the user interface terminal which also provides the ability to sort on the various fault types.
- Ground-fault alarm and trip thresholds are independently programmable to allow warning of a potential problem before a system shut-down is implemented. This allows the heat-tracing system to be checked at a convenient time with minimal impact to plant operations and hardship to personnel.
- Significant cost savings through distributed architecture and reduced RTD wiring (using the RMM2). Temperature input and control output modules can be placed at a convenient location.
- Supports power line carrier option to eliminate the need for separate RTD wiring, field communication cables and conduit installation costs.
- Supervisor client-server software allows heat-tracing control to become an integral part of your Heat Management System. This software provides information and configuration capability at one central location making better use of personnel. Data logging for trending, fault finding and other analysis allows predictive maintenance when using the Supervisor client-server software including automatic heat-tracing system integrity checks and many more features.
- LAN/WAN access allows control and monitoring from any location worldwide.

Other Features

- Passwords provide various levels of access for different user groups. This allows all necessary status and monitoring information to be viewed by anyone but restricts temperature setpoint and fault threshold changes to certified personnel.
- Rack mountable control cards are easily added and removed from the NGC-30 system panel. This allows fast and easy replacement in the case of a failure or the ability to expand the system as your facility grows.







NGC-40 system

The NGC-40 is an advanced, electronic, single-point control, monitoring and power distribution system in a multipoint industrial heat-tracing panel. The single control module per heat-tracing circuit provides the highest reliability architecture for heat-tracing applications. The NGC-40 single-controller architecture ensures that problems occurring with one heat-tracing system stay isolated without affecting the other circuits. The advanced User Interface with touch screen technology simplifies local programming and monitoring through intuitive menus and full text alarm reporting.

The NGC-40 supports up to 80 circuits and provides maximum flexibility through its modular architecture to meet any need at an optimized cost. The NGC-40 is available with two output types: an electromechanical relay (EMR) or a solid state relay (SSR). The system is fully flexible from a configuration point of view and offers individual single-phase and three-phase electrical heat-tracing controllers.

The NGC-40 is supported by the innovative Touch 1500, a 15-inch color touch screen user interface which provides plant personnel with local, intuitive access to the complete control and monitoring system. The Touch 1500 allows for status, alarm and event monitoring of the heat-tracing circuits as well as the easy adjustment of the control and monitoring system to handle revised heat-tracing system configurations.

Full compatibility with the Supervisor software allows not only control and monitoring but also data logging for trending, fault finding and other analysis allows predictive maintenance.

Control

The NGC-40 measures temperatures with 3-wire, 100-ohm platinum RTDs, 2 or 3-wire, 100-ohm nickel iron RTDs, or 2-wire, 100-ohm nickel RTDs. The temperature information may come from a single, direct RTD hard-wired to the NGC-40 control panel, from a local NGC-40 IO module, or from a remote source such as an RMM2 module. Up to eight (8) Resistance Temperature Devices (RTDs) can be used for each heat-tracing circuit allowing a variety of temperature control, monitoring, and alarming configurations. For RTD selection, see Table 11 Selection Matrix.

Monitoring

The NGC-40 system measures a variety of parameters including ground-fault, temperature and load current(s) to ensure system integrity. In the case of three-phase heaters, the current of each phase can be separately measured and monitored. The system can be set to periodically check the heating cable for faults, alerting maintenance personnel of a pending heat-tracing problem, and avoiding costly downtime.

Features

- Each circuit is controlled by individual single-phase or three-phase controllers.
- Control and monitoring of up to 80 individual circuits per panel with multiple panels connected to one Touch 1500 user interface.
- The NGC-40 system is configured with a user interface, Touch 1500, that is a state-of-the-art 15-inch color display with touch screen technology for monitoring and configuration purposes. The Touch 1500 touch screen allows convenient user access on site to all heat-tracing circuits and provides an easy user interface for programming without keyboards or cryptic labels.
- Touch 1500 can be installed either locally on the panel door or in a remote location and communicates to the NGC-40 heat-tracing controllers via Ethernet or serial interface.
- I/O modules allow additional temperature and analog/digital signals to interface with the control modules. Up to 8 RTDs can be assigned to one heat-tracing circuit.
- Each NGC-40 control module (HTC, HTC3) and I/O module provides one programmable multi-purpose digital input for connection to external dry (voltage-free) contact or DC voltage.

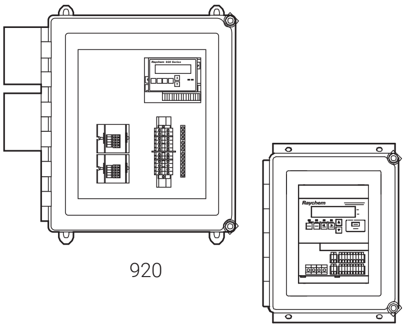
- A dry contact relay per control module and a common alarm is available for alarm annunciation back to a Distributed Control System (DCS). Alternatively, the NGC-40 system can report alarm and monitoring data directly to the DCS via Modbus.
- Many heat-tracing related control algorithms available like ON/OFF, ambient sensing, PASC (Proportional Ambient Sensing Control) and proportional control (if used with solid state relays).
- The NGC-40 control modules operate independently from the user interface touch screen (TOUCH 1500) for increased system reliability. A failure of the TOUCH 1500 will not cause the heat-trace controllers to fail.
- NGC-40 is designed for easy installation and requires minimal wiring on site. All NGC-40 units are packaged in DIN rail mount housings, suitable for installation onto symmetric 35 mm DIN rails. Panel wiring is minimized by using internal network.
- Alarm Output: Each controller monitors and alarms on high or low temperature, load current and ground-fault alarm and trip points set at user defined levels. As required by the NEC and CEC, as an Equipment Protection Device, the controller switches all hot legs of a circuit for ground fault interruption.
- Power and current control on heat-tracing circuits to reduce inrush currents and unnecessary circuit breaker trips.
- Autocycling: The controller will momentarily energize the heat tracing at a user set interval and provide feedback if there are any problems with the heat trace.
- Circuit alarms will be generated as the fault occurs thereby reducing costs of preventative maintenance.
- The Supervisor software package provides a remote, graphic interface for the NGC-40. The software allows the user to configure and monitor various NGC systems from a central location. Supervisor provides various levels of access for different user groups.

Benefits

- Individual circuit control by single circuit controllers provides highest reliability architecture for critical heat tracing circuits.
- Strategic location of Touch 1500 user interface linked to a group of heat-tracing panels leads to optimized maintenance activities.
- The touch screen interface (Touch 1500) provides local, easy, intuitive access to configuration, status, alarms and events of the heat-tracing system.
- Maximum flexibility in heat-tracing control design by using the innovative data sharing among the heat tracing circuits within a panel, as well as, the programmable digital inputs and alarm outputs of each control module.
- Modular System provides maximum flexibility to meet any need at an optimized cost. Individual control and standard communication wiring leads to flexible and optimized panel design to customer requirements.
- Choosing the right control algorithm leads to the most optimized heat-tracing solution by minimizing the energy consumption and installation cost.
- Permanent supervision of the integrity of the heat-tracing circuit and detailed problem reporting simplifies maintenance and increases personnel safety.
- Control on inrush currents leads to the reduction of panel power requirements and therefore significant savings on power distribution costs.
- Controls and monitors any type of heat-tracing cable.

- Central monitoring and configuration via Supervisor Software provides an audible alarm tone, the ability to acknowledge and clear alarms, and contains advanced features such as data logging, trending, implementing changes in batches, fault finding and other useful functions that help streamline operations and maintenance activities.

Single- and Dual-Point Control and Monitoring Systems



910 and 920 controllers

The 910 single-point controller and the 920 dual-point controller sense pipe or tank temperatures to provide tight temperature control for process maintenance applications. They also feature continuous monitoring technology to detect heat-tracing faults, monitor heat-tracing current, and provide networking capabilities. The integral ground-fault protection eliminates the need to install ground-fault circuit breakers, which is especially useful when upgrading or retrofitting new heat-tracing circuits using existing circuit-breaker panels.

Select the 910 and 920 when designing single or dual heat-tracing circuits that require line sensing control and ground-fault protection. Both controllers are available as either single or double-pole units. The double-pole units switch both heat-tracing circuit power wires. Select the double-pole versions in phase-phase power situations such as 208 and 240 Vac.

The 910 and 920 are CSA certified (U.S. and Canada) for use in nonhazardous or Zone 2 hazardous locations. The 920 is also approved by FM.

Reliable control

The units control heat-tracing circuits based on temperature measured by up to two RTD sensors. The heat-tracing circuit is switched by an internal 30 A solid-state relay using either on-off or proportional control. Other current ratings and devices are also available.

Complete monitoring

Monitoring functions ensure that the heat-traced process runs as designed by providing local and remote feedback on important heat-tracing parameters such as:

- Pipe temperature
- Heating cable system ground-fault level
- Heating cable current draw
- RTD sensor integrity
- Controller failure

When the heat-tracing circuit is interrupted, the 910 and 920 controllers detect and signal the fault condition and alert maintenance personnel, thus avoiding frozen pipes, process fluid degradation, and other costly problems.

Easy installation

The units are ready to install right out of the box, eliminating the need for custom panel design and field assembly. Wiring is as simple as connecting incoming and outgoing power wiring and an RTD. An alarm relay is provided for remote annunciation.

Simple operation

Both the 910 and 920 front panels have an LED display, status LEDs, dedicated function keys, and full-text descriptions that make the units easy to configure and operate. All settings are stored in nonvolatile memory in the event of power failure.

910 and 920 units can be connected in a network to a central PC running Supervisor or plant DCS. All settings, operating parameters, and alarms may be accessed from a central location, reducing the need to dispatch maintenance personnel to field-mounted controllers.

Features

- Controls and monitors one or two heat-tracing circuits (up to 30 or 60 Amps).
- Senses pipe or ambient temperature with RTDs (see "Table 11" RTD Selection Matrix).
- Operates on any voltage from 100 Vac to 277 Vac.
  Note: Phase-phase systems may require double-pole versions.
- Replaces ground-fault circuit breakers with integral ground-fault protection.
- Provides alarms for low and high temperature, low and high current, low and high voltage, ground leakage, damaged RTD sensor, solid-state relay failure, microprocessor failure.
- Includes alarm relay contacts and network communication capability for remote annunciation and configuration.
- Operates reliably with industrial electronics enclosed in a rugged TYPE 4X FRP enclosure.
- Approved for use in nonhazardous or Zone 2 hazardous locations.

Benefits

- Alerts maintenance personnel of a heat-tracing interruption and advises the exact nature of any problems as they occur.
- Realizes significant maintenance labor cost savings, since heat-tracing system inspections are easier.
- Easy to program, operate, and interpret normal alarm conditions.

Saves time and money

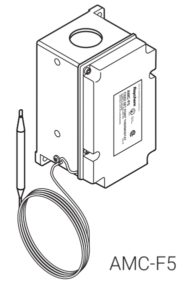
- System includes ground-fault interruption to fulfill the requirements of national electrical codes.
- Lowest installed cost in the market for comparable technological features.
- Single-unit simplicity of the 910 and 920 makes installation easy.
- Eliminates the need to purchase additional handheld programming devices or thermostats.

Expands to meet your needs

- 910 and 920 units can be networked to a central PC running Supervisor to provide a complete overview of the heating system, and additional units can be added as needed.
- Easy-to-use Supervisor software provides complete setup and monitoring from a single location.

THERMOSTATS

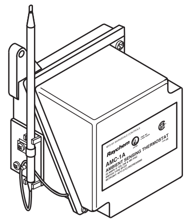
Ambient-Sensing Thermostats


AMC-F5

These thermostats are used to control heating cable circuits in freeze protection applications. When the outdoor temperature drops below the set point, the thermostat switches on. Control multiple circuits by connecting the thermostat to the coil of a contactor.

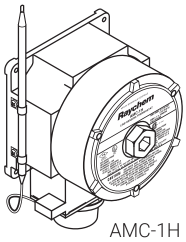
AMC-F5

This thermostat has a fixed set point of 40°F (5°C) and is used for freeze protection applications. The SPST switch, rated 480 Vac, 22 A, is enclosed in a plastic TYPE 4X enclosure. The tin-plated copper sensor assembly is 30 inches long. The unit is UL Listed and CSA certified for use in nonhazardous locations. Select this low-cost thermostat for areas not subject to mechanical abuse.


AMC-1A

AMC-1A

This thermostat has an adjustable set point between 15°F and 140°F (–9°C and 60°C) and is used for freeze protection applications. The TYPE 4X enclosure is coated cast aluminum with stainless steel hardware. The switch is rated 480 Vac, 22 A. The stainless steel sensor assembly is permanently mounted to the enclosure. The unit is UL Listed and CSA certified for use in nonhazardous locations. Select this thermostat where set-point adjustment or mechanical ruggedness is important.

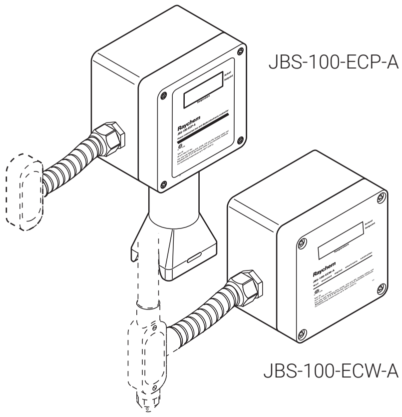

AMC-1H

AMC-1H

This is the hazardous location–approved version of the AMC-1A. It includes a TYPE 4, 7, 9 coated cast-aluminum enclosure and is approved by FM, UL Listed, and CSA certified for use in Division 1 and 2 hazardous locations. Select this thermostat when the control unit must be located in a hazardous location.

Line-Sensing Thermostats

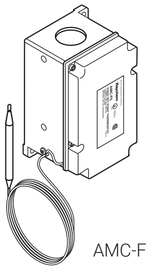
These thermostats are used to control heating cable circuits used in freeze protection and process-temperature maintenance applications. All can be used to switch a heat-tracing circuit directly or switch the coil of a contactor. Those with adjustable set points can be used instead to indicate low- or high-temperature alarm conditions.


JBS-100-ECP-A

JBS-100-ECW-A

JBS-100-ECP-A and JBS-100-ECW-A

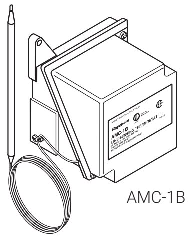
The JBS-100-ECP-A and JBS-100-ECW-A are electronic temperature controllers that provide accurate control of a heating circuit using a RTD sensor. The JBS-100-ECP-A is pipe mounted and serves as a power connection kit for self-regulating, power-limiting and mineral insulated heating cables. The JBS-100-ECW-A is wall mounted and may be used with all types of heating cables. The JBS-100-ECW-A can only be used as a power connection with mineral insulated cables. Combining the power connection and controller into one single unit will significantly reduce installation cost. Both the JBS-100-ECP-A and JBS-100-ECW-A have adjustable set points between 32°F to 425°F (0°C to 218°C), power input of 120 Vac to 277 Vac, and switches current up to 30 A. A local display allows for monitoring of set point, actual temperature, and also indicates alarm conditions (high/low temperature and sensor failure). A form C contact allows for remote annunciation of alarms. These units are c-CSA-us (certified to U.S. and Canadian Standards) for use in nonhazardous locations.



AMC-F5

AMC-F5

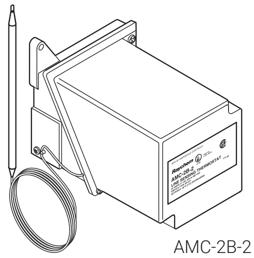
This low-cost thermostat has a fixed set point of 40°F (5°C) and is used for freeze protection. The SPST switch, rated 480 Vac, 22 A, is enclosed in a plastic TYPE 4X enclosure. The tin-plated copper sensor assembly is 30 inches long. The unit is UL Listed and CSA certified for use in nonhazardous locations. Select this low-cost thermostat when using line sensing control for freeze protection in areas not subject to mechanical abuse.



AMC-1B

AMC-1B

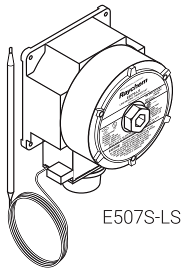
This thermostat has an adjustable set point between 25°F and 325°F (–4°C and 163°C). The TYPE 4X enclosure is coated cast aluminum with stainless steel hardware. The SPDT switch is rated 480 Vac, 22 A. The stainless steel sensor assembly is 9 ft (3 m) in length. The unit is UL Listed and CSA certified for use in nonhazardous locations. Select this thermostat where set point adjustment or mechanical ruggedness is important.



AMC-2B-2

AMC-2B-2

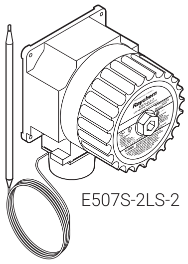
This is the two-pole version of the AMC-1B. It has an adjustable setpoint between 25°F and 325°F (–4°C and 163°C). The control switch in this thermostat opens both heat-tracing circuit power wires. Select this thermostat when local safety standards require that both phases be switched in phase-to-phase supplies such as 208 and 240 Vac. The unit is UL Listed and CSA certified for use in nonhazardous locations. Select this thermostat where set point adjustment or mechanical ruggedness is important.



E507S-LS

E507S-LS

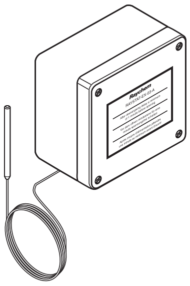
This is the hazardous location–approved version of the AMC-1B. It has an adjustable setpoint between 25°F and 325°F (–4°C and 163°C). It includes a TYPE 4, 7, 9 coated cast-aluminum enclosure and is approved by FM, UL Listed, and CSA certified for use in Division 1 and 2 hazardous locations. Select this thermostat when the control unit must be located in a hazardous location.



E507S-2LS-2

E507S-2LS-2

This is the two-pole version of the E507S-LS. It has an adjustable setpoint between 25°F and 325°F (-4°C and 163°C). The control switch in this thermostat opens both heat-tracing circuit power wires. Select this thermostat when local safety standards require that both phases be switched in phase-to-phase supplies such as 208 and 240 Vac. It includes a TYPE 4, 7, 9 coated cast-aluminum enclosure and is approved by FM, UL Listed, and CSA certified for use in Division 1 and 2 hazardous locations. Select this thermostat when the control unit must be located in a hazardous location.



RAYSTAT-EX-03-A

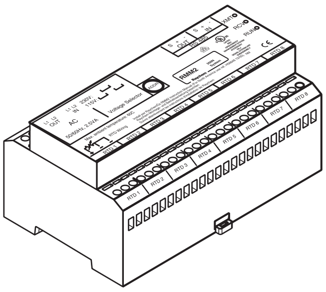
RAYSTAT-EX-03-A

This is an electronic line sensing thermostat particularly suited for high-temperature applications, with an adjustable set point to 930°F (499°C). The unit has a DPDT switch rated 277 Vac, 16 A, inside a TYPE 4X polymeric enclosure. The preinstalled stainless steel RTD sensor assembly is 6 ft (2 m) long. The unit is c-FM-us (approved for US and Canadian standards) for use in Zone 1 or Division 2 hazardous locations. Select this thermostat for high-temperature applications or for precise temperature control.

TEMPERATURE SENSORS

nVent provides a variety of temperature sensing solutions. From RTDs to temperature aggregation and communications, nVent RAYCHEM products meet every application need and help reduce installation costs.

RMM2 (Remote Monitoring Module)

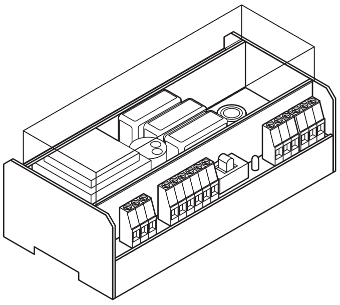


The nVent RAYCHEM remote monitoring module (RMM2) provides temperature monitoring capability for the NGC-30 and NGC-40 heat-tracing control and monitoring systems. The RMM2 accepts up to eight RTDs that measure pipe, vessel, or ambient temperatures in a heat-tracing system. The RMM2 modules are used to aggregate RTD wires in one remote location and send the information back to the control system through a single twisted pair cable. This helps reduce installation costs since only one conduit run returns to the controller, rather than eight. Multiple RMM2s communicate with a single NGC-30 or NGC-40 to provide centralized monitoring of temperatures. A single, twisted pair RS-485 cable connects up to 16 RMM2s for a total monitoring capacity of 128 temperatures.

Each temperature sensor connected to a RMM2 may have individual low- and high-temperature alarms. Alarm limits are set and alarm conditions are reported at the NGC-30 or NGC-40 control panel. Additional alarms are triggered for failed temperature sensors and communication errors. Alarms may be reported remotely through an alarm relay in the control system or through an RS-485 connection to a host computer supporting the Modbus protocol.

The RMM2 clips to a DIN 35 rail and can be mounted in a choice of enclosures, as required for the area classification and environment. For aggressive environments and Division 2 hazardous locations, nVent offers a glass-reinforced polyester TYPE 4X enclosure.

PLI (Power-Line Carrier Interface)



nVent RAYCHEM power-line carrier interfaces (PLI) modules provide temperature-monitoring capability for the NGC-30 heat-tracing control and monitoring unit. The PLI receives input from the power wires for the heat-tracing circuits, which carry the signals from special transmitters. The transmitters provide pipe temperatures from RTDs and continuity confirmation; they are typically located at the unpowered end of the heat-tracing line.

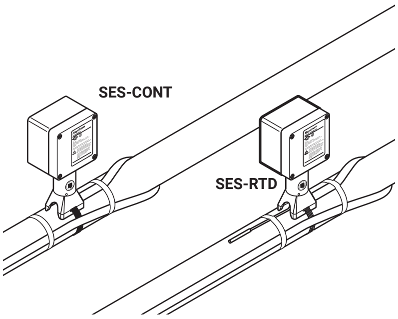
A single twisted-pair RS-485 cable connects up to four PLI modules to a NGC-30.

The PLI system uses frequency-shift keying to encode digital data on the power-line network. Digital ones and zeros are transmitted by coupling high-frequency signals onto the heat-tracing bus wires and the AC power line. The digital data are transmitted in packets that contain error-checking fields to validate the correctness of the data. Since no additional wiring is required to bring temperature and continuity data back to a central location, installation and maintenance costs are significantly reduced.

The PLI modules are designed to be local to the distribution transformer that supplies power to the heat-tracing circuits. Only one PLI module may be used on the secondary side of each heat-tracing transformer. A filter (MoniTrace 700-FEF) is required on the primary side of each transformer to provide electrical noise isolation between the plant environment and the heat-tracing power-line network environment. This ensures that transmissions between the PLI module and the transmitters, SES (Smart End Seal) or SPC (Smart Power Connection), are reliable and error-free.

The PLI module is an electronic device mounted in an enclosure that is to be clipped to a DIN 35-mm rail in a nonhazardous, indoor location only.

SES Transmitter (Smart End Seal)



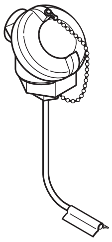
The nVent RAYCHEM SES series of transmitters is used in conjunction with the PLI and comes in two types: temperature/continuity transmitter (SES-RTD) and continuity transmitter (SES-CONT). These transmitters are used in freeze protection and process temperature maintenance applications. The system is unique in that the heating cable bus wires and power cables carry the monitoring signals. No additional field wire is necessary.

The SES-RTD transmitter (typically placed at the end of a heater circuit) replaces conventional RTD sensing elements and associated wiring, sending temperature and continuity information to the central microprocessor-based controller. The SES-CONT provides heater continuity only. The SES is designed for use only with nVent RAYCHEM brand BTV, QTVR, XTV, KTV and VPL parallel heating cables.

The SES transmitter requires a programmable controller (NGC-30), a power line carrier interface (PLI) module, and power-switching contactor panel. Up to 127 strategically placed SES transmitters communicate with one PLI (one PLI per heat-tracing transformer). A total of four PLIs can be connected to each NGC-30 panel.

The SES system requires a dedicated heat-tracing transformer (only the heat-tracing can be connected to the transformer) and MoniTrace 700-FEF front end filter to provide electrical noise isolation between the plant environment and the heat-tracing power in network environment. This ensures that transmission between the PLI module and the SES transmitters is reliable and error-free.

RTDs



nVent RAYCHEM RTDs (Resistive Temperature Detectors) are used to sense ambient or line temperatures and provide feedback to control device. A variety of materials and construction techniques provide solutions for all temperature-sensing requirements. Refer to the table below for product selection.

TABLE 11 RTD SELECTION MATRIX

Catalog number	Maximum exposure	Approvals	Application
RTD-200	200°F (93°C)	Approval associated with control device. Not to be used in Division 1 hazardous locations.	Use when ambient RTD sensor is required.
RTD3CS	400°F (204°C)	Approval associated with control device. Not to be used in Division 1 hazardous locations	Used for pipes or tanks when controller is 3 feet or less from bulb placement. Use RTD extension wire/conduit (terminated in the appropriate enclosure for the area classification) to extend the lead wire to the required length. Not to be used for underground applications.
RTD10CS	400°F (204°C)	Approval associated with control device. Not to be used in Division 1 hazardous locations	Used for pipes or tanks when controller is 10 feet or less from bulb placement. Use RTD extension wire/conduit (terminated in the appropriate enclosure for the area classification) to extend the lead wire to the required length. Not to be used for underground applications.
RTD4AL	900°F (482°C)	CSA (U.S. & Canada) Class I, Div. 2, Groups A, B, C, D Class II, Div. 2, Groups F, G	Used for pipes and includes junction box to extend the lead wire to the required length using RTD extension wire/conduit.
RTD7AL	900°F (482°C)	CSA (U.S. & Canada) Class I, Div. 1, Groups C, D Class II, Div. 1, Groups E, F, G	Used for pipes and includes junction box to extend the lead wire to the required length using RTD extension wire/conduit.
RTD10	1100°F (593°C)	CSA (U.S. & Canada) Class I, Div. 1 & 2, Groups A, B, C, D Class II, Div. 1 & 2, Groups E, F, G Class III	Used for pipes or tanks when controller is 10 feet or less from bulb placement. Use RTD extension wire/conduit (terminated in the appropriate enclosure for the area classification) to extend the lead wire to the required length. Additional lengths are available; contact nVent for additional information.
RTD20	1100°F (593°C)	CSA (U.S. & Canada) Class I, Div. 1 & 2, Groups A, B, C, D Class II, Div. 1 & 2, Groups E, F, G Class III	Used for pipes or tanks when controller is 20 feet or less from bulb placement. Use RTD extension wire/conduit (terminated in the appropriate enclosure for the area classification) to extend the lead wire to the required length. Additional lengths are available; contact nVent for additional information.

HEAT-TRACE PANELS

This section will help you design and select a dedicated heat-tracing power distribution panel. For design assistance, please contact your nVent representative or phone nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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INTRODUCTION

HTPG and HTPI panels are a cost-effective and convenient means of providing ground-fault protection to heat-tracing circuits.

nVent offers two types of heat-trace panels: the nVent RAYCHEM brand HTPG (Heat-Tracing Panel Group Control) and HTPI (Heat-Tracing Panel Individual Control). These distribution panels have the option of using ground-fault circuit breakers (30-mA trip level). Per national electrical codes and nVent requirements, ground-fault protection must be provided for each heat-tracing circuit. The HTPG and HTPI panels are a cost-effective and convenient means to provide this protection. nVent also supplies specialty panels for specific project requirements. Contact your nVent representative for additional information.

SYSTEM OVERVIEW

Fig. 1 represents a typical heat-tracing power distribution system. At the Motor Control Center (MCC) the voltage is reduced to the level required for the heat tracing. The transformer supplies this reduced voltage to the distribution panelboard, which contains the main circuit breaker and branch circuit breakers. From the branch circuit breakers (CB), the voltage is transferred to the heater's power connection box via wire/conduit or cable. This section will assist you in sizing and specifying the transformer and heat-tracing panel.

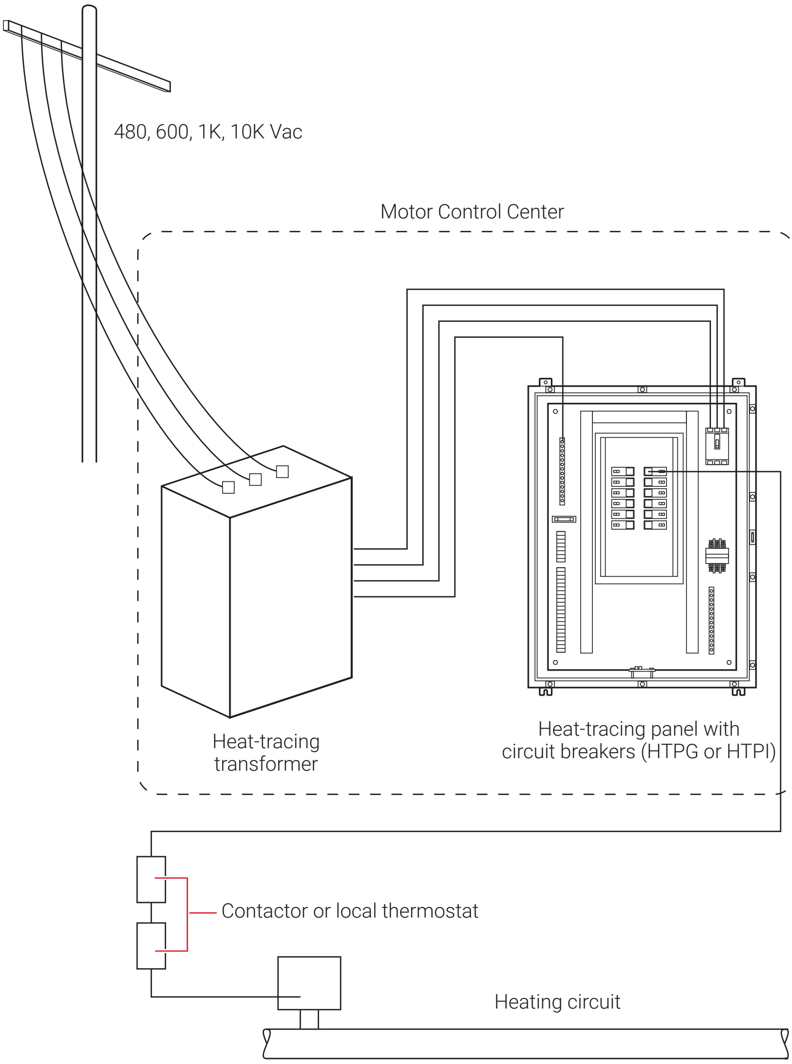


Fig.1 Typical heat-tracing power distribution system

Heat-Trace Panels — Group Control

HTPG

The HTPG is a dedicated power distribution, control, ground-fault protection, monitoring, and alarm panel. This system is used for freeze protection control, broadband maintenance temperature control, or applications in which multiple circuits (branch circuit breakers) are energized at one time.

A typical HTPG panel includes a wall-mounted enclosure, assembled panelboard, main contactor, main circuit breaker, Hand/Off/Auto switch, contactor-energize light, and door disconnect handle.

Fig. 2 shows a typical HTPG panel layout. This wall-mounted enclosure contains an assembled panelboard, main contactor, main circuit breaker, Hand/Off/Auto switch, and contactor-energize light. The panel has options for terminal blocks, alarm relay (form C contacts), common alarm light, door disconnect handle, and alarm horn.

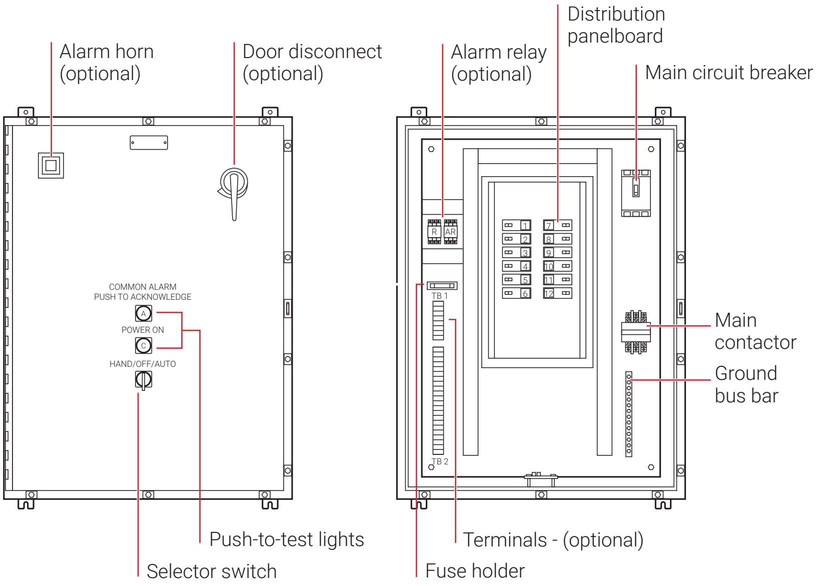
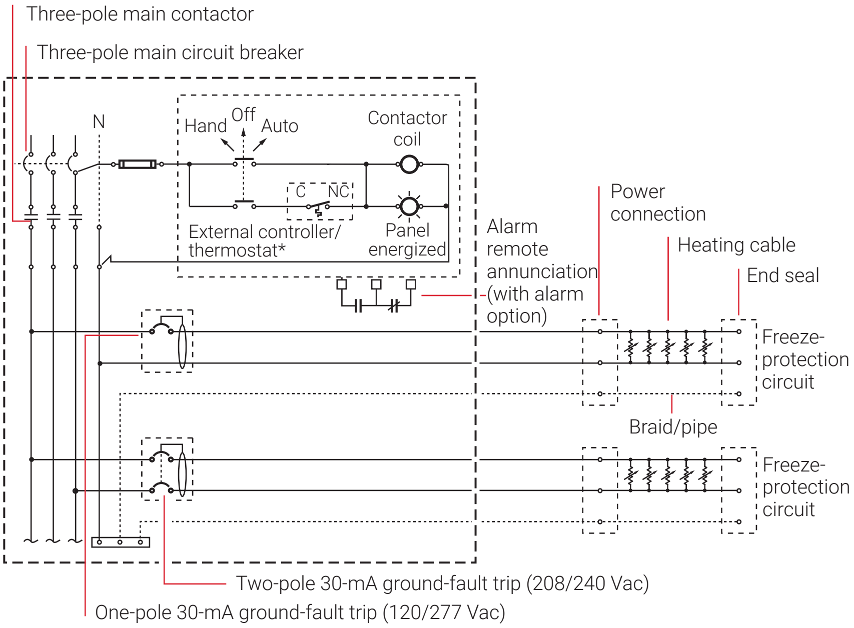


Fig.2 Typical HTPG panel layout

Fig. 3 depicts a typical HTPG schematic. The device that energizes the main contactor can be an ambient sensing thermostat (mounted remotely), an electronic controller, a snow sensor controller, or any device with a contact that changes state when the heat tracing is energized.



* External controller/thermostat sold separately

Fig. 3 Typical HTPG schematic

Heat-Trace Panels — Individual Control

A typical HTPI panel includes a wall-mounted enclosure, assembled panelboard, main circuit breaker, and door disconnect handle.

HTPI

The HTPI is a dedicated power distribution, ground-fault protection, monitoring, and alarm panel. This system is used with a line sensing thermostat (mounted remotely) or a line sensing electronic controller to give individual line sensing control.

Fig. 4 shows a typical panel layout of an HTPI. This wall-mounted enclosure contains an assembled panelboard and main circuit breaker. The panel has options for terminal blocks, alarm relay (form C contacts), common alarm light, door disconnect handle, and alarm horn. Fig. 5 depicts a typical HTPI schematic.

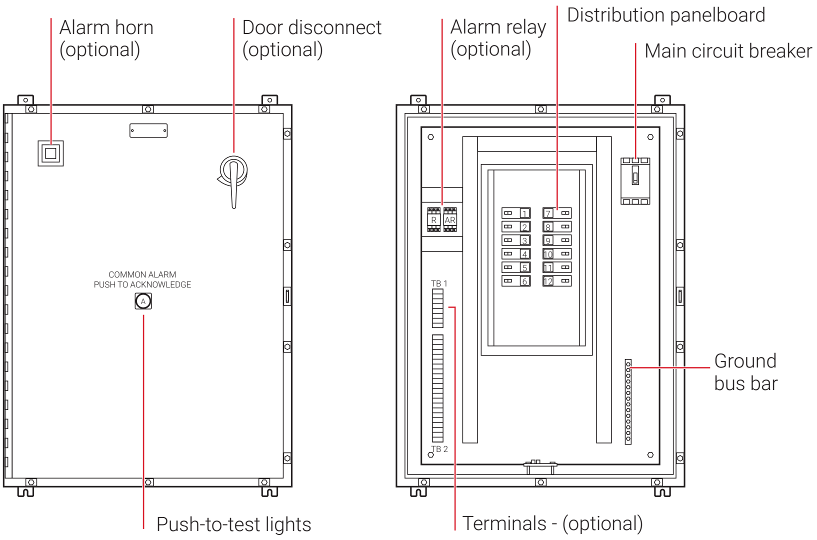


Fig. 4 Typical HTPI panel layout

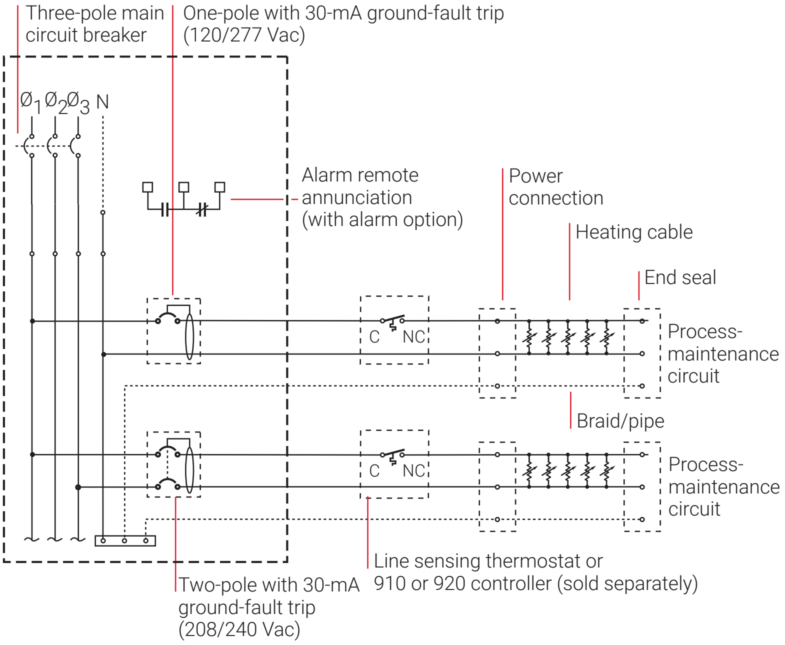


Fig. 5 Typical HTPI schematic

APPROVALS AND CERTIFICATIONS

The HTPG and HTPI heat-trace panels are built to UL 508A guidelines and labeled accordingly. The UL508 control panel label is a certification that all assembly, wiring, and testing was done in strict accordance with UL guidelines. Control panel manufacturers must complete an extensive review process of their procedures and demonstrate an understanding of electrical systems, code requirements, and various safety issues in order to qualify as an ETL Listed panel shop. They are subsequently reviewed on a quarterly basis to ensure that all finished products utilize UL-marked components and are manufactured to all UL standards. Assembly and testing of all panels is done in a ETL Certified facility. All panels are functionally tested before shipment. Other applicable standards include UL 67 for panelboards, UL 50 for cabinets, National Electrical Code, NEMA Standards PB1, and Federal Inspection W-P-115C.

Intertek
9700701

ETL LISTED
CONFORMS TO
ANSI/UL STD. 508
UL STD. 508A

CERTIFIED TO
CAN/CSA C22.2 NO. 14

Intertek

DRAWINGS

For each panel configuration, a set of drawings (elevation/BOM and schematic) is created. These drawings are sent to the purchaser for approval or for information only (panel released at time of order). The drawings are 11" x 17" (B size).

PANEL DESIGN FOR THREE-PHASE SYSTEMS

Overview

The panel design process involves four steps:

1 Gather the necessary information.

  - Total start-up circuit breaker (CB) amps
  - KVA rating of the transformer
  - Phase-to-neutral voltage of the transformer secondary ($V_{p\text{-}n}$)
  - Phase-to-phase voltage of the transformer secondary ($V_{p\text{-}p}$)

2 Determine main circuit breaker and transformer size.

3 Select the panelboard.

4 Select the ground-fault circuit breaker.

Panel Design

Panel Design
1. Gather information
2. Determine main circuit breaker and transformer size
3. Select panelboard
4. Select ground-fault circuit breaker

Step 1 Gather the necessary information

To begin your panel design, gather and record the following information:

- Total start-up CB Amps..
- KVA rating of the transformer..
- Phase-to-neutral voltage of the transformer secondary ($V_{p\text{-}n}$) ....
- Phase-to-phase voltage of the transformer secondary ($V_{p\text{-}p}$)..

Note: Start-up Amps may be obtained by using TraceCalc Pro design software or by contacting your nVent representative.

Panel Design
1. Gather information
2. Determine main circuit breaker and transformer size
3. Select panelboard
4. Select ground-fault circuit breaker

Step 2 Determine main circuit breaker and transformer size

Main Breaker Sizing

The purpose of the main circuit breaker is to protect the panelboard bussing, the transformer, and the wiring between the transformer and the panelboard. The main breaker also provides a way to disconnect power to the panelboard for maintenance purposes. "Table 1" page 169, shows the maximum size main circuit breaker that can be used with each size transformer. Choose the appropriate main circuit breaker based upon your application.

Transformer Sizing

Transformers must be sized for the start-up load. This ensures that the main breaker, which protects the transformer, is large enough to take the start-up currents produced by heaters that have transient currents, such as self-regulating heaters. For most applications, this is based on the total start-up current. The formula for calculating minimum transformer rating is:

$$\frac{V_{p\text{-}n} \times I_T \times SF}{1000} = KVA \quad \text{or} \quad \frac{V_{p\text{-}p} \times I_T \times SF \times 1.73}{1000} = KVA$$

Where: KVA = KVA rating of the transformer

SF = Safety factor (allowance for spare capacity)

I_T = Total start-up current

$V_{p\text{-}n}$ = Phase-to-neutral voltage of the transformer secondary

$V_{p\text{-}p}$ = Phase-to-phase voltage of the transformer secondary

After you have applied the above formula, go to "Table 1" and choose the next largest standard transformer.

Note: The above formulas are based upon the assumption that the transformer is perfectly balanced and the entire panelboard will be energized at the same minimum ambient temperature for which the branch circuit breakers were sized.

Note regarding transformer primary protection: In most cases, the customer will provide the primary main circuit breaker. However, if you must provide the main circuit breaker on the primary side, the formula is:

$$\frac{KVA \times 1000 \times 1.25 \times 1.73}{V_{p\text{-}p}} = \text{Next largest standard breaker}$$

Where: KVA = KVA rating of the transformer

1.25 = NEC factor

Vp-p = Phase-to-phase voltage supplying transformer

TABLE 1 MAXIMUM THREE-PHASE MAIN CIRCUIT BREAKER SIZING

	Maximum primary main circuit breaker size				Maximum secondary main circuit breaker size			
	600 V		480 V		120/208 V		277 V	
Trans. size (KVA)	Calculated CB size		Calculated CB size		Calculated CB size		Calculated CB size	
3	3.6	4-F	4.5	6-F	10.4	15	4.5	6-F
6	7.2	9-F	9.0	15	20.8	30	9.0	15
9	10.8	15	13.5	15	31.3	40	13.5	15
15	18.0	20	22.6	30	52.1	60	22.6	30
30	36.1	40	45.1	50	104.2	125	45.1	50
45	54.1	60	67.7	70	156.3	175	67.7	70
75	90.2	100	112.8	125	260.4	300	112.8	125
112.5	135.3	150	169.1	175	390.6	400	169.2	175
150	180.4	200	225.5	225	520.8	600	225.6	225
225	270.6	300	338.3	400	781.3	800	338.4	400
300	360.8	400	451.1	500	1041.7	1200	451.3	500

TABLE 2 MAXIMUM SINGLE-PHASE MAIN CIRCUIT BREAKER SIZING

	Maximum primary main circuit breaker size				Maximum primary main circuit breaker size	
	600 V		480 V		120/240 V	
Trans. size (KVA)	Calculated CB size		Calculated CB size		Calculated CB size	
3	6.3	9-F	7.8	9-F	15.6	20
5	10.4	15	13.0	15	26.0	30
7.5	15.6	20	19.5	20	39.1	40
10	20.8	30	26.0	30	52.1	60
15	31.3	40	39.1	40	78.1	80
25	52.1	60	65.1	70	130.2	150
37.5	78.1	80	97.7	100	195.3	200
50	104.2	125	130.2	150	260.4	300
75	156.3	175	195.3	200	390.6	400

Panel Design
1. Gather information
2. Determine main circuit breaker and transformer size
3. Select panelboard
4. Select ground-fault circuit breaker

Step 3 Select the panelboard

The standard bus ratings (amperage/phase) for panelboards are 100 A, 225 A, and 400 A. The higher the bus rating, the more expensive the panelboard. Where possible, it is most cost-effective to limit the main circuit breaker and bus rating to 225 A. As mentioned, the main circuit breaker must protect the bussing in the panelboard. Therefore, your main circuit breaker will determine your panelboard bus rating. The maximum number of branch spaces available in panelboards are: 18, 30, 42 and 54 spaces.

Note: Per the NEC, a single panelboard can accommodate a maximum of 42 connections. There are some ground-fault circuit breaker (GFCB) options in which the number of panelboard connections is less than the number of spaces provided. These are discussed in the next section.

Panel Design

1. Gather information
2. Determine main circuit breaker and transformer size
3. Select panelboard
4. Select ground-fault circuit breaker

Step 4 Select ground-fault circuit breaker

The number of spaces taken by GFCBs is a function of both the voltage and whether the GFCBs have alarms. Table 3 lists the number of spaces each breaker takes in a panelboard, as well as the number of connections to a panelboard.

TABLE 3 GFCB PANELBOARD REQUIREMENT

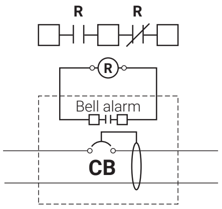
	Number of spaces per GFCB		
Voltage	**Without alarm**	**With alarm relay**	**With bell alarm**
120	1	1	2
208/240	2	2	3
277	2	2	2

Alarm Options

Bell alarm versus relay alarm

We offer two types of alarm options for the HTPI and HTPG heat-trace panels: bell and relay.

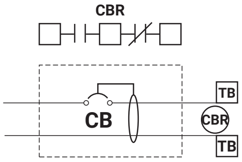
The bell alarm option uses a ground-fault circuit breaker with an alarm contact built into the breaker. Upon a ground fault or trip condition, this alarm contact changes state (closes), sending a signal to the common alarm relay provided in the panel that a breaker has tripped. Once in alarm, turning the breaker to the "Off" or "On" position clears the alarm. Due to the alarm contact, the breakers are larger and take an extra space in the panelboard for 120 / 208 / 240 V breakers, thereby reducing the number of breakers you can install in a given panelboard (see Fig. 6).



Each breaker requires an extra space in the panelboard due to the bell alarm contact (except for 277 V ground-fault breakers).

Fig. 6 Ground-fault circuit breaker with bell alarm contact

The relay alarm uses standard ground-fault circuit breakers wired to a relay. Upon a ground fault / trip condition or if / when the breaker is turned off, the relay changes state (closes) sending a signal to the common alarm relay provided in the panel that the breaker has tripped or has been turned to the "Off" position. Once in alarm, turning the breaker to the "On" position or removing the relay will clear the alarm (see Fig. 7).



External terminal block

Fig. 7 Ground-fault circuit breaker with external relay for alarmBuried piping

PRODUCT SELECTION

HTPG Overview

The HTPG selection process involves two steps:

1 Gather the necessary information:

- Voltage
- Panelboard size
- Circuit breaker type and rating
- Number of circuit breakers (availability per voltage)
- Type of enclosure
- Main circuit breaker and contactor
- Options

1 Assemble the catalog number.

HTPG Catalog Number

HTPG comes in a variety of configurations. The following chart outlines the elements that constitute a configuration and the corresponding catalog number.

HTPG - Voltage - Panelboard - C.B. type - # of C.B./# of poles (rating) - Enclosure - MCB - Options

HTPG - 277/480 - 30 - 2 - 14/1P (30) - 4X - 200 - H

Voltage

120/208 120/240* 277/480

Panelboard size

18 = 18 space panelboard (277 V only)
30 = 30 space panelboard
42 = 42 space panelboard
54 = 54 space panelboard (277 V only)

Circuit breaker type

2 = GFCB (30-mA trip) without alarm
3 = GFCB (30-mA trip) with bell alarm
4 = GFCB (30-mA trip) with relay alarm (includes terminal block option). Not available for 277 V

Number of circuit breakers/number of poles (circuit breaker rating) see prior page

# of breakers (no bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277V (1P)
18	(1–18)	(1–8)	(1–8)	(1–8)
30	(1–30)	(1–14)	(1–14)	(1–14)
42	(1–42)	(1–20)	(1–20)	(1–20)
54	–	–	–	(1–26)

# of breakers (bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277 V (1P)
18	(1–8)	(1–6)	(1–6)	(1–8)
30	(1–14)	(1–10)	(1–10)	(1–14)
42	(1–20)	(1–14)	(1–14)	(1–20)
54	–	–	–	(1–26)

Option

0 = None
A = Alarm horn (requires C.B. type 3 or 4)
B = Alarm beacon (requires C.B. type 3 or 4)
C = Heat-trace contactor failure light
D = Door disconnect
E = Environmental purge (NEMA Type 4 or 4X enclosures only)
G = Panel power-on light
H = Space heater and thermostat
L = Individual circuit breaker trip indication lights (requires C.B. type 4)
P = Heat-trace energized light
T = Terminal blocks (prewired)
W = Wired for ETI controller
Z = Z-purge system (NEMA Type 4 or 4X enclosures only)
SP = Special requirement: Must contain complete description of variance

MCB

Main circuit breaker and contactor

Panelboard size	120/208	120/240	277/480
18	50, 100	50, 100	30, 50, 70, 125
30	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
42	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
54	–	–	50, 70, 125, 175, 225

Enclosure

12 = NEMA Type 12 (indoors)
4 = NEMA Type 4 (outdoors)
4X = NEMA Type 4X (stainless steel–outdoors)

* Single phase

Fig. 8 HTPG catalog number elements

Voltage

This is the voltage at which the heater is powered. If you have a combination of 120 V and 208 V heaters in the same panelboard, use 120 / 208 as the voltage. For 240 V, we are assuming that the voltage to the panelboard is single-phase (two phases and a neutral).

Panelboard size

Specify the panelboard size you will require based on the number and type of circuit breakers required. You can specify a larger-than-required panelboard for spare space.

Circuit breaker type and rating

Specify the type of ground-fault breakers you require in the panelboard. In the parenthesis, fill in the amperage of the breakers (refer to Fig. 9.8). If more than one amperage is required, then list all the amperages; for example, 3/2P(50), 4/2P(40).

number of breakers

Fig. 8 lists the standard numbers of breakers we offer in a single panelboard. If you require more or fewer than the number of breakers shown, list the actual number of breakers required and we can provide a factory quote.

Enclosure

Fig. 8 shows the standard enclosures. If the panel will be located in a hazardous location (CID1 or CID2), specify 7 for a NEMA Type 7 explosion-proof enclosure; specify NEMA Type 4 or 4X enclosure for a Z-purge system and choose Z (Z purged) option.

MCB / contactor

If you require a main circuit breaker less than 100 A, state the required amperage. If you require a main circuit breaker larger than 225 A, state the required amperage and we can provide a factory quote.

HTPG Selection Process

HTPG Selection
1. Gather information
2. Assemble catalog number

Step 1 Gather the necessary information

Gather and record the following information:

- Voltage..
- Panelboard size ....
- Circuit breaker type and rating ....
- Number of circuit breakers (availability per voltage)..
- Type of enclosure ....
- MCB/contactor ....
- Options ....

Example: Information on sample application

Voltage	277
Panelboard size	30
Circuit breaker type and rating	30 A without alarm
Number of breakers	14
Type of enclosure	NEMA Type 4X
MCB/contactor	200 A MCB/contactors
Options	Space heater with thermostat

HTPG Selection
1. Gather information
2. Assemble catalog number

Step 2 Assemble the catalog number

Example: HTPG-277/480-30-2-14/1P(30)-4X-200-H

HTPI Overview

The HTPI selection process involves two steps:

1 Gather the necessary information:

- Voltage
- Panelboard size
- Circuit breaker type and rating
- Number of circuit breakers (availability per voltage)
- Type of enclosure
- MCB
- Options

2 Determine configuration and the corresponding catalog number.

HTPI Catalog Number

HTPI comes in a variety of configurations. The following chart outlines the elements that constitute a configuration and the corresponding catalog number.

HTPI - Voltage - Panelboard - C.B. type - # of C.B./# of poles (rating) - Enclosure - MCB - Options

HTPI - 277/480 - 30 - 2 - 10/1P (20) - 4X - 200 - H

Voltage
120/208 120/240* 277/480

Panelboard size
18 = 18 space panelboard
30 = 30 space panelboard
42 = 42 space panelboard
54 = 54 space panelboard (277 V only)

Circuit breaker type
1 = Overcurrent circuit breakers**
2 = GFCB (30-mA trip) without alarm
3 = GFCB (30-mA trip) with bell alarm
4 = GFCB (30-mA trip) with relay alarm (includes terminal block option). Not available for 277 V

Number of circuit breakers/number of poles (circuit breaker rating) see prior page

# of breakers (no bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277V (1P)	277 V** (std. C.B.) (1P)
18	(1–18)	(1–8)	(1–8)	(1–7)	(1–17)
30	(1–29)	(1–14)	(1–14)	(1–13)	(1–29)
42	(1–41)	(1–20)	(1–20)	(1–19)	(1–41)
54	–	–	–	(1–25)	–

# of breakers (bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277 V (1P)
18	(1–8)	(1–6)	(1–8)	(1–7)
30	(1–14)	(1–9)	(1–9)	(1–13)
42	(1–20)	(1–13)	(1–13)	(1–19)
54	–	–	–	(1–25)

Option
0 = None
A = Alarm horn (requires C.B. type 3 or 4)
B = Alarm beacon (requires C.B. type 3 or 4)
D = Door disconnect
E = Environmental purge (NEMA Type 4 or 4X enclosures only)
G = Panel power-on light
H = Space heater and thermostat
L = Individual circuit breaker trip indication lights (requires C.B. type 4)
T = Terminal blocks (prewired)
Z = Z-purge system (NEMA Type 4 or 4X enclosures only)
SP = Special requirement: Must contain complete description of variance

MCB

Main circuit breaker size or MLO for no main breaker

Panelboard size	120/208	120/240	277/480
18	50, 100	50, 100	30, 50, 70, 125
30	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
42	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
54	–	–	50, 70, 125, 175, 225

Enclosure
1 = NEMA Type 1 (indoors)
12 = NEMA Type 12 (indoors)
4 = NEMA Type 4 (outdoors)
4X = NEMA Type 4X (stainless steel–outdoors)

* Single phase
** Overcurrent circuit breakers require ground-fault protection from controller

Fig. 9 HTPI catalog number elements

Voltage

This is the voltage at which the heater is powered. If you have a combination of 120 V and 208 V heaters in the same panelboard, use 120 / 208 as the voltage. For 240 V, we are assuming that the voltage to the panelboard is single-phase (two phases and a neutral).

Panelboard size

Specify the panelboard size you will require based on the number and type of circuit breakers required. You can specify a larger-than-required panelboard for spare space.

Circuit breaker type and rating

Specify the type of breakers you require in the panelboard. If you choose a standard circuit breaker, the ground-fault protection function must come from the controller. In the parenthesis ( ), fill in the amperage of the breakers (refer to Fig. 9). If more than one amperage is required, then list all the amperages; for example, 3/2P(50), 4/2P(40).

Number of breakers

Fig. 9 lists the standard numbers of breakers we offer in a single panelboard. If you require more or fewer than the number of breakers shown, list the actual number of breakers required and we can provide a factory quote.

Enclosure

Fig. 9 shows the standard enclosures. If the panel will be located in a hazardous location (CID1 or CID2), specify 7 for a NEMA Type 7 explosion-proof enclosure; specify NEMA Type 4 or 4X enclosure for a Z-purge enclosure and choose Z (Z purged) option.

MCB

If you require a main circuit breaker less than 100 A, state the required amperage. If you require a main circuit breaker larger than 225 A, state the required amperage and we can provide a factory quote.

HTPI Selection Process

HTPI Selection
1. Gather information
2. Assemble catalog number

Step 1 Gather the necessary information

Gather and record the following information:

- Voltage
- Panelboard size
- Circuit breaker type and rating
- Number of circuit breakers (availability per voltage)
- Type of enclosure
- Type of main circuit breaker
- Options

Example: Information on sample application

Voltage	277
Panelboard size	30
Circuit breaker type and rating	20 A without alarm
Number of breakers	10
Type of enclosure	NEMA Type 4X
Type of main circuit breaker	200 A main circuit breaker
Options	Space heater with thermostat

HTPI Selection
1. Gather information
2. Assemble catalog number

Step 2 Assemble the catalog number

Example: HTPI-277/480-30-2-10/1P(20)-4X-200-H

ENGINEERED PRODUCTS

This section provides an overview of engineered products available from nVent. For complete design assistance and product selection, contact your nVent representative or phone nVent at (800) 545-6258. Also visit our web site at nvent.com.

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INTRODUCTION

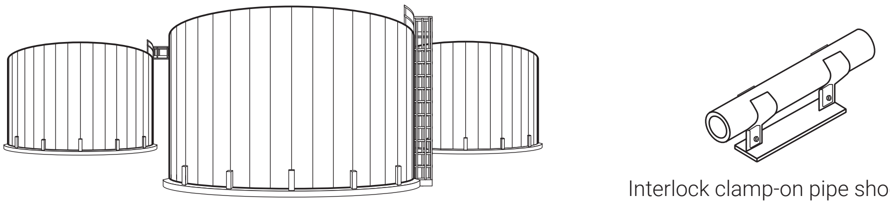
nVent offers engineered products for the industrial market.

- Standing lock-seam tank insulation systems
- Weldless, clamp-on pipe shoes
- MI downhole flow assurance and enhanced oil recovery

Each product is designed to add value to even the simplest of heat-tracing installations. Typical benefits served by these products include:

- Tank heat loss prevention
- Pipe support and control and power distribution optimization
- High flow rate temperature management and pressure equalization along long horizontal producing zones for downhole applications

A description of the features and benefits of each technology is provided in the following pages.

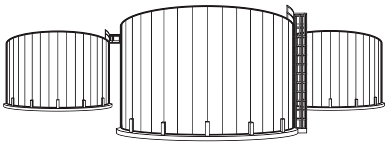


Trac-Loc vertical lock seam tank insulation

Interlock clamp-on pipe shoe

Fig. 1 Engineered products

TRAC-LOC VERTICAL LOCK-SEAM TANK INSULATION



DESCRIPTION

The Trac-Loc tank insulation system is a vertical double-locking standing seam insulation panel system that's unique in its design, panel construction and installation techniques.

APPLICATIONS

Trac-Loc is ideal for large, flat-bottomed tanks used for storage of materials that are sensitive to temperature fluctuations and require a covering of insulation and jacketing to reduce heat loss or gain.

DESIGN

The Trac-Loc advanced interlock panel system consists of prefabricated panels of insulation and jacketing material. These panels, fabricated to the height of the storage tank, include flanges that are mechanically seamed to an adjacent panel. This mechanical seam creates a homogeneous jacket that not only secures the panels to the storage tank, but also reduces moisture ingress, damage due to wind, and inherent expansion and contraction of the storage tank.

PANEL CONSTRUCTION

Panels are fabricated by laminating insulation material to a preformed jacket. Insulation can be made up of one or more insulating materials and jacket materials conform to industry standards. The following tables contain some of the typical insulation and jacketing materials used for panel construction.

TABLE 1 INSULATION MATERIAL

Insulation	K factor*	T_{max}	
Polyisocyanurate***	0.19 BTU-in / hr – ft² – °F	250°F	(121°C)
Fiberglass	0.24 BTU-in / hr – ft² – °F	850°F	(454°C)
Mineral wool***	0.26 BTU-in / hr – ft² – °F	1200°F	(649°C)
Calcium silicate**	0.40 BTU-in / hr – ft² – °F	1200°F	(649°C)
Perlite**	0.46 BTU-in / hr – ft² – °F	1200°F	(649°C)
Cellular glass	0.30 BTU-in / hr – ft² – °F	900°F	(482°C)

* K factor based on 100°F mean temperature

** Used in double-layer applications only

*** May be combined with a foil facer

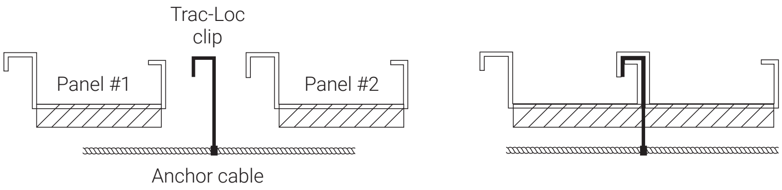
TABLE 2 JACKETING MATERIAL

Material	Thickness
Aluminum*	0.024" (0.610 mm)
Stainless steel	0.016" (0.406 mm)
Steel	26 gauge
Galvalume	0.024" (0.610 mm)

* Jacket material may be coated for corrosive environments and colored for aesthetics.

INSTALLATION

In order to temporarily secure the panels to the surface, a cable system is secured to the tank circumference. Trac-Loc clips secure the panels to the cables. A seaming tool forms the adjacent panels into a double locking vertical seam that includes the clip.



Step 1

Trac-Loc clip and panels prior to assembly.
Clip is secured to anchor cable.

Step 2

Alignment of Trac-Loc clip and panels.
Panels held in place by mating flanges with clip inserted between male/female flange.

Step 3

Double locking of panels creates seal.
Mechanical crimping of seam accomplished by single pass of seaming tool.

Step 4

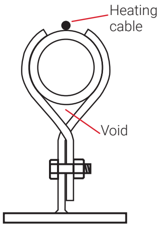
Final seam creates homogeneous jacketing along tank surface.

Fig. 2 Trac-Loc installation

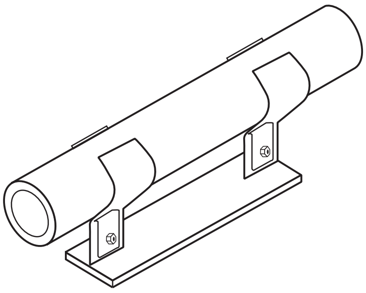
The Trac-Loc system is provided as a complete turnkey system. Additional value-added services include:

- Estimates
- Thermal calculations
- AutoCAD® designs
- Tank heater pads and self-regulating cable designs
- Immersion heaters, circulation heaters, etc.
- Under tank designed heating systems

INTERLOCK CLAMP-ON PIPE SHOE



Ideal for traced pipes



The Interlock clamp-on pipe shoe is a patented pipe support design that eliminates field-welding requirements for pipe supports.

DESCRIPTION

The Interlock shoe includes a base with either two or three (depending on the application) support tongs welded to it. These support tongs have a lever gap stamped in their base, through which a mating tong is inserted. When the mating tong is bolted to the support tong the pipe ends of the tong are drawn together, gripping the pipe.

The entire assembly is galvanized (6 mil thick) for corrosion protection.

The Interlock shoe can be used on nominal pipe sizes ranging from 1-in (25.4 mm) through 8-in (203 mm), and is available in heights of 3-in (76 mm), 4-in (102 mm) or 6-in (152 mm) to accommodate varying thicknesses of pipe insulation.

The Interlock shoe is made out of A-36 carbon steel, but is also available in other materials of construction for special applications. The standard (A-36) Interlock shoe can be used in services from –20° F (–29°C) to 400°F (204°C).

When the Interlock shoe is used on stainless steel pipe an optional isolation insert is available to isolate the dissimilar metals, in compliance with most pipe support specifications.

APPLICATIONS

Pipes that can be installed on supports include bare pipe, painted pipe, insulated pipe, and heat-traced pipe. Using the clamp-on pipe shoe can allow you to:

- Minimize or eliminate wear on the pipe caused by normal movement of a pipeline. This movement can be attributed to many things, including thermal expansion of the pipe due to process temperature changes or changes in ambient temperature.
- Provide a means for guiding the pipe so that multiple lines within a rack do not rub against one another during normal movement.
- Allow spacing between the pipe support and the pipe itself to facilitate the installation of pipe insulation.

The Interlock clamp-on pipe shoe is not intended for anchoring or vertical support requirements.

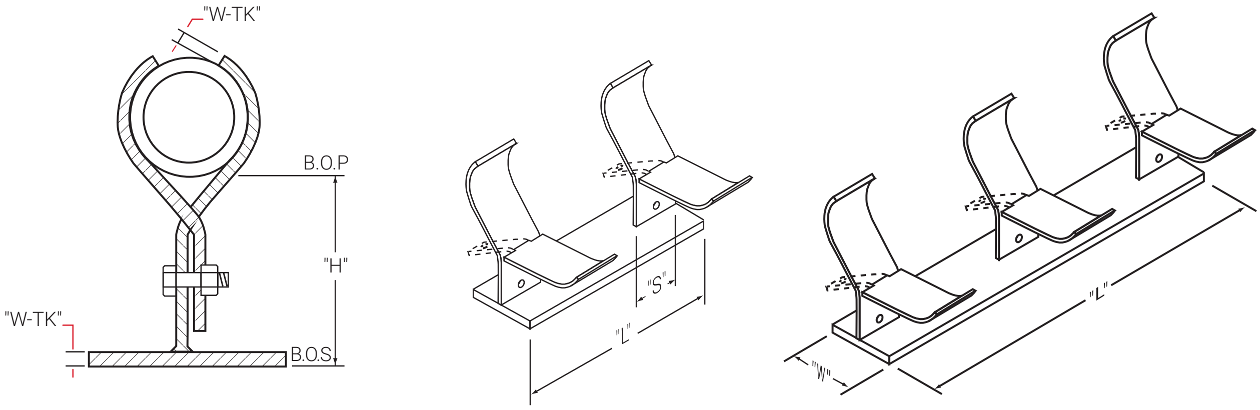


Fig. 3 Interlock pipe support

ADVANTAGES

- Reduced cross sectional area (as compared to conventional clamp on shoes).
  - Reduces space requirements in the pipe rack, minimizing rack congestion.
- Reduced heat loss at the pipe support.
  - Minimizes the need to serpentine or loop heat-tracing cable or tubing, eliminating as much as 15% of the heat-tracing requirements on a typical application.
- Eliminates field welding for supports.
  - Achieves a higher level of quality.
  - Eliminates rework because the shoe was not located correctly.
  - Eliminates the need for scaffolding or lift equipment.
  - Eliminates the need to paint pipe support field welds.
  - Eliminates the need for fire watch or full weld enclosures.
  - Eliminates the need for hot work permits.
  - Eliminates stress corrosion of pipe at welds.
- Easy to install.
- Doesn’t retain moisture between the support and the pipe.
  - Eliminates corrosion by not allowing moisture (or other corrosive media) to collect between the support and the pipe.
- Less costly (as compared to welded-on supports).
  - The total installed cost of an Interlock shoe is significantly less then the total installed cost of a welded-on shoe.

PRODUCT SELECTION AND CATALOG NUMBER ASSEMBLY

PRODUCT SELECTION

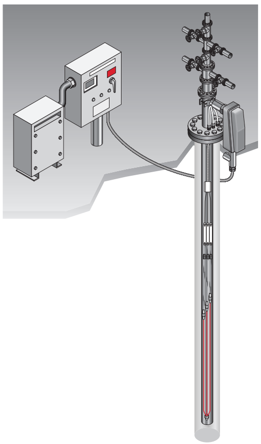
- Determine pipe size
  - Available in sizes 1-in (25.4 mm) through 8-in (203 mm)
- Determine height requirement – considerations include:
  - Pipe rack spacing/density
  - Insulation thickness
  - Standard heights include 3-in (76 mm), 4-in (102 mm), and 6-in (152 mm)
- Determine length
  - Length is determined by analysis of piping conditions and is designed to accommodate expected movement based on expansion and contraction of piping system.

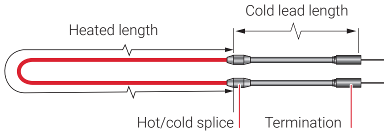
1-3-12-B

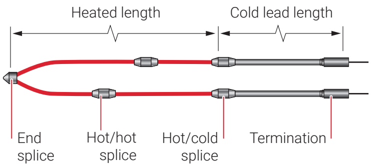
A = Pipe size: 1" (25.4 mm), 1.5" (38 mm), 2" (51 mm), 3" (76 mm), 4" (102 mm), 6" (152 mm), 8" (203 mm)
B = Shoe height: 3" (76 mm), 4" (102 mm), 6" (152.4 mm)
C = Shoe length: 12" (305 mm), 18" (457 mm)
D = Isolation/heat trace thermal boot: n/a, B

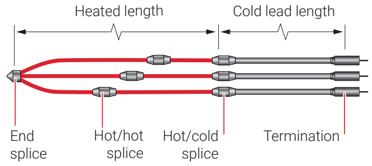
Fig. 4 Interlock catalog number

PRODUCT SELECTION









ENGINEERING SERVICES

Understanding the effects of heat transfer in oil wells is a complex study. nVent can produce and supply wellbore thermal models and temperature profiles to better show the interaction of a PetroTrace Downhole Heating system within the wellbore.

In addition, nVent utilizes computational fluid dynamics and other engineering tools to ensure that each PetroTrace Downhole Heating system is engineered to match the application and environmental requirements.

INSTALLATION

The Tracer Turnkey Solutions team has over 20 years of experience in the installation of PetroTrace Downhole Heaters and over 40 years of experience installing Heat Management Systems throughout the oilfield industry. Installation and commissioning services can be provided with all PetroTrace Downhole Heating Systems.

For proper design and installation of the PetroTrace MI downhole heating system, contact nVent.

STEAM TRACING

This section provides an overview of the nVent offering for steam and recirculating fluid nVent TRACER heat-tracing systems. For additional information, contact your nVent representative or phone nVent at (800) 545-6258. Also visit our web site at nVent.com.

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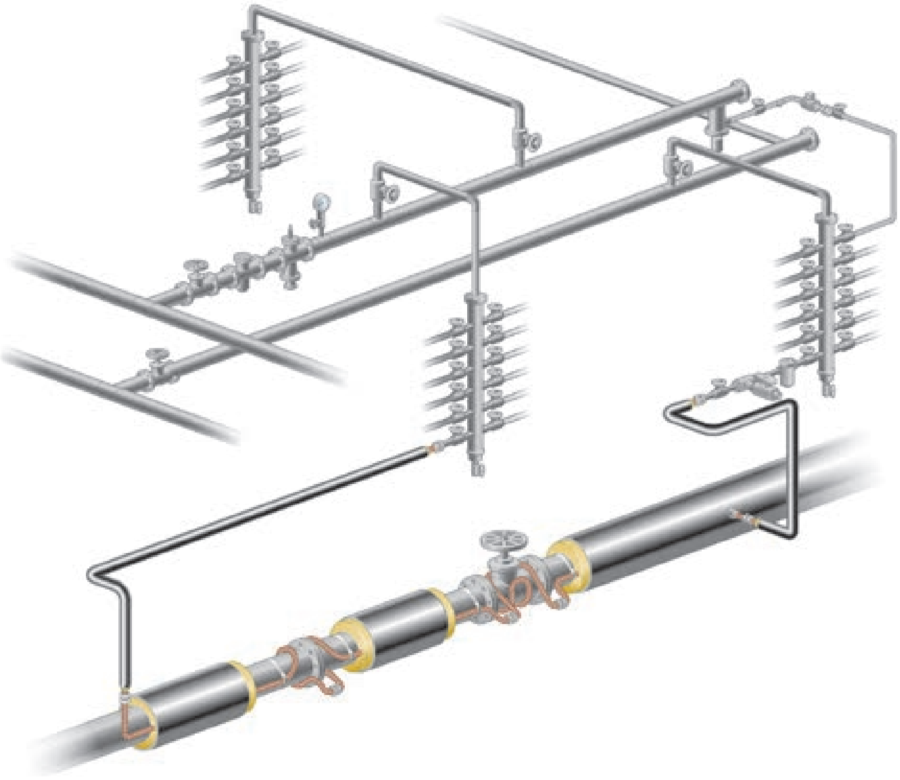
INTRODUCTION

nVent offers complete project execution of steam and recirculating fluid-tracing systems through our nVent TRACER Turnkey Solutions team. Design, optimization, material supply, installation, and commissioning of the tracing system by a single source ensures that accountability for the system performance rests in one location. Working from project-specific material and performance specifications, nVent offers a complete system from header design through condensate collection.



Typical steam-tracing layout

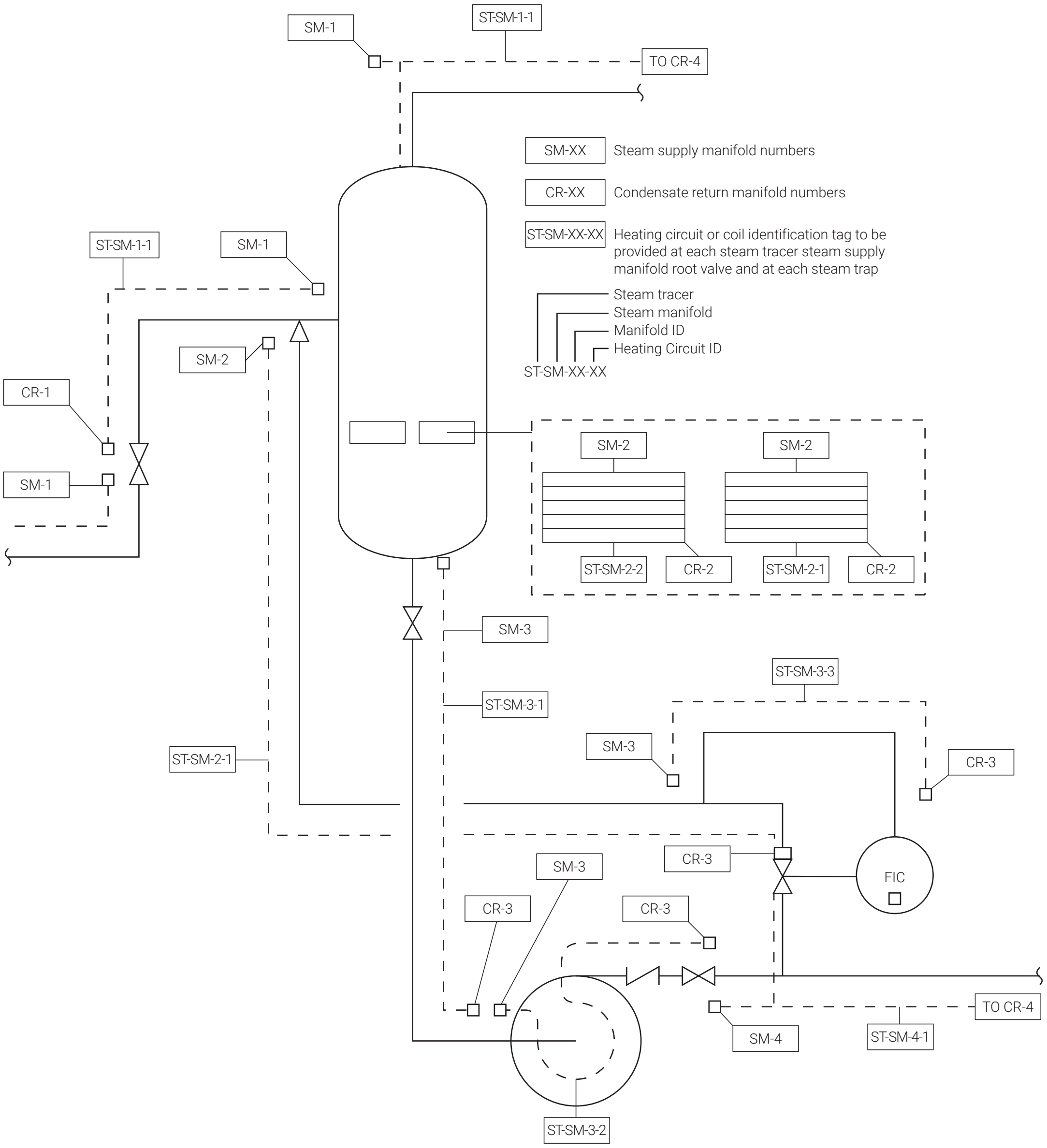
ENGINEERING AND DESIGN

Quality installations include a complete and properly documented design.

nVent employs an experienced staff of engineers and designers to form the industry's leading heat-tracing engineering organization in North America.

Our engineering capabilities extend to all types of circulating fluid (i.e. steam, tepid water, hot oil, glycol) systems. Engineering deliverables include:

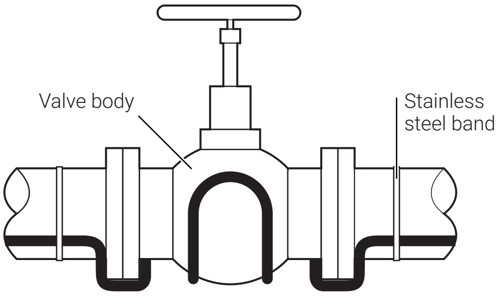
- Isometric detail drawings with heat-tracing design parameters and calculations
- Heat-tracing P&ID
- Typical and project-specific installation details
- Nameplate and tagging schedules
- Complete project bills of material
- Heat-trace circuit plot plans and/or schedules
- Post-construction "as-built" documentation
- Comprehensive operation and maintenance instruction manuals



Typical steam-trace P&ID

STANDARD PRACTICES

Adherence to industry-standard practices for steam-tracing installations, combined with complete premobilization designs, ensures the proper performance of steam and recirculating fluid systems.



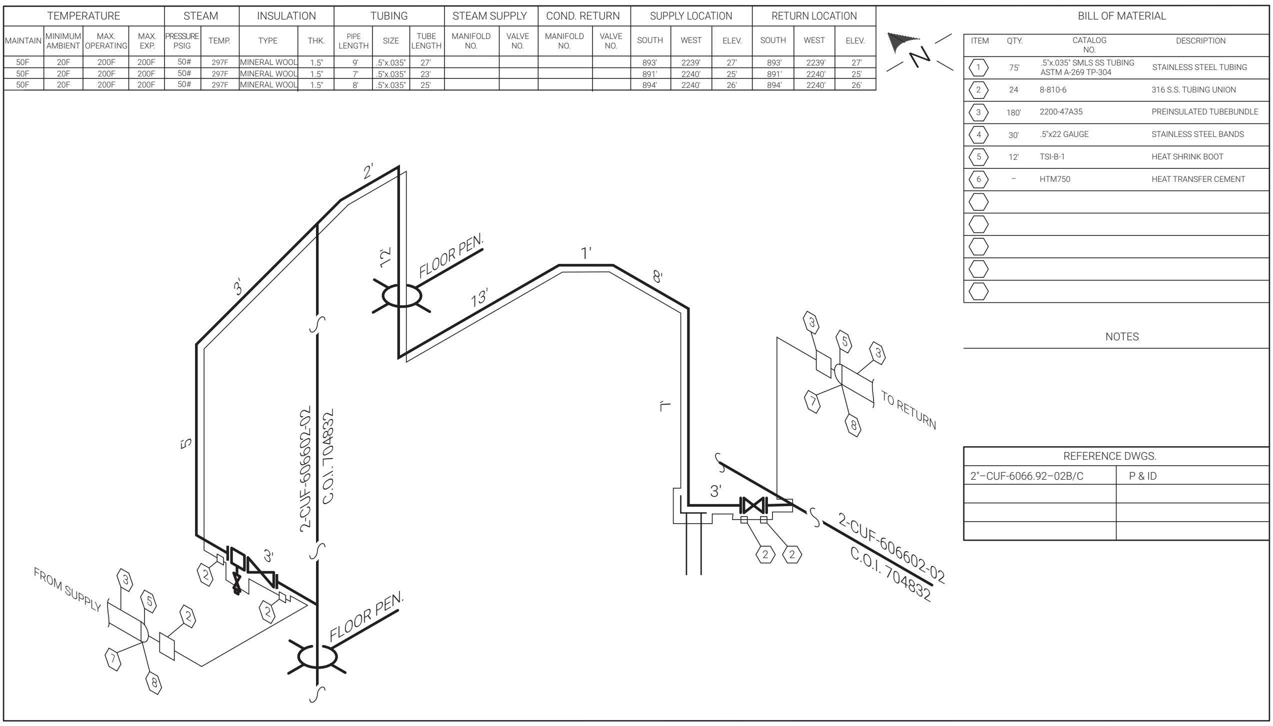
Note: Tubing “basket” should be installed such that it can be easily separated for valve maintenance

Typical installation detail – valve

TURNKEY INSTALLATION

Heat tracing is our core competency. We are dedicated to training our managers and craftsmen in the safest, most efficient methods for installing all system components. This ensures that projects are installed with front-line direct-hire labor, assuring that installations will be done cost effectively, thereby minimizing the total installed cost.

Installation includes complete documentation of the system. This consists of test logs and markups of the design isometrics to reflect any piping changes. All of this information is assembled in a comprehensive operation and maintenance manual.


TEMPERATURE				STEAM		INSULATION		TUBING			STEAM SUPPLY		COND. RETURN		SUPPLY LOCATION			RETURN LOCATION		
MAINTAIN	MINIMUM AMBIENT	MAX. OPERATING	MAX. EXP.	PRESSURE PSIG	TEMP.	TYPE	THK.	PIPE LENGTH	SIZE	TUBE LENGTH	MANIFOLD NO.	VALVE NO.	MANIFOLD NO.	VALVE NO.	SOUTH	WEST	ELEV.	SOUTH	WEST	ELEV.
50F	20F	200F	200F	50#	297F	MINERAL WOOL	1.5"	9'	.5"x.035"	27'					893'	2239'	27'	893'	2239'	27'
50F	20F	200F	200F	50#	297F	MINERAL WOOL	1.5"	7'	.5"x.035"	23'					891'	2240'	25'	891'	2240'	25'
50F	20F	200F	200F	50#	297F	MINERAL WOOL	1.5"	8'	.5"x.035"	25'					894'	2240'	26'	894'	2240'	26'

BILL OF MATERIAL

ITEM	QTY.	CATALOG NO.	DESCRIPTION
1	75'	.5"x.035" SMLS SS TUBING ASTM A-269 TP-304	STAINLESS STEEL TUBING
2	24	8-810-6	316 S.S. TUBING UNION
3	180'	2200-47A35	PREINSULATED TUBEBUNDLE
4	30'	.5"x22 GAUGE	STAINLESS STEEL BANDS
5	12'	TSI-B-1	HEAT SHRINK BOOT
6	–	HTM750	HEAT TRANSFER CEMENT

NOTES

REFERENCE DWGS.	
2"–CUF-6066.92–02B/C	P & ID

Typical steam-tracing circuit isometric

MAINTENANCE AND REPAIR SERVICES

The unique characteristics of a steam-tracing system dictate that a comprehensive maintenance and monitoring program is utilized to ensure for proper system performance. nVent has the ability to inspect and assist you in the management of your steam-tracing system by offering comprehensive system audits, repair and renovation estimates, as well as repair and maintenance services performed by trained nVent TRACER field service technicians.

nVent
RAYCHEM

TECHNICAL DATA SHEETS

This section provides individual technical data sheets for all of the Thermal Management products. Each data sheet is also available in .pdf format on our web site at nVent.com

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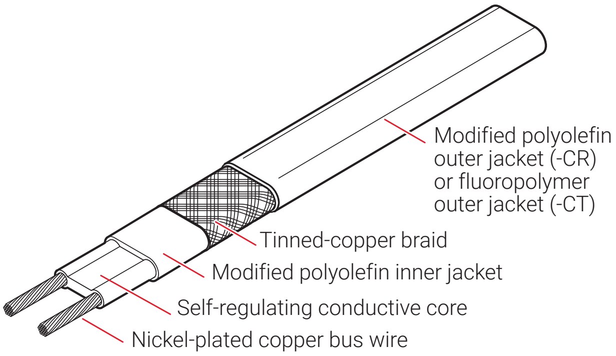
BTV

SELF-REGULATING HEATING CABLES ELECTRICAL FREEZE PROTECTION FOR BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

PRODUCT OVERVIEW

The nVent RAYCHEM BTV family of self-regulating heating cables provides the solution to freeze-protection and process-temperature maintenance applications.

BTV heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C).

The heating cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

BTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.
For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal and plastic
Chemical resistance	• Exposure to aqueous inorganic chemicals: Use -CR (modified polyolefin outer jacket) • Exposure to organic chemicals or corrosives: Use -CT (fluoropolymer outer jacket) • For aggressive organics and corrosives: Consult your nVent representative.

SUPPLY VOLTAGE

BTV1	100–130 Vac
BTV2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	150°F (65°C)
Maximum intermittent exposure temperature, 1000 hours (power on)	185°F (85°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T6: 185°F (85°C)	Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

IECEx

IECEx BAS 06.0043X
Ex e IIC T6 Gb
Ex tD A21 IP66 T80°C

(1) BTV-CR is not CSA Certified for Division 1
(2) BTV-CT only

Hazardous Locations

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

Class I, Div. 1(1) & 2, Groups A, B, C, D
Class II, Div. 1(1) & 2, Groups E, F, G
Class III

BTV heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

Zone Approvals

CLI, ZN1, AEx e II T6(2)

Ex e II T6(2)

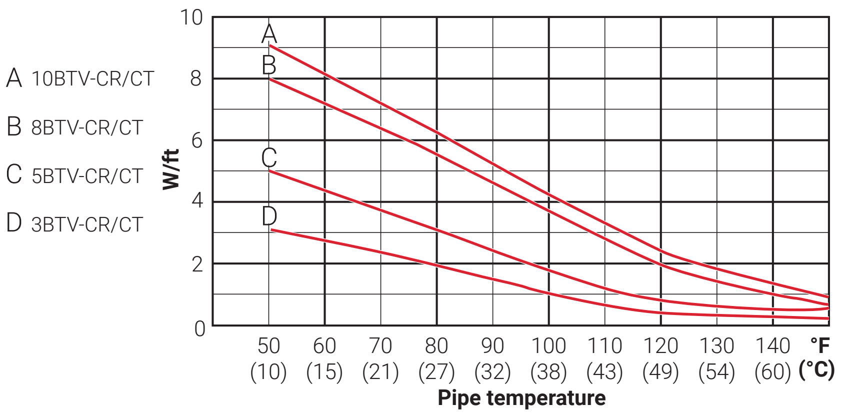
Ex e IIC T6 Gb

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the nVent Installation and Maintenance Manual (H57274). Literature is available via nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	Circuit length
208 V		
3BTV2-CR/CT	0.82	0.96
5BTV2-CR/CT	0.85	0.94
8BTV2-CR/CT	0.89	0.92
10BTV2-CR/CT	0.89	0.92
277 V		
3BTV2-CR/CT	1.13	1.08
5BTV2-CR/CT	1.12	1.09
8BTV2-CR/CT	1.08	1.11
10BTV2-CR/CT	1.08	1.11



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker							
			120 V				240 V			
			15 A	20 A	30 A	40 A	15 A	20 A	30 A	40 A
3BTV-CR/CT	50°F	(10°C)	330	330	330	330	660	660	660	660
	0°F	(–18°C)	200	265	330	330	395	530	660	660
	–20°F	(–29°C)	175	235	330	330	350	465	660	660
	–40°F	(–40°C)	155	205	310	330	310	410	620	660
5BTV-CR/CT	50°F	(10°C)	230	270	270	270	460	540	540	540
	0°F	(–18°C)	140	190	270	270	285	380	540	540
	–20°F	(–29°C)	125	165	250	270	250	330	500	540
	–40°F	(–40°C)	110	145	220	270	220	295	440	540
8BTV-CR/CT	50°F	(10°C)	150	200	210	210	300	400	420	420
	0°F	(–18°C)	100	130	200	210	200	265	400	420
	–20°F	(–29°C)	85	115	175	210	175	235	350	420
	–40°F	(–40°C)	80	105	155	210	155	210	315	420
10BTV-CR/CT	50°F	(10°C)	120	160	180	180	240	315	360	360
	0°F	(–18°C)	80	110	160	180	160	215	325	360
	–20°F	(–29°C)	70	95	140	180	145	190	285	360
	–40°F	(–40°C)	65	85	125	170	125	170	255	340

PRODUCT CHARACTERISTICS

	3BTV, 5BTV	8BTV, 10BTV
Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	0.7	1.0
Bus wire size	16 AWG	16 AWG
Outer jacket color	Black	Black
Heating cable dimensions	0.46 in x 0.25 in (11.7 mm x 6.35 mm)	0.65 in x 0.26 in (16.5 mm x 6.6 mm)

ORDERING DETAILS

Description	Part number
3BTV1-CR	013331-000
3BTV1-CT	893301-000
3BTV2-CR	914279-000
3BTV2-CT	469145-000
5BTV1-CR	208489-000
5BTV1-CT	313747-000
5BTV2-CR	414809-000
5BTV2-CT	487509-000
8BTV1-CR	413851-000
8BTV1-CT	481491-000
8BTV2-CR	479821-000
8BTV2-CT	008633-000
10BTV1-CR	002349-000
10BTV1-CT	516277-000
10BTV2-CR	677245-000
10BTV2-CT	567513-000

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals.
These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

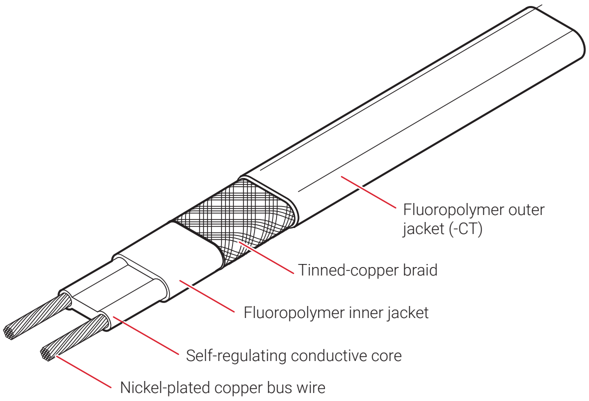
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

QTVR

nVent RAYCHEM

SELF-REGULATING HEATING CABLES ELECTRICAL PROCESS-TEMPERATURE MAINTENANCE FOR BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM QTVR family of self-regulating heating cables is designed for pipe heat tracing in industrial applications. QTVR heating cables can provide process-temperature maintenance up to 225°F (110°C) and can also be used for freeze protection in systems having high heat loss. The heating cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

QTVR cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code. For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal and some plastics For use on plastic pipes, refer to TraceCalc Pro design software.
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

QTVR1	100–130 Vac
QTVR2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	225°F (110°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T4: 275°F (135°C)
Temperature ID numbers are consistent with North America national electrical codes.

TECHNICAL DATA SHEETS

APPROVALS

IECEx

IECEx BAS 06.0045X
Ex e IIC T4 Gb
Ex tD A21 IP66 T130°C

Hazardous Locations

FM APPROVED: Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

-W: Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Ex e IIC T4 Gb

Zone Approvals

FM APPROVED: CLI, ZN1, AEx e II T4

-W: Ex e II T4

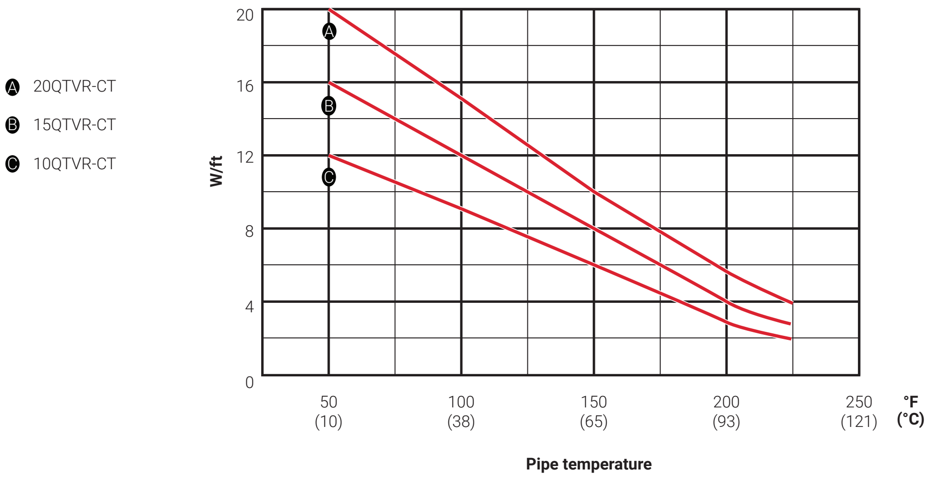
QTVR heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the nVent Installation and Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	Circuit length
208 V	0.78	0.94
10QTVR2-CT	0.85	0.94
15QTVR2-CT	0.91	0.91
20QTVR2-CT	0.90	0.91
277 V		
10QTVR2-CT	1.18	1.06
15QTVR2-CT	1.09	1.10
20QTVR2-CT	1.07	1.11



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker									
			120 V					240 V				
			15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
10QTVR-CT	50°F	(10°C)	100	130	195	195	†	200	265	390	390	†
	0°F	(–18°C)	80	105	160	195	†	160	210	320	390	†
	–20°F	(–29°C)	70	95	145	195	†	145	195	295	390	†
	–40°F	(–40°C)	65	90	135	180	†	135	180	275	365	†
15QTVR-CT	50°F	(10°C)	75	100	150	200	220	160	210	320	340	†
	0°F	(–18°C)	60	80	120	160	200	125	170	255	340	†
	–20°F	(–29°C)	55	70	110	145	185	115	155	235	315	†
	–40°F	(–40°C)	50	65	100	135	170	110	145	220	290	†
20QTVR-CT	50°F	(10°C)	60	80	120	160	195	120	160	240	320	390
	0°F	(–18°C)	45	60	95	125	160	95	125	190	255	320
	–20°F	(–29°C)	40	55	85	115	145	85	115	175	235	295
	–40°F	(–40°C)	40	55	80	110	135	80	110	165	220	275

† Not permitted

PRODUCT CHARACTERISTICS

	10QTVR1-CT, 10QTVR2-CT, 15QTVR2-CT	15QTVR1-CT, 20QTVR1-CT, 20QTVR2-CT
Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	0.85	1.21
Bus wire size	16 AWG	14 AWG
Outer jacket color	Brown	Brown
Heating cable dimensions	0.55 in x 0.25 in (14 mm x 6.35 mm)	0.61 in x 0.25 in (15.5 mm x 6.35 (mm)

ORDERING DETAILS

Description	Part number
10QTVR1-CT	259951-000
10QTVR2-CT	391991-000
15QTVR1-CT	148345-000
15QTVR2-CT	040615-000
20QTVR1-CT	498703-000
20QTVR2-CT	988967-000

CONNECTION KITS

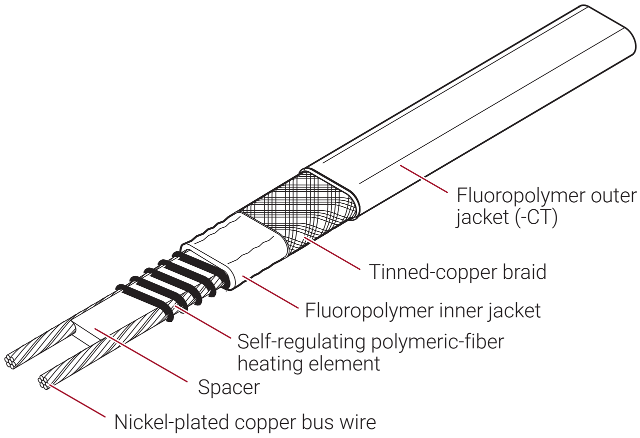
nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

XTV

HIGH-TEMPERATURE SELF-REGULATING HEATING CABLES ELECTRICAL FREEZE PROTECTION AND PROCESS-TEMPERATURE MAINTENANCE FOR BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

PRODUCT OVERVIEW

The nVent RAYCHEM XTV family of self-regulating heating cables provides solutions for industrial freeze protection and process-temperature maintenance applications requiring high power output. XTV heating cables can withstand temperatures up to 482°F (250°C) and provide process temperature maintenance to 250°F (121°C).

The heating cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

The power output of self-regulating heating cable depends on the heating cable temperature, and can provide up to 20 W/ft at 50°F (10°C).

XTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code. For additional information, contact your nVent representative or call (800) 545-6258.

10 YEAR Product warranty

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

XTV1	100–130 Vac
XTV2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	250°F (121°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	482°F (250°C)*
Minimum installation temperature	–40°F (–40°C)

*The 250°C rating applies to all products printed “MAX INTERMITTENT EXPOSURE 250C”

TEMPERATURE ID NUMBER (T-RATING)

T2C: 446°F (230°C)	**T2D:** 419°F (215°C)	**T3:** 392°F (200°C)

Temperature ID numbers are consistent with North America National Electrical Codes.

20XTV1-CT-T2, 20XTV2-CT-T2	15XTV1-CT-T2	5XTV1-CT-T3, 5XTV2-CT-T3, 10XTV1-CT-T3, 10XTV2-CT-T3 15XTV2-CT-T3
Based on systems approach*	T3-T6	

* XTV heating cables are approved for T3 – T6 temperature classes when stabilized or controlled designs are used according to the requirements of applicable national and international approvals standards. Use TraceCalc Pro design software or contact nVent.

APPROVALS

IECEx

IECEx BAS 06.0044X
Ex e IIC T* Gb
Ex tD A21 IP66 T**°C

Hazardous Locations

FM APPROVED

Class I, Div. 2, Groups A, B, C, D
Class II(1), Div. 2, Groups F, G
Class III(1)

-W

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

XTV heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

Zone Approvals

FM APPROVED

CLI, ZN1, AEx e II T3 (T2)

-W

Ex e II T3 (T2)

09-IEx-0005X
Ex e IIC T* Gb

(1) Applications must be reviewed by the manufacturer.

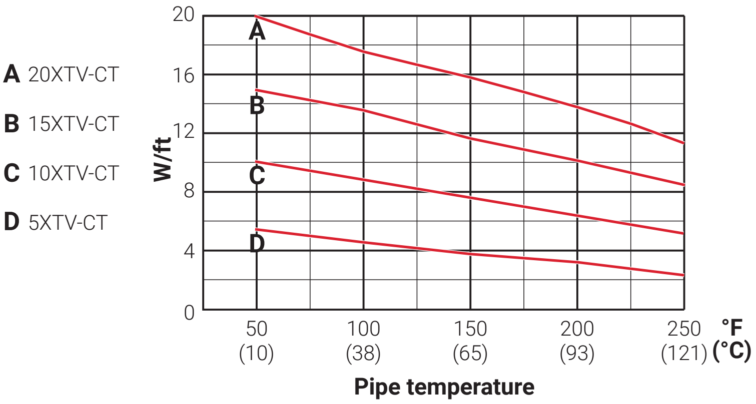
(*, **) For maximum surface temperature, see heating cable, design documentation or schedule

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the nVent (H57274). Literature is available via the nVent web site, nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	**Circuit length**
208 V		
5XTV2	0.87	0.93
10XTV2	0.88	0.92
15XTV2	0.88	0.92
20XTV2	0.89	0.94
277 V		
5XTV2	1.07	1.12
10XTV2	1.08	1.09
15XTV2	1.08	1.12
20XTV2	1.07	1.12



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker									
			120 V					240 V				
			15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
5XTV-CT	50°F	(10°C)	180	240	360	385	385	360	480	720	765	765
	0°F	(–18°C)	160	210	320	385	385	315	420	625	765	765
	–20°F	(–29°C)	150	200	305	385	385	295	395	595	765	765
	–40°F	(–40°C)	145	195	290	385	385	285	380	570	760	765
10XTV-CT	50°F	(10°C)	110	145	220	270	270	220	295	440	540	540
	0°F	(–18°C)	95	130	195	260	270	195	260	385	515	540
	–20°F	(–29°C)	95	125	190	250	270	185	245	370	495	540
	–40°F	(–40°C)	90	120	180	240	270	175	235	355	470	540
15XTV-CT	50°F	(10°C)	75	100	150	200	220	150	200	300	400	445
	0°F	(–18°C)	65	90	135	180	220	130	175	265	355	440
	–20°F	(–29°C)	65	85	130	170	215	125	165	250	335	420
	–40°F	(–40°C)	60	80	125	165	205	120	160	240	320	405
20XTV-CT	50°F	(10°C)	60	80	120	160	190	115	150	230	305	380
	0°F	(–18°C)	50	70	105	140	180	100	135	205	275	345
	–20°F	(–29°C)	50	65	100	135	170	100	130	200	265	330
	–40°F	(–40°C)	50	65	100	130	165	95	125	190	255	320

PRODUCT CHARACTERISTICS

Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	1.1
Bus wire size	14 AWG
Outer jacket color	Red
Heating cable dimensions	0.46 in x 0.3 in (11.7 mm x 7.6 mm)

ORDERING DETAILS

Description	Part Number
5XTV1-CT-T3	P000001668
5XTV2-CT-T3	P000001669
10XTV1-CT-T3	P000001671
10XTV2-CT-T3	P000001672
15XTV1-CT-T2	P000001674
15XTV2-CT-T3	P000001675
20XTV1-CT-T2	P000001676
20XTV2-CT-T2	P000001677

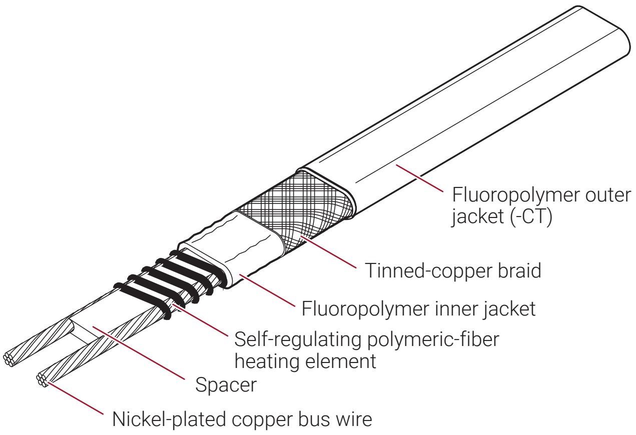
CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HIGH-TEMPERATURE SELF-REGULATING HEATING CABLES ELECTRICAL FREEZE PROTECTION AND PROCESS-TEMPERATURE MAINTENANCE FOR BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM KTV family of self-regulating heating cables provides high-temperature electrical heat-tracing for industrial freeze protection and process temperature maintenance applications requiring high power output. KTV heating cables can withstand temperatures up to 482°F (250°C) and provide process temperature maintenance to 300°F (150°C).

The heating cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

KTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.
For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

KTV1	100–130 Vac
KTV2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	300°F (150°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	482°F (250°C)*
Minimum installation temperature	–40°F (–40°C)

*The 250°C rating applies to all products printed “MAX INTERMITTENT EXPOSURE 250C”

TEMPERATURE ID NUMBER (T-RATING)

	T2C: 446°F (230°C) Temperature ID numbers are consistent with North America National Electrical Codes.
Based on systems approach*	T3 -T6

* KTV heating cables are approved for T3 -T6 temperature classes when stabilized or controlled designs are used according to the requirements of applicable national and international approvals standards. Use TraceCalc Pro design software or contact nVent Industrial.

APPROVALS

IECEx

IECEx BAS 06.0046X
Ex e IIC T* Gb
Ex tD A21 IP66 T**°C

Hazardous Locations

FM APPROVED

Class I, Div. 2, Groups A, B, C, D
Class II(1), Div. 2, Groups F, G
Class III(1)

CSA -W

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

KTV heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

Zone Approvals

FM APPROVED

CLI, ZN1, AEx e II T3 (T2)

CSA -W

Ex e II T3 (T2)

(1) Applications must be reviewed by the manufacturer.

(*, **) For maximum surface temperature, see heating cable, design documentation or schedule

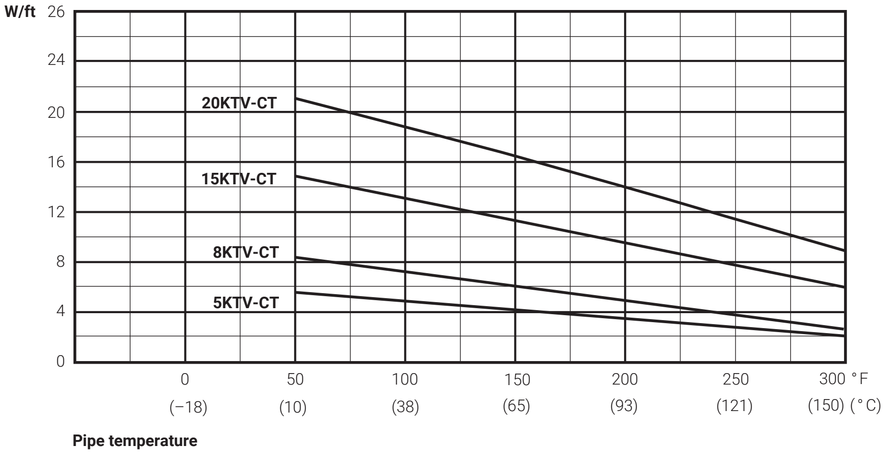
DESIGN AND INSTALLATION

For proper design and installation, use nVent RAYCHEM TraceCalc Pro design software or the design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the and Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	**Circuit length**
208 V	0.78	0.94
277 V	1.19	1.06

Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.



MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up	**Maximum circuit length (in feet) per circuit breaker**									
		120 V					**240 V**				
		15 A	**20 A**	**30 A**	**40 A**	**50 A**	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
5KTV	50°F (10°C)	180	240	360	385	385	360	480	720	765	765
	0°F (-18°C)	160	215	320	385	385	320	430	640	765	765
	−20°F (-29°C)	155	205	305	385	385	310	415	620	765	765
	−40°F (-40°C)	145	195	290	385	385	300	400	600	765	765
8KTV	50°F (10°C)	130	170	260	300	300	260	345	515	600	600
	0°F (-18°C)	115	150	225	300	300	230	310	465	600	600
	−20°F (-29°C)	110	145	215	290	300	225	295	445	595	600
	−40°F (-40°C)	105	140	205	275	300	215	285	430	570	600
15KTV	50°F (10°C)	80	105	160	215	220	160	215	320	425	440
	0°F (-18°C)	75	95	145	195	220	145	190	285	385	440
	−20°F (-29°C)	70	95	140	185	220	140	185	275	370	440
	−40°F (-40°C)	65	90	135	180	220	135	180	265	355	440
20KTV	50°F (10°C)	55	75	115	155	185	115	155	230	305	375
	0°F (-18°C)	50	70	105	140	175	105	140	210	280	350
	−20°F (-29°C)	50	65	100	135	165	100	135	200	270	335
	−40°F (-40°C)	50	65	95	130	160	95	130	195	260	325

PRODUCT CHARACTERISTICS

Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	1.35
Bus wire size	14 AWG
Outer jacket color	Red
Heating cable dimensions	0.61 in x 0.36 in (13.3 mm x 7.6 mm)

ORDERING DETAILS

Description	**Part Number**
5KTV1-CT	P000001678
5KTV2-CT	P000001679
8KTV1-CT	P000001680
8KTV2-CT	P000001681
15KTV1-CT	P000001682
15KTV2-CT	P000001683
20KTV1-CT	P000001684
20KTV2-CT	P000001685

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

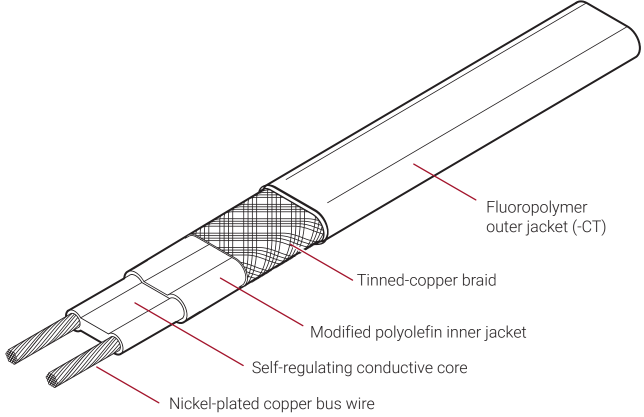
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HBTV

SELF-REGULATING HEATING CABLES FOR ELECTRICAL FREEZE PROTECTION IN C1D1 HAZARDOUS LOCATIONS

Heating cable construction



PRODUCT OVERVIEW

The nVent RAYCHEM HBTV family of self-regulating heating cables provides the solution to freeze-protection and process-temperature maintenance applications for CID1 areas. HBTV heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C). The cables are configured for use in CID1 areas, including areas where corrosives may be present.

HBTV cables meet the requirements of the U.S. National Electrical Code. For additional information, contact your nVent representative or call (800) 545-6258.

10 YEAR Product warranty

APPLICATION

Area classification	Hazardous locations
Traced surface type	Metal and plastic
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

HBTV1	100–130 Vac
HBTV2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	150°F (65°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	185°F (85°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T6: 185°F (85°C)
Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

(1) All Class I, Div. 1 designs must be reviewed by the manufacturer.

Hazardous Locations

FM APPROVED

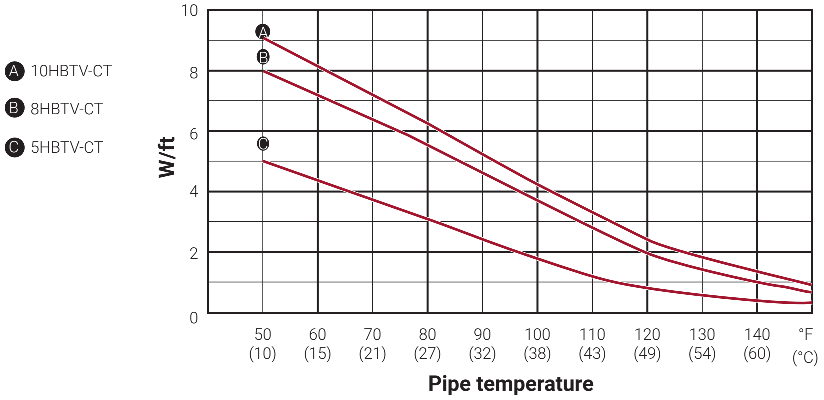
Class I, Div. 1(1), Groups B, C, D
Class II, Div. 1, Groups E, F, G
Class III

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the nVent and Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	Circuit length
208 V		
5HBTV2-CT	0.85	0.94
8HBTV2-CT	0.89	0.92
10HBTV2-CT	0.89	0.92
277 V		
5HBTV2-CT	1.12	1.09
8HBTV2-CT	1.08	1.11
10HBTV2-CT	1.08	1.11



Note: Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker							
			120 V				240 V			
			15 A	20 A	30 A	40 A	15 A	20 A	30 A	40 A
5HBTV-CT	50°F	(10°C)	230	270	270	270	460	540	540	540
	0°F	(–18°C)	140	190	270	270	285	380	540	540
	–20°F	(–29°C)	125	165	250	270	250	330	500	540
	–40°F	(–40°C)	110	145	220	270	220	295	440	540
8HBTV-CT	50°F	(10°C)	150	200	210	210	300	400	420	420
	0°F	(–18°C)	100	130	200	210	200	265	400	420
	–20°F	(–29°C)	85	115	175	210	175	235	350	420
	–40°F	(–40°C)	80	105	155	210	155	210	315	420
10HBTV-CT	50°F	(10°C)	120	160	180	180	240	315	360	360
	0°F	(–18°C)	80	110	160	180	160	215	325	360
	–20°F	(–29°C)	70	95	140	180	145	190	285	360
	–40°F	(–40°C)	65	85	125	170	125	170	255	340

PRODUCT CHARACTERISTICS

	5HBTV-CT	8HBTV-CT, 10HBTV-CT
Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	0.7	1.0
Bus wire size	16 AWG	16 AWG
Outer jacket color	Black	Black
Heating cable dimensions	0.46 in x 0.25 in (11.7 mm x 6.35 mm)	0.65 in x 0.26 in (16.5 mm x 6.6 mm)

ORDERING DETAILS

Description	Part number
5HBTV1-CT	264861-000
8HBTV1-CT	340733-000
10HBTV1-CT	435195-000

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

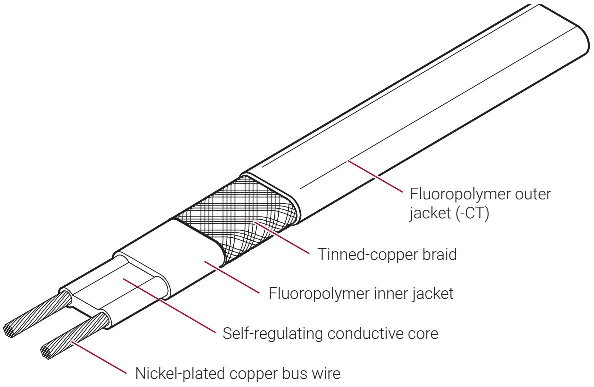
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HQTV

nVent
RAYCHEM

CLASS I, DIVISION 1 SELF-REGULATING HEATING CABLES ELECTRICAL PROCESS-TEMPERATURE MAINTENANCE FOR CID1 HAZARDOUS LOCATIONS



Heating cable construction

10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM HQTV family of self-regulating heating cables is designed for pipe heat tracing in industrial applications. HQTV heating cables can provide process-temperature maintenance up to 225°F (110°C) and can also be used for freeze protection in systems having high heat loss. The cables are configured for use in CID1 locations including areas where corrosives may be present.

HQTV-CT cables meet therequirements of the U.S. National Electrical Code. For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Hazardous locations
Traced surface type	Metal and plastic
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

HQTV1	120 V (100–130 Vac)
HQTV2	240 V (200–277 Vac)

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	225°F (110°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	225°F (110°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T4: 275°F (135°C)
Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

(1) All Class I, Div. 1 designs must be reviewed by the manufacturer.

Hazardous Locations

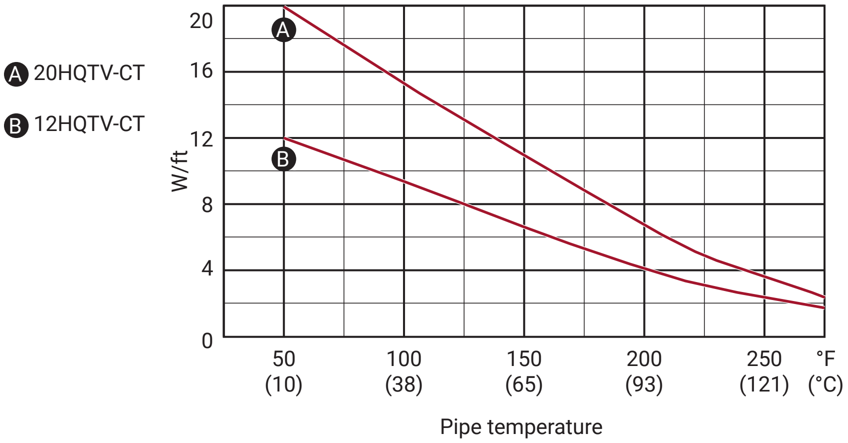
Class I, Div. 1(1), Groups B, C, D
Class II, Div. 1, Groups E, F, G
Class III

DESIGN AND INSTALLATION

For proper design and installation, use nVent RAYCHEM TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the Industrial Heat-Tracing Installation and Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors Power output	Circuit length
208 V		
12HQTV2-CT	0.85	0.94
20HQTV2-CT	0.90	0.91
277 V		
12HQTV2-CT	1.18	1.06
20HQTV2-CT	1.07	1.11



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker									
			120 V					240 V				
			15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
12HQTV-CT	50°F	(10°C)	100	130	195	195	†	200	265	390	390	†
	0°F	(–18°C)	80	105	160	195	†	160	210	320	390	†
	–20°F	(–29°C)	70	95	145	195	†	145	195	295	390	†
	–40°F	(–40°C)	65	90	135	180	†	135	180	275	365	†
20HQTV-CT	50°F	(10°C)	60	80	120	160	195	120	160	240	320	390
	0°F	(–18°C)	45	60	95	125	160	95	125	190	255	320
	–20°F	(–29°C)	40	55	85	115	145	85	115	175	235	295
	–40°F	(–40°C)	40	55	80	110	135	80	110	165	220	275

† Not permitted

PRODUCT CHARACTERISTICS

	12HQTV1-CT, 12HQTV2-CT	20HQTV1-CT, 20HQTV2-CT
Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	0.85	1.21
Bus wire size	16 AWG	14 AWG
Outer jacket color	Brown	Brown
Heating cable dimensions	0.55 in x 0.25 in (14 mm x 6.35 mm)	0.61 in x 0.25 in (15.5 mm x 6.35 mm)

ORDERING DETAILS

Description	Part number
12HQTV1-CT	899597-000
20HQTV1-CT	172891-000
12HQTV2-CT	550107-000
20HQTV2-CT	094323-000

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

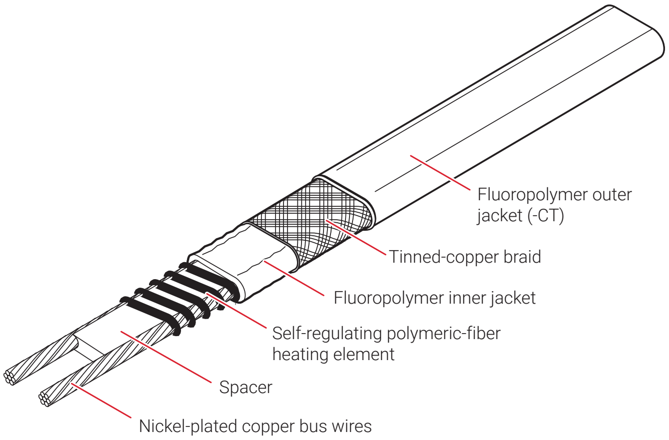
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HXTV

nVent
RAYCHEM

CLASS I, DIVISION 1 SELF-REGULATING HEATING CABLES ELECTRICAL FREEZE PROTECTION AND PROCESS-TEMPERATURE MAINTENANCE FOR CID1 HAZARDOUS LOCATIONS



10 YEAR Product warranty

Heating cable construction

PRODUCT OVERVIEW

The nVent RAYCHEM HXTV family of self-regulating heating cables provides solutions to industrial freeze protection and process-temperature maintenance applications requiring high power output. HXTV heating cables can withstand temperatures up to 482°F (250°C) and provide process-temperature maintenance to 250°F (121°C).

All of the HXTV family of heating cables can be used in CID1 locations, including areas where corrosives may be present.

The power output of self-regulating heating cable is dependent on the heating cable temperature and can provide up to 20 W/ft at 50°F (10°C).

HXTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.
For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Hazardous locations
Traced surface type	Metal and some plastics For use on plastic pipes, refer to TraceCalc Pro design software.
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

HXTV1	100–130 Vac
HXTV2	200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	250°F (121°C)
Maximum intermittent exposure temperature, 1000 hours (power-on or off)	482°F (250°C)*
Minimum installation temperature	–40°F (–40°C)

*The 250°C rating applies to all products printed “MAX INTERMITTENT EXPOSURE 250C”

TEMPERATURE ID NUMBER (T-RATING)

T2C: 446°F (230°C)	**T2D:** 419°F (215°C)	**T3:** 392°F (200°C)

Temperature ID numbers are consistent with North America National Electrical Codes.

20HXTV2-CT-T2, 20HXTV1-CT-T2	15HXTV1-CT-T2	5HXTV1-CT-T3, 5HXTV2-CT-T3, 10HXTV1-CT-T3, 10HXTV2-CT-T3, 15HXTV2-CT-T3
Based on systems approach*	T3-T6	

* HXTV heating cables are approved for T3 – T6 temperature classes when stabilized or controlled designs are used according to the requirements of IEEE 515. Use TraceCalc Pro design software or contact nVent.

APPROVALS

(1) All Class I, Div. 1 designs must be reviewed by the manufacturer.

Hazardous Locations

FM APPROVED

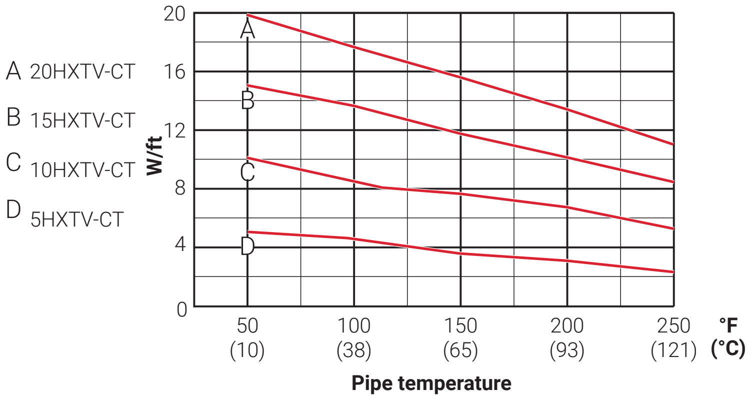
Class I, Div. 1(1), Groups B, C, D
Class II, Div. 1, Groups E, F, G
Class III

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the Industrial Heat-Tracing Installation and Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V / 240 V

	Adjustment factors	
	Power output	Circuit length
208 V		
5HXTV2-CT	0.87	0.99
10HXTV2-CT	0.88	0.99
15HXTV2-CT	0.88	0.98
20HXTV2-CT	0.86	1.00
277 V		
5HXTV2-CT	1.07	1.08
10HXTV2-CT	1.08	1.06
15HXTV2-CT	1.08	1.06
20HXTV2-CT	1.07	1.08



Note: To choose the correct heating cable for your application, use the Design section of the Advanced Industrial Solutions Heat-Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up	Maximum circuit length (in feet) per circuit breaker									
		120 V					240 V				
		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
5HXTV-CT	50°F (10°C)	180	240	360	385	385	360	480	720	765	765
	0°F (–18°C)	160	210	320	385	385	315	420	625	765	765
	–20°F (–29°C)	150	200	305	385	385	295	395	595	765	765
	–40°F (–40°C)	145	195	290	385	385	285	380	570	760	765
10HXTV-CT	50°F (10°C)	110	145	220	270	270	220	295	440	540	540
	0°F (–18°C)	95	130	195	260	270	195	260	385	515	540
	–20°F (–29°C)	95	125	190	250	270	185	245	370	495	540
	–40°F (–40°C)	90	120	180	240	270	175	235	355	470	540

	Ambient temperature at start-up	Maximum circuit length (in feet) per circuit breaker									
		120 V					240 V				
		15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
15HXTV-CT	50°F (10°C)	75	100	150	200	220	150	200	300	400	445
	0°F (−18°C)	65	90	135	180	220	130	175	265	355	440
	−20°F (−29°C)	65	85	130	170	215	125	165	250	335	420
	−40°F (−40°C)	60	80	125	165	205	120	160	240	320	405
20HXTV-CT	50°F (10°C)	60	80	120	160	190	115	150	230	305	380
	0°F (−18°C)	50	70	105	140	180	100	135	205	275	345
	−20°F (−29°C)	50	65	100	135	170	100	130	200	265	330
	−40°F (−40°C)	50	65	100	130	165	95	125	190	255	320

PRODUCT CHARACTERISTICS

Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	1.1
Bus wire size	14 AWG
Outer jacket color	Red
Heating cable dimensions	0.46 in x 0.3 in (11.7 mm x 7.6 mm)

ORDERING DETAILS

Description	Part Number
5HXTV1-CT	P000001686
5HXTV2-CT	P000001687
10HXTV1-CT	P000001688
10HXTV2-CT	P000001689
15HXTV1-CT	P000001690
15HXTV2-CT	P000001691
20HXTV1-CT	P000001692
20HXTV2-CT	P000001693

CONNECTION KITS

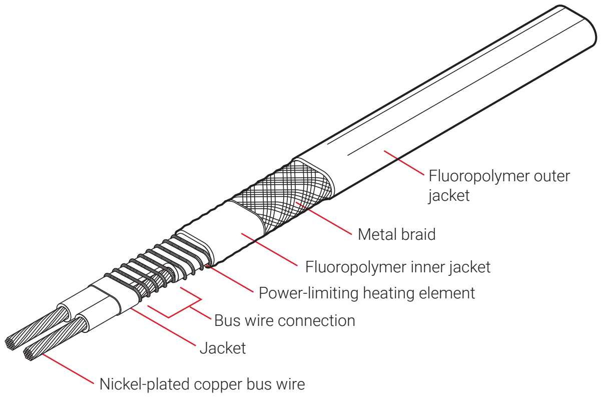
nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

VPL

HIGH-TEMPERATURE POWER-LIMITING HEATING CABLES FOR FREEZE PROTECTION AND PROCESS TEMPERATURE MAINTENANCE (NONHAZARDOUS AND HAZARDOUS LOCATIONS)



Heating cable construction

PRODUCT OVERVIEW

nVent RAYCHEM VPL is a family of power-limiting heating cables designed for pipe heat tracing in industrial applications. VPL can be used for freeze protection and process-temperature maintenance requiring high power output and/or high temperature exposure up to 455°F (235°C) and can withstand routine steam purges and temperature excursions to 500°F (260°C) with power off.

Power-limiting cables are parallel heaters formed by a coiled resistor alloy heating element wrapped around two parallel bus wires. The distance between conductor contact points forms the heating zone length. This parallel construction allows the cable to be cut to length and terminated on site. The power output of VPL heating cables decreases with increasing temperature. VPL heating cables can be overlapped. The relatively flat power temperature curve of VPL ensures a low start-up current and high output at elevated temperatures.

VPL cables are approved for use in non-hazardous and hazardous locations. Approvals are listed below.

VPL cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code. For additional information contact your nVent representative or call (800) 545-6258.

10 YEAR Product warranty

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

TECHNICAL DATA SHEETS

TEMPERATURE RATING

Maximum exposure temperature (power off)	500°F (260°C)
Minimum installation temperature	−40°F (−40°C)

Maximum continuous maintain (power on) temperature table						
Cable	**120 V**	**208 V**	**230 V**	**240 V**	**277 V**	**480 V**
5VPL1-CT	445°F (230°C)	–	–	–	–	–
10VPL1-CT	400°F (205°C)	–	–	–	–	–
15VPL1-CT	335°F (170°C)	–	–	–	–	–
20VPL1-CT	300°F (150°C)	–	–	–	–	–
5VPL2-CT	–	455°F (235°C)	445°F (230°C)	445°F (230°C)	435°F (225°C)	–
10VPL2-CT	–	425°F (220°C)	410°F (210°C)	400°F (205°C)	390°F (200°C)	–
15VPL2-CT	–	410°F (210°C)	375°F (190°C)	335°F (170°C)	240°F (115°C)	–
20 VPL2-CT	–	300°F (150°C)	300°F (150°C)	300°F (150°C)	–	–
5VPL4-CT	–	–	–	–	–	445°F (230°C)
10VPL4-CT	–	–	–	–	–	400°F (205°C)
15VPL4-CT	–	–	–	–	–	335°F (170°C)
20VPL4-CT	–	–	–	–	–	300°F (150°C)

TEMPERATURE ID NUMBER (T-RATING)

To be established using the principles of stabilized design.
Use nVent RAYCHEM TraceCalc Pro design software or contact nVent for assistance.

APPROVALS

IECEx

IECEx BAS 06.0048X
EX e IIC T* Gb
Ex tD A21 IP66 T**°C

[1] For maximum surface temperature, see heating cable, design documentation or schedule

Hazardous Locations

Class I, Div. 2, Groups B, C, D
Class II, Div. 2, Groups F, G
Class III
T-class by design

Ex e IIC T* Gb

-W

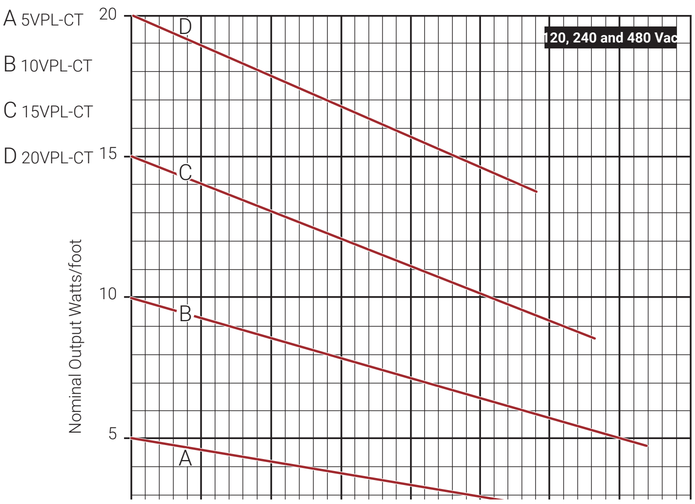
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Ex e II T*
*T-class by design

DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). Also, refer to the nVent Maintenance Manual (H57274). Literature is available via the nVent web site, nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES AT 120 V, 240 V AND 480 V

	Adjustment factors	
	Power output	**Circuit length**
208 V		
5VPL2-CT	0.77	0.89
10VPL2-CT	0.78	0.90
15VPL2-CT	0.79	0.91
20VPL2-CT	0.80	0.92
277 V		
5VPL2-CT	1.30	1.13
10VPL2-CT	1.28	1.11
15VPL2-CT	1.26	1.09
20VPL2-CT	Not allowed	



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Products & Services Catalog (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

		Maximum circuit length (in feet) per circuit breaker														
		120 V					240 V					480 V				
	Ambient temperature at start-up	15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A	15 A	20 A	30 A	40 A	50 A
5VPL-CT	50°F (10°C)	260	350	370	370	370	525	85	40	740	740	1050	1370	1480	1480	1480
	0°F (–18°C)	240	325	370	370	370	485	645	0	740	740	970	1290	1480	1480	1480
	–20°F (–29°C)	235	315	370	370	370	470	625	740	740	740	940	1250	1480	1480	1480
	–40°F (–40°C)	225	305	370	370	370	455	610	740	740	740	910	1220	1480	1480	1480
10VPL-CT	50°F (10°C)	130	175	260	260	260	260	50	525	525	525	520	700	1050	1050	1050
	0°F (–18°C)	120	165	245	260	260	245	25	490	525	525	490	650	980	1050	1050
	–20°F (–29°C)	120	160	240	260	260	235	315	475	525	525	470	630	950	1050	1050
	–40°F (–40°C)	115	155	230	260	260	230	310	465	525	525	460	620	930	1050	1050
15VPL-CT	50°F (10°C)	85	115	175	215	215	175	230	350	430	430	350	460	700	860	860
	0°F (–18°C)	80	110	165	215	215	165	220	325	430	430	330	440	650	860	860
	–20°F (–29°C)	80	105	160	215	215	160	215	320	425	430	320	430	640	850	860
	–40°F (–40°C)	75	100	155	210	215	155	210	310	415	430	310	420	620	830	860
20VPL-CT	50°F (10°C)	65	85	130	175	185	130	175	260	350	370	260	350	520	700	740
	0°F (–18°C)	60	85	125	165	185	125	165	250	330	370	250	330	500	660	740
	–20°F (–29°C)	60	80	120	160	185	120	160	245	325	370	240	320	490	650	740
	–40°F (–40°C)	60	80	120	160	185	115	155	240	320	370	230	310	480	640	740

PRODUCT CHARACTERISTICS

	5VPL1-CT, 10VPL1-CT 15VPL1-CT, 20VPL1-CT	5VPL2-CT, 10VPL2-CT 15VPL2-CT, 20VPL2-CT	5VPL4-CT, 10VPL4-CT 15VPL4-CT, 20VPL4-CT
Minimum bend radius	0.75 in	0.75 in	0.75 in
Supply voltage	100–120 Vac	200–277 Vac (20VPL2-CT 200–240 Vac only)	400–480 Vac
Bus wire size	12 AWG	12 AWG	12 AWG
Outer jacket color	Red	Red	Red
Weight (lb per 10 ft, nominal)	1.4	1.4	1.4
Heating cable dimensions	0.46 in x 0.3 in (11.7 mm x 7.6 mm)	0.46 in x 0.3 in (11.7 mm x 7.6 mm)	0.46 in x 0.3 in (11.7 mm x 7.6 mm)

ORDERING DETAILS

Description	Part number
5VPL1-CT	587458-000
5VPL2-CT	451828-000
5VPL4-CT	P000000678
10VPL1-CT	276822-000
10VPL2-CT	892652-000
10VPL4-CT	P000000679
15VPL1-CT	181162-000
15VPL2-CT	068380-000
15VPL4-CT	P000000680
20VPL1-CT	005614-000
20VPL2-CT	589252-000
20VPL4-CT	P000000681

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

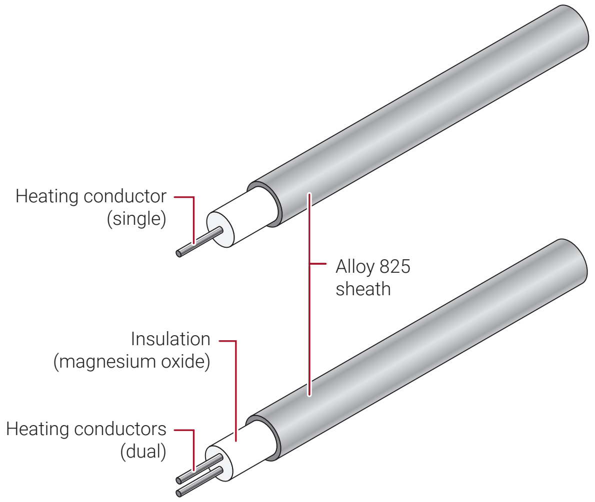
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

480 V VPL must use nVent RAYCHEM 920, nVent RAYCHEM NGC-30 or NGC-40 controllers only, which provide ground-fault protection at 480 volts.

XMI-A (ALLOY 825)

HIGH TEMPERATURE CONSTANT WATTAGE MINERAL INSULATED HEATING CABLES



Heating cable construction

10
YEAR
Product
warranty

PRODUCT OVERVIEW

nVent RAYCHEM XMI-A heating cables provide solutions for industrial freeze protection and process- temperature maintenance applications up to 1022°F (550°C) and maximum exposure temperatures up to 1200°F (650°C).

They are available as 300 V and 600 V rated heating cables and are approved for applications up to 61 watts per foot (200 watts per meter) of power output, and can be used for pipe and vessel tracing in both hazardous and nonhazardous area applications.

XMI-A heating cables are constructed using an Alloy 825 sheath and are ideally suited for heating applications where high power output, high exposure temperatures, or extreme resistance to environmental corrosives is needed.

For additional information, contact your nVent Industrial Heat Tracing Solutions representative or call (800) 545-6258.

TEMPERATURE RATING

Maximum continuous exposure temperature for heating cable*	1200°F (650°C)
Maximum continuous exposure temperature for brazed components such as hot/cold joints and end cap*	1022°F (550°C)

* Higher temperature/power capabilities may also be available depending on the application; contact nVent Industrial Heat Tracing Solutions for additional information.

TEMPERATURE ID NUMBER (T-RATING)

To be established by calculating the maximum sheath temperature. Use TraceCalc Pro design software or contact nVent for assistance.

APPROVALS

XMI-A
(Alloy 825 sheath)
Nonhazardous and Hazardous Locations

Class I, Div 1 (Zone 1) and
Div 2 (Zone 2) Group A, B, C, D

Class II, Div 1 and Div 2 Group E, F, G

Class III Div 1 and Div 2; T **

Note: Division to Zone equivalence per CEC 18-100 and 18-150

Ex e IIC T* Gb

SPECIFICATIONS

Product Family	Sheath Material	Product Code	Voltage Rating	Number of Conductors	Max. Power Output**	Bending Radius
XMI-A	Alloy 825	XMI-A61	600 V	1	61 W/ft; 200 W/m	6 times heating cable diameter
XMI-A	Alloy 825	XMI-A32	300 V	2	60 W/ft; 197 W/m	6 times heating cable diameter
XMI-A	Alloy 825	XMI-A62	600 V	2	61 W/ft; 200 W/m	6 times heating cable diameter

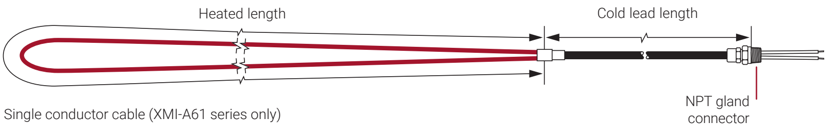
** Actual power output values are application specific and may be lower, particularly for designs in hazardous locations. Use TraceCalc Pro design software or contact nVent Industrial Heat Tracing Solutions for design assistance.

BASIC HEATING CABLE DESIGN CONFIGURATIONS

XMI-A heating cables are designed as engineered heating units according to your specific application. An engineered heating unit consists of a length of heating cable (Heated length) joined to a length of non-heating cold lead (Cold lead length). Engineered heating units are designed using our TraceCalc Pro software. This section describes the available XMI-A engineered heating unit design configurations.

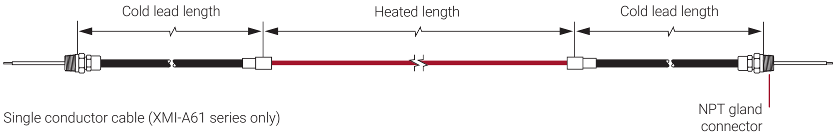
Various quick connector options are available for the XMI-A cold lead (Canada only). Refer to data sheet H59126 for further details.

Design A



Single conductor cable (XMI-A61 series only)

Design B

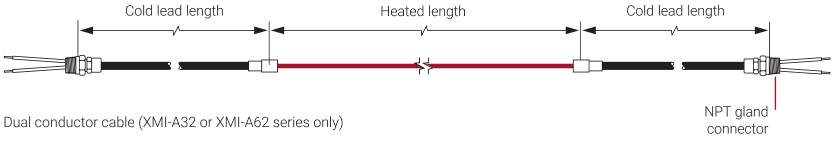


Single conductor cable (XMI-A61 series only)

Design D

Dual conductor cable (XMI-A32 or XMI-A62 series only)

Design E



Dual conductor cable (XMI-A32 or XMI-A62 series only)

HEATING CABLE CATALOG NUMBER

An XMI-A engineered heating unit is ordered by compiling the catalog number based on the design of the specific engineered heating unit required for your application. Typically, an engineered heating unit is designed using our TraceCalc Pro design software which provides the catalog number as part of the design output. An explanation of the catalog number follows:

Example: Engineered Heating Unit (Part No.: EHU)
EHU: D/32SA2200/40/538/208/7/S25A/X/N12/RG1/PE/S

Position:	1	/ 2	/ 3	/ 4	/ 5	/ 6	/ 7	/ 8	/ 9	/ 10	/ 11	/ 12
	D	/ 32SA2200	/ 40	/ 538	/ 208	/ 7	/ S25A	/ X	/ N12	/ RG1	/ PE	/ S

Position	Characteristic	Code Options	Description
1	Design configuration	A, B, D or E	Designates the basic heating cable design configuration of the XMI-A engineered heating unit.
2	Heating cable reference	See Tables 3, 4 and 5	Indicates the XMI-A heating cable reference used in the design.
3	Heated length	Length of the heating cable in feet or meters	Default value is in feet; if in meters add "M" after the length.
4	Power	Power output of the heating cable unit	Power output at maintain temperature, in Watts, for the total heated length of the engineered heating unit.
5	Voltage	Effective voltage applied to a heating unit	This is the designed effective voltage that will be applied to the engineered heating unit (in the case of series connected heating units, it is the voltage across a single unit).
6	MI cold lead length	(length) or (length)–(length) Length of the MI cold lead in feet or meters	Default value is in feet; if in meters add "M" after the length. Standard lengths for XMI-A engineered heating units are 4 feet (1.2 m) or 7 feet (2.1 m), however custom lengths can be designated here. For E and B configurations, which have cold leads on each end, a single value (such as “7”) indicates that both MI cold leads are to be 7 feet long. A hyphenated value (such as “5-7”) indicates that the cold lead on one end is 5 feet long and the cold lead on the other end is 7 feet long.
7	MI cold lead code	Select the cold lead code from Table 2	Table 2 is used to select the appropriate MI cold lead based on the current and voltage rating required by the design.
8	Hot-cold joint type	X	“X” type joint is used with all XMI-A engineered heating units.
9	Gland size reference	Refer to Table 2	Gland size depends on the cold lead code selected from Table 2.
10	Reverse gland	RG12, RG34, RG1	Optional reversed gland added to the cold lead to make a water tight seal for design configurations A and D, when used for internal pipe tracing applications. • Design A configuration: only 1" NPT (RG1) reversed gland available. • Design D configuration: 1/2" NPT (RG12), 3/4" NPT (RG34) or 1" NPT (RG1) reversed gland available.
11	Pulling eye	PE	Optional pulling eye to aid in pulling a cable inside a pipe or channel. Use with Design D configuration only.
12	Special feature	S	Indicates a special non-standard feature has been added to the heating cable.

Examples

D/62SQ3100/200/9920/480/4/S25A/X/N12

- Configuration is Design D
- XMI-A62 heating cable (600 V rated, dual conductor cable), resistance at 20°C is 0.100 Ω/ft (0.328 Ω/m)
- Heating cable length is 200 ft (61 m)
- Heating cable wattage is 9920 W at 480 V
- MI cold lead length is 4 ft (1.2 m)
- MI cold lead code is S25A (25 Amps)
- Hot-cold joint type is “X” for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT

XMI-A (ALLOY 825)

E/32SQ3200/25M/870/120/2.1M/LS23A/X/N12

- Configuration is Design E
- XMI-A32 heating cable (300 V rated, dual conductor cable), resistance at 20°C is 0.200 Ω/ft (0.656 Ω/m)
- Heating cable length is 25 m (82 ft)
- Heating cable wattage is 870 W at 120 V
- MI cold lead length is 2.1 m (7 ft) on both ends
- MI cold lead code is LS23A (23 Amps)
- Hot-cold joint type is “X” for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT

B/61SQ3118/250/6820/480/5-7/S29A/X/N12

- Configuration is Design B
- XMI-A61 heating cable (600 V rated, single conductor cable), resistance at 20°C is 0.118 Ω/ft (0.387 Ω/m)
- Heating cable length is 250 ft (76 m)
- Heating cable wattage is 6820 W at 480 V
- MI cold lead length is 5 ft (1.5 m) on one end and 7 ft (2.1 m) on the other end
- MI cold lead code is S29A (29 Amps)
- Hot-cold joint type is “X” for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT

D/32SA2200/40/538/208/7/S25A/X/N12/RG1/PE

- Configuration is Design D
- XMI-A32 heating cable (300 V rated, dual conductor cable), resistance at 20°C is 2.0 Ω/ft (6.56 Ω/m)
- Heating cable length is 40 ft (12.2 m)
- Heating cable wattage is 538 W at 208 V
- MI cold lead length is 7 ft (2.1 m)
- MI cold lead code is S25A (25 Amps)
- Hot-cold joint type is “X” for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT
- Supplied with 1” NPT reversed gland
- Supplied with pulling eye

TABLE 1 HEATING CABLE REFERENCE DECODING

	6	**2**	**S**	**A**	**2**	**2**	**0**	**0**
Position	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Position	**Description**	
1	Maximum voltage rating	3 = 300 V, 6 = 600 V
2	Number of conductors	1 or 2
3	Sheath material	S = Alloy 825
4	Conductor material	A, B, C, F, P, Q, or T
5	Move decimal point to left indicated number of places	1, 2, 3, 4, 5, or 6 places
6 to 8	Cable resistance to 3 whole numbers (use with digit 5)	2200 = 2.00 Ω/cable foot at 20°C

TABLE 2 ALLOY 825 SHEATHED COLD LEADS

The cold lead is supplied from the factory with a standard stainless steel National Pipe Thread (NPT) gland connector ready for assembly into the junction box or panel using the flexible wire tails extending from the MI cold lead. The cold lead is selected based on the voltage and current requirements of the XMI-A engineered heating unit. The standard tail length is 12 in (30 cm) unless otherwise specified, and the gauge size (AWG) for the tails is shown in the table below.

Cold lead code for catalog number	Maximum voltage (V)	Maximum current (A)	Cold lead diameter in	mm	Gland size (NPT)	Gland size reference for catalog no.	Tail size (AWG)
Design A, D, E							
S25A	600	25	0.355	9.0	1/2 in	N12	14
LS23A	300	23	0.319	8.1	1/2 in	N12	14
S34A	600	34	0.402	10.2	3/4 in	N34	10
S49A	600	49	0.496	12.6	3/4 in	N34	8
S65A	600	65	0.543	13.8	3/4 in	N34	6
Design B							
S29A	600	29	0.215	5.5	1/2 in	N12	12
S40A	600	40	0.273	6.9	1/2 in	N12	10
S48A	600	48	0.253	6.4	1/2 in	N12	8
S66A	600	66	0.319	8.1	1/2 in	N12	6
S86A	600	86	0.355	9.0	1/2 in	N12	4

Note: MI cold lead minimum bending radius is 6 times the cable diameter.

TABLE 3 XMI-A61 SERIES MI HEATING CABLE SPECIFICATIONS (600 V, SINGLE CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C Ω/ft	Ω/m	Approximate in	mm	Maximum unjointed cable length ft	m	Nominal weight lb/1000 ft	kg/1000 m
61SA2200	2.00	6.56	0.170	4.3	1333	406	50	75
61SA2160	1.60	5.25	0.163	4.1	1452	443	44	66
61SA2130	1.30	4.27	0.160	4.1	1508	460	42	63
61SA2100	1.00	3.28	0.160	4.1	1510	460	43	64
61SA3850	0.850	2.79	0.170	4.3	1338	408	48	72
61SA3700	0.700	2.30	0.160	4.1	1514	462	43	64
61SA3500	0.500	1.64	0.170	4.3	1344	410	49	73
61ST3280	0.280	0.919	0.170	4.3	1337	408	48	72
61SB3200	0.200	0.656	0.180	4.6	1198	365	55	82
61SB3150	0.150	0.492	0.170	4.3	1350	412	51	76
61SQ3118	0.118	0.387	0.175	4.4	1260	384	50	75
61SQ4732	0.0732	0.240	0.170	4.3	1338	410	48	72
61SQ4581	0.0581	0.191	0.172	4.4	1308	399	50	75
61SP4467	0.0467	0.153	0.170	4.3	1337	408	48	72
61SP4366	0.0366	0.120	0.173	4.4	1292	394	50	75
61SP4290	0.0290	0.0951	0.177	4.5	1236	377	53	79
61SP4231	0.0231	0.0758	0.174	4.4	1282	391	52	78
61SP4183	0.0183	0.0600	0.170	4.3	1347	411	50	75
61SP4145	0.0145	0.0476	0.170	4.3	1351	412	51	76
61SP4113	0.0113	0.0371	0.186	4.7	1130	345	61	91
61SC5651	0.00651	0.0214	0.187	4.7	1110	338	60	89
61SC5409	0.00409	0.0134	0.191	4.9	1069	326	64	95
61SC5258	0.00258	0.00846	0.215	5.5	848	259	83	124
61SC5162	0.00162	0.00531	0.268	6.8	546	166	129	192
61SC5102	0.00102	0.00335	0.253	6.4	622	190	124	185
61SC6640	0.00064	0.00210	0.319	8.1	391	119	197	294

TABLE 4 XMI-A32 SERIES MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR)

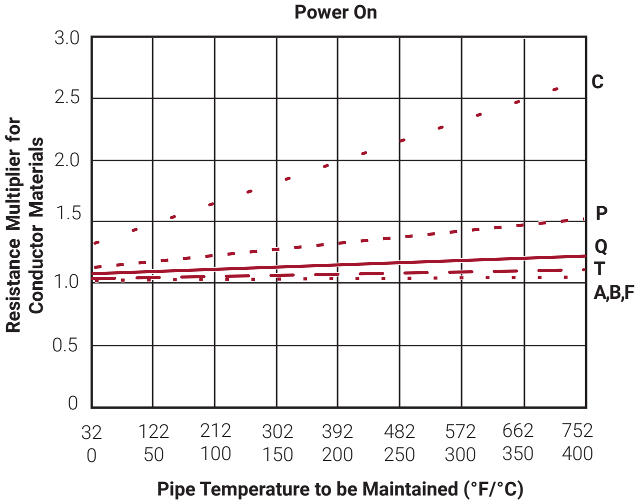
Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
32SF1180	18.0	59.0	0.174	4.4	1271	387	49	73
32SF1110	11.0	36.1	0.156	4.0	1584	483	40	60
32SF2900	9.00	29.5	0.160	4.1	1507	459	42	63
32SF2750	7.50	24.6	0.157	4	1565	477	41	61
32SA2600	6.00	19.7	0.160	4.1	1507	459	42	63
32SA2400	4.00	13.1	0.146	3.7	1816	554	36	54
32SA2318	3.18	10.4	0.174	4.4	1277	389	50	74
32SA2275	2.75	9.02	0.153	3.9	1657	505	40	60
32SA2200	2.00	6.56	0.169	4.3	1359	414	49	73
32SA2170	1.70	5.58	0.167	4.2	1395	425	48	72
32SB2114	1.14	3.74	0.174	4.4	1279	390	51	76
32SB3914	0.914	3.00	0.162	4.1	1480	451	45	67
32SB3700	0.700	2.30	0.170	4.3	1347	411	50	74
32SQ3472	0.472	1.55	0.177	4.5	1232	376	52	78
32SQ3374	0.374	1.23	0.183	4.6	1153	352	55	82
32SQ3293	0.293	0.961	0.179	4.5	1206	368	53	79
32SQ3200	0.200	0.656	0.161	4.1	1498	457	44	66
32SQ3150	0.150	0.492	0.168	4.3	1378	420	49	73
32SQ3100	0.100	0.328	0.185	4.7	1140	348	60	89
32SP4734	0.0734	0.241	0.174	4.4	1284	391	52	78
32SP4583	0.0583	0.191	0.178	4.5	1230	375	55	82
32SP4458	0.0458	0.150	0.188	4.8	1105	337	62	92
32SC4324	0.0324	0.106	0.184	4.7	1145	349	57	85

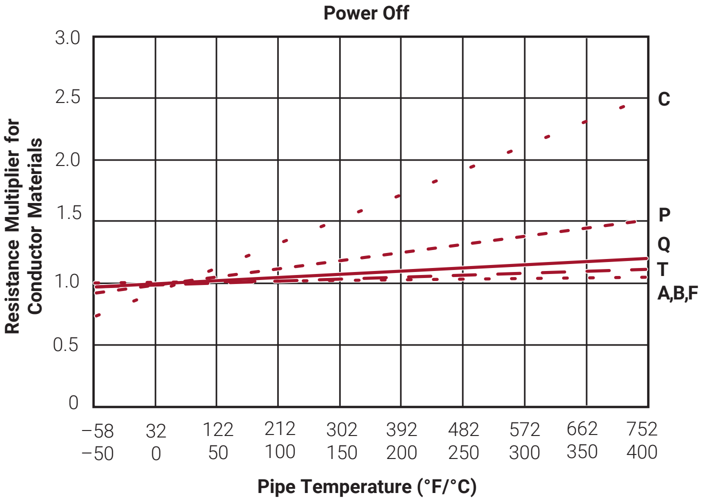
TABLE 5 XMI-A62 SERIES MI HEATING CABLE SPECIFICATIONS (600 V, DUAL CONDUCTOR)

Heating cable reference	Nominal cable resistance at 20°C		Approximate cable diameter		Maximum unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
62SF1110	11.0	36.1	0.194	4.9	1023	312	61	91
62SF2900	9.00	29.5	0.194	4.9	1024	312	61	91
62SF2750	7.50	24.6	0.205	5.2	916	279	69	103
62SF2600	6.00	19.7	0.230	5.8	728	222	86	128
62SA2414	4.14	13.6	0.240	6.1	669	204	94	140
62SA2275	2.75	9.02	0.225	5.7	762	232	84	125
62SF2200	2.00	6.56	0.245	6.2	644	196	100	149
62SA2170	1.70	5.58	0.240	6.1	671	205	96	143
62ST2115	1.15	3.77	0.215	5.5	834	254	76	113
62SB3914	0.914	3.00	0.232	5.9	718	219	89	132
62SB3700	0.700	2.30	0.265	6.7	550	168	117	174
62ST3505	0.505	1.66	0.215	5.5	837	255	77	115
62SQ3374	0.374	1.23	0.215	5.5	834	254	76	113
62SQ3286	0.286	0.938	0.222	5.6	783	239	81	121
62SQ3200	0.200	0.656	0.227	5.8	750	229	86	128
62SQ3150	0.150	0.492	0.227	5.8	751	229	86	128
62SQ3100	0.100	0.328	0.257	6.5	586	179	111	165
62SP4775	0.0775	0.254	0.250	6.4	618	188	104	155
62SP4561	0.0561	0.184	0.263	6.7	560	171	116	173
62SP4402	0.0402	0.132	0.277	7	505	154	130	194
62SP4281	0.0281	0.0922	0.292	7.4	456	139	147	219
62SC4200	0.0200	0.0656	0.285	7.2	476	145	135	201
62SC4130	0.0130	0.0427	0.304	7.7	419	128	156	233
62SC5818	0.00818	0.0268	0.331	8.4	330	100	187	279
62SC5516	0.00516	0.0169	0.364	9.2	294	90	230	343
62SC5324	0.00324	0.0106	0.402	10.2	242	74	290	432
62SC5204	0.00204	0.00669	0.496	12.6	159	48	438	653
62SC5128	0.00128	0.00420	0.543	13.8	469	143	516	769

RESISTANCE CORRECTION FACTOR

Various conductor materials behave differently. Use the graphs below for approximate adjustment of power and resistance as a function of temperature. For detailed design, use TraceCalc Pro design software or contact nVent Industrial Heat Tracing Solutions.





ALLOY 825 QUICK REFERENCE GUIDE

		Nominal chemical composition, % (major elements)				Thermal conductivity Btu-in/ft^2-hr-°F (W/m-C)		High temperature resistance +1000°F (+540°C)		Corrosion resistance **G-E=** Good to excellent **NR =** Not recommended **A =** Acceptable **X =** Check for specific data											
Alloy	**Description**	**Nickel (+Cobalt)**	**Iron**	**Chromium**	**Other**	**70°F (20°C)**	**1500°F (815°C)**	**Oxidation**	**Carburization**	**Sulfuric acid**	**Hydrochloric acid**	**Hydrofluoric acid**	**Phosphoric acid**	**Nitric acid**	**Organic acid**	**Alkalis**	**Salts**	**Seawater**	**Chloride cracking**
INCOLOY Alloy 825 nickel-iron-chromium	Excellent resistance to a wide variety of corrosives. Resists pitting and intergranular type corrosion, reducing acids and oxidizing chemicals	42.0	30.0	21.5	Mo 3.0 Cu 2.2	77 (11.1)	164 (23.6)	G-E	G-E	G-E	G-E	G-E	G-E	G-E	G-E	G-E	G-E	G-E	G-E

*From Huntington Alloys Publication 78-348-2

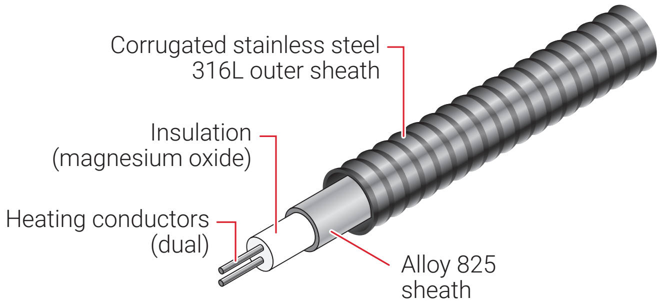
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed and to comply with the requirements of nVent Industrial Heat Tracing Solutions, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

XMI-L

nVent
RAYCHEM

STAINLESS STEEL, LOW TEMPERATURE SHEATH CONSTANT WATTAGE MINERAL INSULATED HEATING CABLES



Heating cable construction

10 YEAR Product warranty

PRODUCT OVERVIEW

nVent RAYCHEM XMI-L heating cables provide solutions for industrial freeze protection and process-temperature maintenance applications up to 752°F (400°C) and maximum continuous exposure temperatures up to 1022°F / 550°C.

They are available as 300 V and 600 V rated heating cables and are approved for applications up to 50 watts per foot (164 watts per meter) of power output and are ideally suited for heating applications where high power output, high exposure temperatures, or extreme resistance to environmental corrosives is needed.

XMI-L heating cables are constructed using Alloy 825 sheathed MI heating cables inside a small or large corrugated 316L stainless steel sheath, providing a lower sheath temperature for optimized, reduced pass designs and improved constructability in hazardous area applications. The heating units are available in lengths up to 150 feet (45.7 meters).

For additional information, contact your Thermal Management representative or call (800) 545-6258.

TEMPERATURE RATING

Standard environmental conditions		
Typical outdoor, wet location conditions. Corrosives may be present; acidic pH levels; high chloride	Maximum continuous exposure temperature	842°F / 450°C
	Maximum intermittent exposure temperature (1000 hours, power off)	1022°F / 550°C
Protected environmental conditions		
Corrosives not present; controlled pH and chloride levels	Maximum continuous exposure temperature	1022°F / 550°C

TEMPERATURE ID NUMBER (T-RATING)

To be established by calculating the maximum sheath temperature.
Use TraceCalc Pro design software or contact Thermal Management for assistance.

APPROVALS

XMI-L

(Low temperature sheath)

Hazardous Locations

Class I, Div 2 (Zone 2), Groups A, B, C and D; Class II, Div 2, Groups E, F and G; Class III, Div 1 and Div 2; T**
Ex e IIC T** (for use in Zone 1 and Zone 2 locations)
Class I, Zone 1, AEx e IIC T**

SPECIFICATIONS

Product Family	Sheath Material	Product Code	Voltage Rating	Number of Conductors	Approximate Cable Diameter*	Maximum Length	Max. Power Output**
XMI-L	316L stainless steel	XMI-L32-CS	300 V	2	0.49 in; 12.4 mm (-CS)	150 ft; 45.7 m	50 W/ft; 164 W/m
XMI-L	316L stainless steel	XMI-L32-CL	300 V	2	0.57 in; 14.5 mm (-CL)	150 ft; 45.7 m	50 W/ft; 164 W/m
XMI-L	316L stainless steel	XMI-L62-CL	600 V	2	0.57 in; 14.5 mm (-CL)	150 ft; 45.7 m	50 W/ft; 164 W/m

* Large corrugated sheath (-CL) provides maximum reduction of sheath temperature. Small corrugated sheath (-CS) is recommended for smaller diameter pipes to allow greater contact around flanges, valves and other heat sink areas.

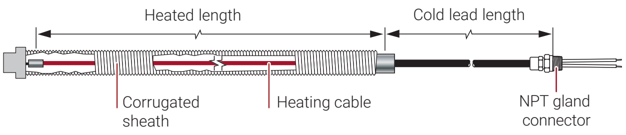
** Actual power output values are application specific and may be lower, particularly for designs in hazardous locations. Use TraceCalc Pro design software or contact Thermal Management for design assistance.

BASIC HEATING CABLE DESIGN CONFIGURATIONS

XMI-L heating cables are designed as engineered heating units according to your specific application. An engineered heating unit consists of a length of heating cable (Heated length) joined to a length of non-heating cold lead (Cold lead length). Engineered heating units are designed using our TraceCalc Pro software. This section describes the available XMI-L engineered heating unit design configurations.

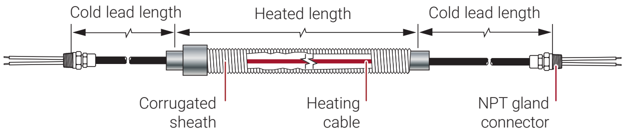
Various quick connector options are available for the XMI-L cold lead (Canada only). Refer to data sheet H59126 for further details.

Design D



Dual conductor cable (XMI-L32 or XMI-L62 series)

Design E



Dual conductor cable (XMI-L32 or XMI-L62 series)

HEATING CABLE CATALOG NUMBER

An XMI-L engineered heating unit is ordered by compiling the catalog number based on the design of the specific engineered heating unit required for your application. Typically, an engineered heating unit is designed using our TraceCalc Pro design software which provides the catalog number as part of the design output. An explanation of the catalog number follows:

Example: **Engineered Heating Unit (Part No.: EHU)**
EHU: D/32SA2200-CL/40/538/208/7/S25A/C/N12/S

Position:	**1**	**/**	**2**	**/**	**3**	**/**	**4**	**/**	**5**	**/**	**6**	**/**	**7**	**/**	**8**	**/**	**9**	**/**	**10**
	D	**/**	**32SA2200-CL**	**/**	**40**	**/**	**538**	**/**	**208**	**/**	**7**	**/**	**S25A**	**/**	**C**	**/**	**N12**	**/**	**S**

Position	Characteristic	Code Options	Description
1	Design configuration	D or E	Designates the basic heating cable design configuration of the XMI-L engineered heating unit.
2	Heating cable reference	See Table 3, 4 and 5	Indicates the XMI-L heating cable reference used in the design.
3	Heated length	Length of the heating cable in feet or meters	Default value is in feet; if in meters add "M" after the length.
4	Power	Power output of the heating cable unit	Power output at maintain temperature, in Watts, for the total heated length of the engineered heating unit.
5	Voltage	Effective voltage applied to a heating unit	This is the designed effective voltage that will be applied to the engineered heating unit (in the case of series connected heating units, it is the voltage across a single unit).
6	MI cold lead length	(length) or (length)–(length) Length of the MI cold lead in feet or meters	Default value is in feet; if in meters add "M" after the length. Standard lengths for XMI-L engineered heating units are 4 feet (1.2 m) or 7 feet (2.1 m), however custom lengths can be designated here. For E configurations, which have cold leads on each end, a single value (such as “7”) indicates that both MI cold leads are to be 7 feet long. A hyphenated value (such as “5-7”) indicates that the cold lead on one end is 5 feet long and the cold lead on the other end is 7 feet long.
7	MI cold lead code	Select the cold lead code from Table 2	Table 2 is used to select the appropriate MI cold lead based on the current and voltage rating required by the design.
8	Hot-cold joint type	C	“C” type joint is used with all XMI-L engineered heating units.
9	Gland size reference	Refer to Table 2	Gland size depends on the cold lead code selected from Table 2.
10	Special feature	S	Indicates a special non-standard feature has been added to the heating cable.

Examples

D/32SQ3100-CL/100/1360/120/4/LS23A/C/N12

- Configuration is Design D
- XMI-L32-CL heating cable (300 V rated, dual conductor, low temperature large corrugated sheath cable), resistance at 20°C is 0.100 Ohm/ft (0.328 Ohm/m)
- Heating cable length is 100 ft (30 m)
- Heating cable wattage is 1360 W at 120 V
- MI cold length is 4 ft (1.2 m)
- MI cold lead code is LS23A (23 Amps)
- Hot-cold joint type is "C" for use with XMI-L low temperature sheath cables
- Gland connector is 1/2 in NPT

E/32SQ3200-CS/82/870/120/5-2/LS23A/C/N12

- Configuration is Design E
- XMI-L32-CS heating cable (300 V rated, dual conductor, low temperature small corrugated sheath cable), resistance at 20°C is 0.200 Ohm/ft (0.656 Ohm/m)
- Heating cable length is 82 ft (25 m)
- Heating cable wattage is 870 W at 120 V
- MI cold lead length is 5 ft (1.5 m) on one end and 2 ft (0.6 m) on the other end
- MI cold lead code is LS23A (23 Amps)
- Hot-cold joint type is "C" for use with XMI-L low temperature sheath cables
- Gland connector is 1/2 in NPT

* Basic heating cable sheath is Alloy 825, however XMI-L (low temperature sheath) has an additional 316L stainless steel corrugated sheath covering the Alloy 825 heating cable.

TABLE 1 HEATING CABLE REFERENCE DECODING

	6	2	S	A	2	2	0	0	-	C	L
Position	1	2	3	4	5	6	7	8		9	10

Position	Description	
1	Maximum voltage rating	3 = 300 V, 6 = 600 V
2	Number of conductors	1 or 2
3	Sheath material	S = Alloy 825*
4	Conductor material	A, B, F, P, Q, or T
5	Move decimal point to left indicated number of places	1, 2, 3 or 4 places
6 to 8	Cable resistance to 3 whole numbers (use with digit 5)	2200 = 2.00 Ω/cable foot at 20°C
9 to 10	Extensions for low temperature sheath heating cable	"CL" indicates large corrugated 316L stainless steel sheath "CS" indicates small corrugated 316L stainless steel sheath

TABLE 2 ALLOY 825 SHEATHED COLD LEADS

This cold lead is supplied from the factory with a standard stainless steel National Pipe Thread (NPT) gland connector ready for assembly into the junction box or panel using the flexible wire tails extending from the MI cold lead. The cold lead is selected based on the voltage and current requirements of the XMI-L engineered heating unit. The standard tail length is 12 in (30 cm) unless otherwise specified, and the gauge size (AWG) for the tails is shown in the table below.

Cold lead code for catalog number	Maximum voltage (V)	Maximum current (A)	Cold lead diameter		Gland size (NPT)	Gland size reference for catalog no.	Tail size (AWG)
			in	mm			
Design D, E							
S25A	600	25	0.355	9.0	1/2 in	N12	14
LS23A	300	23	0.319	8.1	1/2 in	N12	14
S34A	600	34	0.402	10.2	3/4 in	N34	10
S49A	600	49	0.496	12.6	3/4 in	N34	8
S65A	600	65	0.543	13.8	3/4 in	N34	6

Note: MI cold lead minimum bending radius is 6 times the cable diameter.

TABLE 3 XMI-L32-CS SERIES MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR, LOW TEMPERATURE SHEATH, SMALL CORRUGATED CONDUIT)

Heating cable reference	Nominal cable resistance at 20°C		Nominal weight		Minimum bending radius	
	Ω/ft	Ω/m	lb/1000 ft	kg/1000 m	in	mm
32SF1180-CS	18.0	59.0	99	147	1.0	25
32SF1110-CS	11.0	36.1	90	134	0.9	23
32SF2900-CS	9.00	29.5	92	137	1.0	25
32SF2750-CS	7.50	24.6	91	136	0.9	23
32SA2600-CS	6.00	19.7	92	137	1.0	25
32SA2400-CS	4.00	13.1	86	128	0.9	23
32SA2318-CS	3.18	10.4	100	148	1.0	25
32SA2275-CS	2.75	9.02	90	134	0.9	23
32SA2200-CS	2.00	6.56	99	148	1.0	25
32SA2170-CS	1.70	5.58	98	146	1.0	25
32SB2114-CS	1.14	3.74	101	151	1.0	25
32SB3914-CS	0.914	3.00	95	141	1.0	25
32SB3700-CS	0.700	2.30	100	149	1.0	25
32SQ3472-CS	0.472	1.55	102	152	1.1	28
32SQ3374-CS	0.374	1.23	105	157	1.1	28
32SQ3293-CS	0.293	0.961	103	154	1.1	28
32SQ3200-CS	0.200	0.656	94	140	1.0	25
32SQ3150-CS	0.150	0.492	99	148	1.0	25
32SQ3100-CS	0.100	0.328	110	164	1.1	28
32SP4734-CS	0.0734	0.241	102	152	1.0	25
32SP4583-CS	0.0583	0.191	105	157	1.1	28
32SP4458-CS	0.0458	0.150	112	167	1.1	28

TABLE 4 XMI-L32-CL SERIES MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR, LOW TEMPERATURE SHEATH, LARGE CORRUGATED CONDUIT)

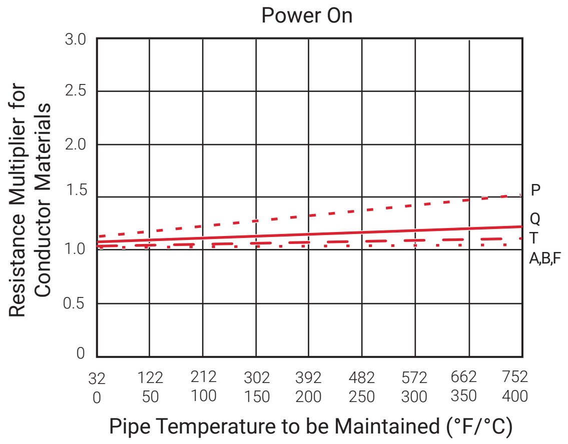
Heating cable reference	Nominal cable resistance at 20°C		Nominal weight		Minimum bending radius	
	Ω/ft	Ω/m	lb/1000 ft	kg/1000 m	in	mm
32SF1180-CL	18.0	59.0	131	197	1.0	25
32SF1110-CL	11.0	36.1	122	184	0.9	23
32SF2900-CL	9.00	29.5	124	187	1.0	25
32SF2750-CL	7.50	24.6	123	185	0.9	23
32SA2600-CL	6.00	19.7	124	187	1.0	25
32SA2400-CL	4.00	13.1	118	176	0.9	23
32SA2318-CL	3.18	10.4	132	198	1.0	25
32SA2275-CL	2.75	9.02	122	182	0.9	23
32SA2200-CL	2.00	6.56	131	195	1.0	25
32SA2170-CL	1.70	5.58	130	194	1.0	25
32SB2114-CL	1.14	3.74	133	198	1.0	25
32SB3914-CL	0.914	3.00	127	191	1.0	25
32SB3700-CL	0.700	2.30	132	197	1.0	25
32SQ3472-CL	0.472	1.55	134	200	1.1	28
32SQ3374-CL	0.374	1.23	137	204	1.1	28
32SQ3293-CL	0.293	0.961	135	201	1.1	28
32SQ3200-CL	0.200	0.656	126	188	1.0	25
32SQ3150-CL	0.150	0.492	131	195	1.0	25
32SQ3100-CL	0.100	0.328	142	212	1.1	28
32SP4734-CL	0.0734	0.241	134	200	1.0	25
32SP4583-CL	0.0583	0.191	137	204	1.1	28
32SP4458-CL	0.0458	0.150	144	215	1.1	28

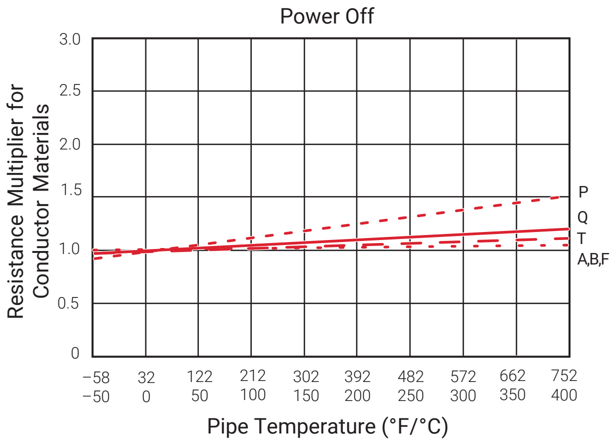
TABLE 5 XMI-L62-CL SERIES MI HEATING CABLE SPECIFICATIONS (600 V, DUAL CONDUCTOR, LOW TEMPERATURE SHEATH, LARGE CORRUGATED CONDUIT)

	Nominal cable resistance at 20°C		Nominal weight		Minimum bending radius	
Heating cable reference	**Ω/ft**	**Ω/m**	**lb/1000 ft**	**kg/1000 m**	**in**	**mm**
62SF1110-CL	11.0	36.1	143	213	1.2	30
62SF2900-CL	9.00	29.5	143	213	1.2	30
62SF2750-CL	7.50	24.6	151	227	1.2	30
62SF2600-CL	6.00	19.7	168	252	1.4	36
62SA2414-CL	4.14	13.6	176	264	1.4	36
62SA2275-CL	2.75	9.02	166	249	1.4	36
62SF2200-CL	2.00	6.56	182	271	1.5	38
62SA2170-CL	1.70	5.58	178	267	1.4	36
62ST2115-CL	1.15	3.77	158	236	1.3	33
62SB3914-CL	0.914	3.00	171	256	1.4	36
62SB3700-CL	0.700	2.30	199	298	1.6	40
62ST3505-CL	0.505	1.66	159	237	1.3	33
62SQ3374-CL	0.374	1.23	158	237	1.3	33
62SQ3286-CL	0.286	0.938	163	243	1.3	33
62SQ3200-CL	0.200	0.656	168	250	1.4	36
62SQ3150-CL	0.150	0.492	168	250	1.4	36
62SQ3100-CL	0.100	0.328	193	288	1.5	38
62SP4775-CL	0.0775	0.254	186	277	1.5	38
62SP4561-CL	0.0561	0.184	198	295	1.6	41
62SP4402-CL	0.0402	0.1320	212	316	1.7	43
62SP4281-CL	0.0281	0.0922	229	341	1.8	46

RESISTANCE CORRECTION FACTOR

Various conductor materials behave differently. Use the graphs below for approximate adjustment of power and resistance as a function of temperature. For detailed design, use TraceCalc Pro design software or contact nVent Thermal Management.





316L STAINLESS STEEL QUICK REFERENCE GUIDE

		Nominal chemical composition, % (major elements)				Thermal conductivity Btu-in/ft^2-hr-°F (W/m-C)	High temperature resistance +1000°F (+540°C)		Corrosion resistance G-E = Good to excellent G = Good NR = Not recommended A = Acceptable X = Check for specific data									
Alloy	Description	Nickel (+Cobalt)	Iron	Chromium	Other	70°F (20°C)	Oxidation	Carburization	Sulfuric acid	Hydrochloric acid	Hydrofluoric acid	Phosphoric acid	Nitric acid	Organic acid	Alkalis	Salts	Seawater	Chloride cracking
316L	Molybdenum-bearing austenitic stainless steel that is more resistant to general corrosion and pitting/crevice corrosion than conventional chromium nickel austenitic stainless steels such as 304.	12	69	16.5	Mo 2.1	101 (14.6)	G-E	NR	A	NR	—	A	G	G	G	G-E	G	A

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed and to comply with the requirements of Thermal Management, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

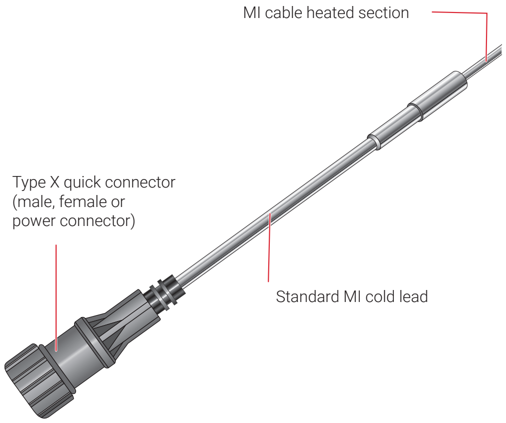
Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

COLD LEAD OPTIONS

FOR XMI MINERAL INSULATED (MI) HEATING CABLES

PRODUCT OVERVIEW

XMI with standard MI cold lead and Type X connector



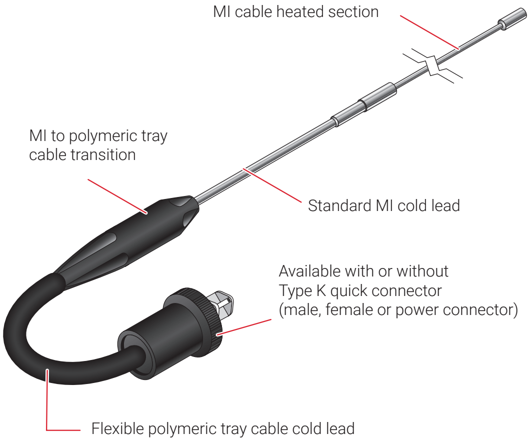
nVent RAYCHEM XMI mineral insulated cold lead cables can be supplied with optional Type X quick connectors. The connector is a "plug-in" style used to make quick and easy connections to other XMI heating cables in series, or to connect to a cable supplying power to the XMI heating cable.

FEATURES

- Easy installation in the field without the need for a junction box.
- Reduced labor costs in the field as wiring of junction box is eliminated for splice connections.
- Coaxial type connector means no rotational alignment of connectors on cold leads is required.
- Quick connection and disconnection of cold leads and power connections in the field results in reduced maintenance costs.
- Ideal for applications in module yards where series connected heating cables will be joined at module breaks.

PRODUCT OVERVIEW

XMI with PyroFLX cold lead and Type K connector



XMI mineral insulated cold lead cables are also available with an optional flexible polymeric PyroFLX cold lead with or without quick connectors. The PyroFLX cold lead option offers all of the benefits of a metal sheathed, Alloy 825 MI heating cable, along with the added advantages of a flexible, easy-to-install cold lead section.

The PyroFLX cold lead consists of a section of cold weather capable, highly impact resistant, flexible polymeric Type TC tray cable, integrated to a short segment of standard MI cold lead.

FEATURES

- Installations using the PyroFLX cold lead can be performed without excessive cold lead shaping and forming, minimizing expensive on-site labor costs, especially when long cold leads are required.
- The cable can be easily routed in the field and junction boxes and cable-to-cable connections can be extended to make them easily accessible for maintenance purposes, avoiding costly scaffolding and maintenance troubleshooting time.
- Ideal for applications in module yards where series connected heating cables will be joined at module breaks, around high maintenance valves to allow quick disconnection, and when re-locating the heating cable junction box down to grade level from a high point on a pipe rack.

This data sheet must be used in conjunction with the XMI-A data sheet H56870 and the XMI-L data sheet H59079.
For additional information on other optional connectors that are available for MI cold leads, contact your nVent representative or call (800) 545-6258.

APPROVALS

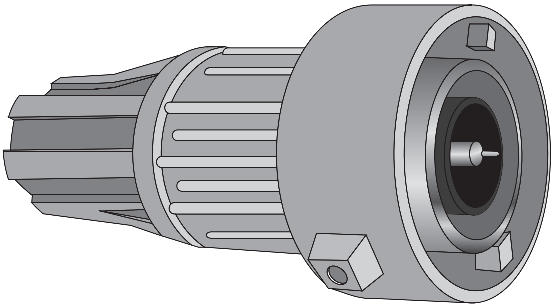
XMI (with type X quick connector or with PyroFLX cold lead and type K quick connectors)
Nonhazardous and Hazardous Locations
(CSA Canada-only approval)

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups E, F, G
Class III
Class 1, Zone 2

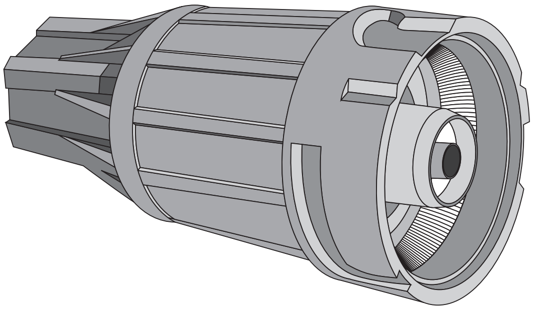
TYPE X QUICK CONNECTOR SPECIFICATIONS

Voltage Rating	600 V
Current Rating	35 A
Connector Rating	Type 6, IP 67
Temperature Rating (ambient)	–40°F to 122°F (–40°C to 50°C)
Connector Length	
Male	5 in (127 mm)
Female	5 in (127 mm)
Connector Insert Color	
Male	Black
Female	Blue

Type X Male connector



Type X Female connector

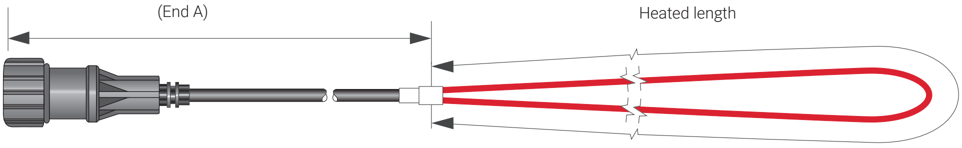


BASIC HEATING CABLE DESIGN CONFIGURATIONS WITH TYPE X QUICK CONNECTOR

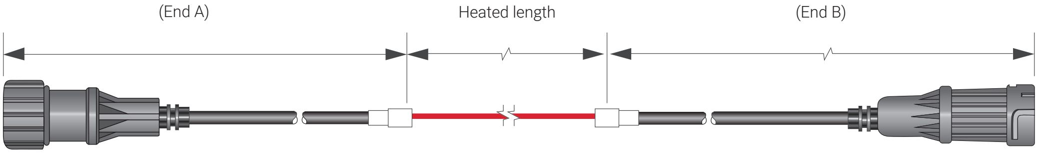
XMI mineral insulated heating cables can be supplied with Type X quick connectors in the four basic design configurations shown below. Design configurations A and D are supplied from the factory with one or more quick connectors assembled to the cold lead. Configurations B and E can be supplied with a combination of connectors or with a connector on one end and no connector on the other end.

Type X quick connectors for conventional MI cold leads are available in a combination of male, female, or power connector options (power connectors consist of a female and a male connector on a cold lead cable).

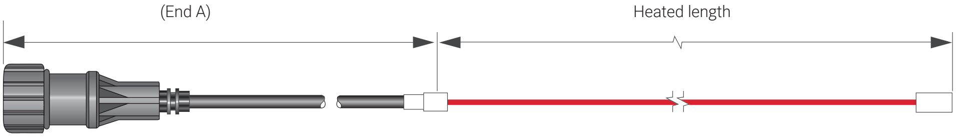
Design A (Single conductor)



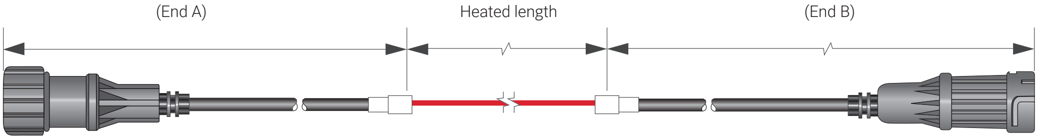
Design B (Single conductor)



Design D (Dual conductor)



Design E (Dual conductor)



HEATING CABLE CATALOG NUMBER WITH TYPE X QUICK CONNECTOR

An XMI heating unit with Type X connectors is ordered by compiling the catalog number based on the design of the specific engineered heating unit required for your application. Typically, an engineered heating unit is designed using our TraceCalc Pro design software which provides the catalog number as part of the design output. An explanation of the catalog number follows:

Example: **Engineered Heating Unit (Part No.: EHU)**
EHU: E/32SA2200/40/538/208/**5-7/S25A/X/N12/XMF**
E / 32SA2200 / 40 / 538 / 208 / **5 - 7 / S25A / X / N12 / XMF**
Position: **1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10**

Position	Characteristic	Code options	Description
1	Design Configuration1	A, B, D, or E	Designates the basic heating cable design configuration of the XMI engineered heating unit (XMI-L units available only in D and E configurations).
2	Heating cable reference	See XMI-A and XMI-L data sheets	Indicates the XMI-A or XMI-L heating cable reference used in the design. Refer to data sheets H56870 and H59079.
3	Heated length	Length of the heated section in feet or meters	Default value is in feet; if in meters add “M” after the length.
4	Power	Power output of the heating unit	Power output at maintain temperature, in Watts, for the total heated length of the engineered heating unit.
5	Voltage	Effective voltage applied to a heating unit	This is the designed effective voltage that will be applied to the engineered heating unit (in the case of series connected heating units, it is the voltage across a single unit).

Position	Characteristic	Code options	Description
6	MI cold lead length	Length of the MI cold lead in feet or meters (End A length) or (End A length)–(End B length)	Default value is in feet; if in meters add "M" after the length. Standard lengths for XMI engineered heating units are 4 feet (1.2 m) or 7 feet (2.1 m), however, custom lengths can be designated here. For E and B configurations, which have cold leads on each end, a single value (such as "7") indicates that the MI cold lead on both ends is 7 feet long. A hyphenated value (such as "5-7") indicates that the cold lead on one end (End A) is 5 feet long and the cold lead on the other end (End B) is 7 feet long. Note that when specifying quick connectors for E and B configurations with two different cold lead lengths (such as "5-7"), the first number (5) is the length for End A and the second number (7) is the length for End B. This nomenclature ensures that the correct connector is installed on the correct length of cold lead.
7	MI cold lead code	Select the cold lead code from Table 1	Table 1 is used to select the appropriate MI cold lead based on the current and voltage rating required by the design.
8	Hot-cold joint type	X or C	"X" type joint is used with all XMI-A engineered heating units. "C" type joint is used with all XMI-L engineered heating units.
9	Gland size reference	Refer to Table 1	Gland size depends on the cold lead code selected from Table 1.
10	Connector options[2]		Position 10 in the EHU catalog number consists of three letters. The first letter (X) indicates Type X connector, the second letter (M, P, or N) is the connector option for End A and the third letter (M, F, or N) is the connector option for End B.
		XMN - Male/Nothing	Standard MI cold lead with a Male connector on End A and no connector on End B.
		XNF - Nothing/Female	Standard MI cold lead with no connector on End A and a Female connector on End B.
		XMF - Male/Female	Standard MI cold lead with a Male connector on End A and a Female connector on End B.
		XPF - Power/Female	Standard MI cold lead with a Power connector on End A and a Female connector on End B.
		XPN - Power/Nothing	Standard MI cold lead with a Power connector on End A and no connector on End B.
		XMM - Male/Male	Standard MI cold lead with a Male connector on End A and a Male connector on End B.

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[1] Since Design A and Design D units only have a single cold lead, End B will always be "Nothing" (i.e. no connector).

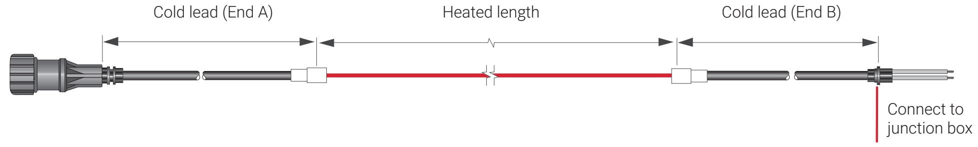
[2] A Power connector consists of both a Female and a Male connector (the Male connector is attached to the cold lead; the Female connector will be connected to the power supply at the job site).

HEATING UNIT OPTIONS USING TYPE X QUICK CONNECTOR

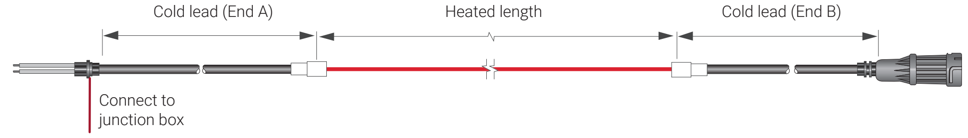
Design A (Single conductor)
Design D (Dual conductor)

Note: D design configuration shown

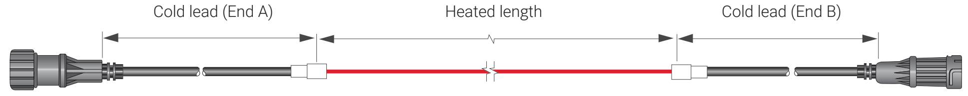
Design B (Single conductor)
Design E (Dual conductor)



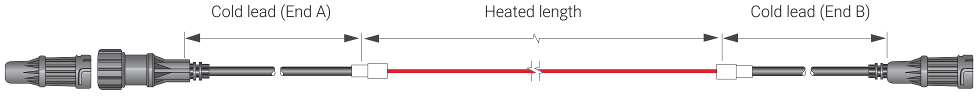
XMN - Male/Nothing (MI cold lead with a Male connector on End A and no connector on End B)



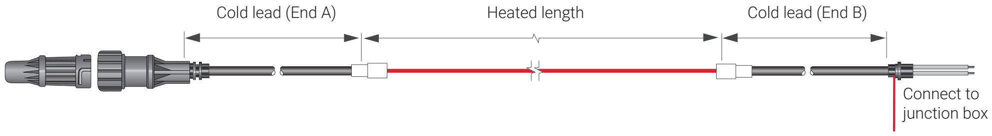
XNF - Nothing/Female (MI cold lead with no connector on End A and a Female connector on End B)



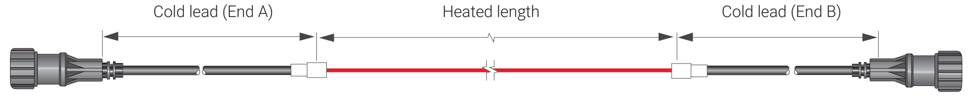
XMF - Male/Female (MI cold lead with a Male connector on End A and a Female connector on End B)



XPF - Power/Female (MI cold lead with a Power connector on End A and a Female connector on End B)



XPN - Power/Nothing (MI cold lead with a Power connector on End A and no connector on End B)



XMM - Male/Male (MI cold lead with a Male connector on End A and a Male connector on End B)

Note: E design configuration shown

EXAMPLES USING TYPE X QUICK CONNECTORS

D/62SQ3100/200/9920/480/4/S25A/X/N12/XMN

- Configuration is Design D
- XMI-A62 heating cable (600 V rated, dual conductor cable), resistance at 20°C is 0.100 Ω/ft (0.328 Ω/m)
- Heating cable length is 200 ft (61 m)
- Heating cable wattage is 9920 W at 480 V
- MI cold lead length is 4 ft (1.2 m) on End A
- MI cold lead code is S25A (25 Amps)
- Hot-cold joint type is "X" for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT
- Type X Male connector on End A

B/61SQ3118/250/6820/480/5-7/S29A/X/N12/XMF

- Configuration is Design B
- XMI-A61 heating cable (600 V rated, single conductor cable), resistance at 20°C is 0.118 Ω/ft (0.387 Ω/m)
- Heating cable length is 250 ft (76 m)
- Heating cable wattage is 6820 W at 480 V
- MI cold lead length is 5 ft (1.5 m) on End A and 7 ft (2.1 m) on End B
- MI cold lead code is S29A (29 Amps)
- Hot-cold joint type is "X" for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT
- Type X Male connector on End A and Female connector on End B

COLD LEAD OPTIONS

E/32SQ3200/25M/870/120/2.1M/LS23A/X/N12/XPF

- Configuration is Design E
- XMI-A32 heating cable (300 V rated, dual conductor cable), resistance at 20°C is 0.200 Ω/ft (0.656 Ω/m)
- Heating cable length is 25 m (82 ft)
- Heating cable wattage is 870 W at 120 V
- MI cold lead length is 2.1 m (7 ft) on both End A and End B
- MI cold lead code is LS23A (23 Amps)
- Hot-cold joint type is “X” for use with XMI-A Alloy 825 sheath cables
- Gland connector is 1/2 in NPT
- Type X Power connector on End A and Female connector on End B

TABLE 1 MI COLD LEAD SELECTION FOR USE WITH TYPE X QUICK CONNECTORS

Due to current rating limitations, only the standard cold leads shown in Table 1 may be used with Type X connectors. The cold lead is supplied from the factory with one or more quick connectors assembled to the cold lead.

Cold lead code	Maximum voltage (V)	Maximum current (A)	Cold lead diameter (in)	(mm)	Gland size (NPT)3	Gland size reference	Tail size (AWG)4
Design A, D, E							
LS23A	300	23	0.319	8.1	1/2 in	N12	14
S25A	600	25	0.355	9.0	1/2 in	N12	14
S34A	600	34	0.402	10.2	3/4 in	N34	10
S49A	600	35	0.496	12.6	3/4 in	N34	8
Design B							
S29A	600	29	0.215	5.5	1/2 in	N12	12
S40A	600	35	0.273	6.9	1/2 in	N12	10

Note: MI cold lead minimum bending radius is 6 times the cable diameter.

[3] NPT gland will be factory-assembled to the quick connector and not visible. If a quick connector is not supplied on one end of a Design B or E unit, the cold lead will be terminated with the standard NPT gland connector.

[4] Tail size applies to cold leads without quick connectors

PYROFLX COLD LEAD OPTIONS

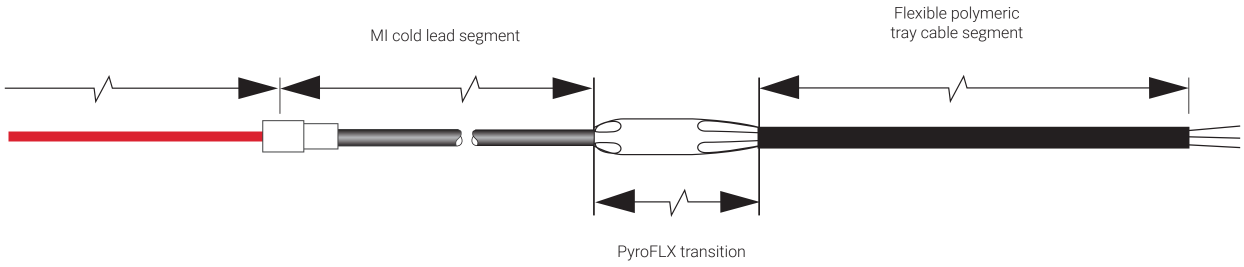
Heating cables with the PyroFLX cold lead option are supplied as complete factory-fabricated assemblies consisting of a MI heated section joined to a short segment of MI nonheating cold lead, which transitions into a flexible, polymeric tray cable by means of a molded splice.

There are three options for connection configurations on the PyroFLX cold lead.

1) No connector
  - PyroFLX cold lead only for attachment into junction box
  - Customer must supply approved junction box connector for Type TC tray cable

2) Factory installed Type K quick connector
  - Installed standard at the factory (can be replaced in the field)
  - Available in both male, female, and power configurations

3) Field-installed Type K quick connector
  - Mechanically attached to PyroFLX cold lead cable in the field
  - Available in both male, female, and power configurations

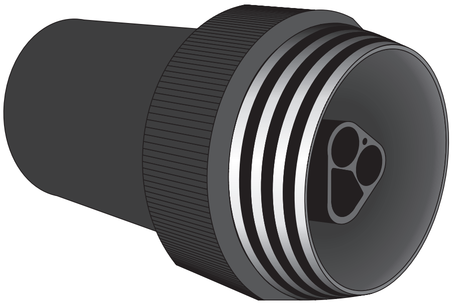


PYROFLX COLD LEAD AND TYPE K QUICK CONNECTOR SPECIFICATIONS

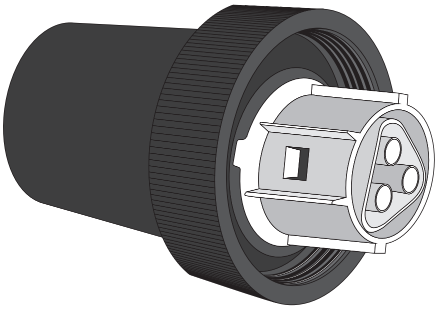
Voltage Rating	600 V
Current Rating	30 A
Standard PyroFLX Cold Lead	
MI Cold Lead Segment[5]	5 ft (1.5 m)
Flexible Tray Cable Segment[5]	3 ft (0.9 m)
Flexible Tray Cable Diameter	0.56 in (14.2 mm)
Flexible Tray Cable AWG Size	10 AWG
Flexible Tray Cable Bending Radius	2.2 in (56 mm)
Flexible Tray Cable Maximum Exposure Temperature	194°F (90°C)
Connector Rating	Type 6P, IP 65 … IP 68
Temperature Rating (ambient)	–40°F to 140°F (–40°C to 60°C)
Connector Length	
Male	3.2 in (81 mm)
Female	2.8 in (70 mm)
Connector Insert Color	
Male	Black
Female	Light gray

[5] Longer lengths available

Type K Male connector



Type K Female connector



BASIC HEATING CABLE DESIGN CONFIGURATIONS WITH PYROFLX COLD LEAD AND TYPE K CONNECTOR

XMI mineral insulated heating cables can be supplied with PyroFLX cold leads with or without Type K quick connectors. They are available in the four basic design configurations shown below. PyroFLX cold leads, for all design configurations, can be supplied with optional factory-installed Type K quick-connectors which do not require a junction box, or without a connector for field routing, trimming and installation into a junction box using standard tray cable connectors.

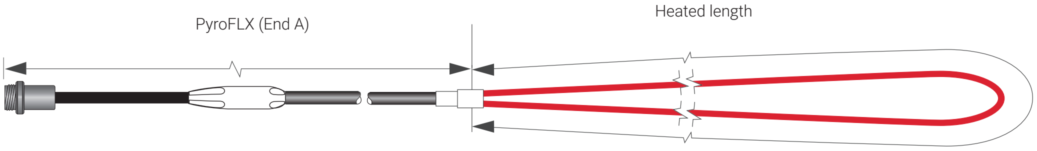
Type K quick connectors for PyroFLX cold leads are available in a combination of male, female, or power connector options (power connectors consist of a female and a male connector on one end of the heating cable).

HEATING CABLE CATALOG NUMBER WITH PYROFLX COLD LEAD

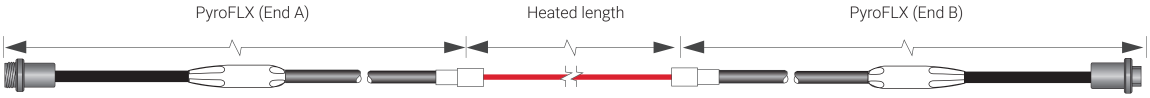
AnXMI heating unit with PyroFLX cold leads, with or without Type K connectors, is ordered by compiling the catalog number based on the design of the specific engineered heating unit required for your application. Typically, an engineered heating unit is designed using our TraceCalc Pro design software which provides the catalog number as part of the design output. An explanation of the catalog number followss.

Example: **Engineered Heating Unit (Part No.: EHU)**
EHU: E/32SA2200/40/538/208/5-7/S25A/X/NG/T8-10/RKFM
E / 32SA2200 / 40 / 538 / 208 / 5 - 7 / S25A / X / NG / T8-10 / RKFM
Position: 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11

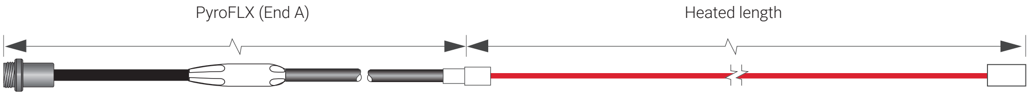
Design A (Single conductor)



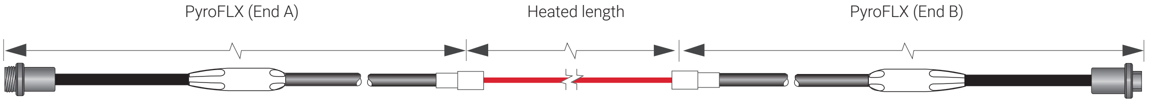
Design B (Single conductor)



Design D (Dual conductor)



Design E (Dual conductor)



Position	Characteristic	Code options	Description
1	Design Configuration[6]	A, B, D, or E	Designates the basic heating cable design configuration of the XMI engineered heating unit (XMI-L units available only in D and E configurations).
2	Heating cable reference	See XMI-A and XMI-L data sheets	Indicates the XMI-A or XMI-L heating cable reference used in the design. Refer to data sheets H56870 and H59079.
3	Heated length	Length of the heated section in feet or meters	Default value is in feet; if in meters add "M" after the length.
4	Power	Power output of the heating unit	Power output at maintain temperature, in Watts, for the total heated length of the engineered heating unit.
5	Voltage	Effective voltage applied to unit	This is the designed effective voltage that will be applied to the engineered heating unit (in the case of series connected heating units, it is the voltage across a single unit).

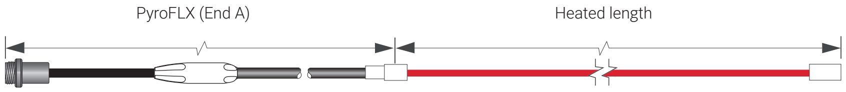
Position	Characteristic	Code options	Description
6	MI cold lead length	Length of the MI cold lead in feet or meters (End A length) or (End A length)–(End B length)	Default value is in feet; if in meters add "M" after the length. Standard MI cold lead length is 5 feet (1.5 m) for units with PyroFLX cold leads, however, custom lengths can be designated here. For E and B configurations, which have cold leads on each end, a single value (such as “5”) indicates that both MI cold leads are to be 5 feet long. A hyphenated value (such as “5-7”) indicates that the cold lead on one end (End A) is 5 feet long and the cold lead on the other end (End B) is 7 feet long. Note that when specifying quick connectors for E and B configurations with two different cold lead lengths (such as “5-7”), the first number (5) is the length for End A and the second number (7) is the length for End B. This nomenclature ensures that the correct connector is installed on the correct length of cold lead.
7	MI cold lead code	Select the cold lead code from Table 2	Table 2 is used to select the appropriate MI cold lead based on the current and voltage rating required by the design.
8	Hot-cold joint type	X or C	“X” type joint is used with all XMI-A engineered heating units. “C” type joint is used with all XMI-L engineered heating units.
9	Gland size reference	NG	For PyroFLX cold leads, gland size default is “NG” (no gland)
10	Type TC flexible tray cable length	Length of the tray cable in feet or meters T(End A length) or T(End A length)–T(End B length)	Default value is in feet; if in meters add "M“ after the length. Standard lengths for flexible tray cable is 3 feet (0.9 m), however, custom lengths can be designated here. For E and B configurations, which have cold leads on each end, a single value (such as “T3”) indicates that the flexible tray cable on both ends is 3 feet long. A hyphenated value (such as “T3-T7”) indicates that the flexible tray cable on one end (End A) is 3 feet long and the flexible tray cable on the other end (End B) is 7 feet long. Note that when specifying Type K quick connectors for E and B configurations with two different flexible tray cable lengths (such as “T3-T7”), the first number (3) is the length for End A and the second number (7) is the length for End B. This nomenclature ensures that the correct connector is installed on the correct length of tray cable.
11	Connector options[7]	RNN - Nothing/Nothing	PyroFLX cold lead with no connector on End A and no connector on End B Position 11 in the EHU catalog number for a PyroFLX cold lead with Type K connectors consists of four letters. The first letter (R) indicates the PyroFLX cold lead, the second letter (K) indicates Type K connector, the third letter (M, P, or N) is the connector option for End A and the fourth letter (M, F, or N) is the connector option for End B.
		RKMN - Male/Nothing	PyroFLX cold lead with a Male connector on End A and no connector on End B
		RKNF - Nothing/Female	PyroFLX cold lead with no connector on End A and a Female connector on End B
		RKMF - Male/Female	PyroFLX cold lead with a Male connector on End A and a Female connector on End B
		RKPF - Power/Female	PyroFLX cold lead with a Power connector on End A and a Female connector on End B
		RKPN - Power/Nothing	PyroFLX cold lead with a Power connector on End A and no connector on End B
		RKMM - Male/Male	PyroFLX cold lead with a Male connector on End A and a Male connector on End B

[6] Since Design A and Design D units only have a single cold lead, End B will always be “nothing” (i.e. no connector).

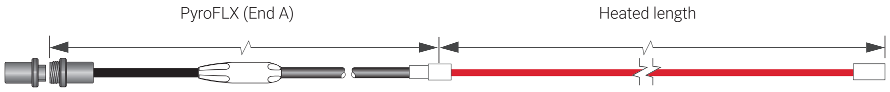
[7] A Power connector consists of both a Female and a Male connector (the male connector is attached to the cold lead; the Female connector will be connected to the power supply at the job site).

HEATING UNIT OPTIONS USING PYROFLX COLD LEADS AND TYPE K QUICK CONNECTOR

Design A (Single conductor
Design D (Dual conductor)



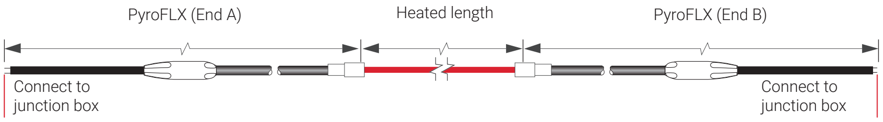
RKMN - Male/Nothing (PyroFLX cold lead with a Male connector on End A)



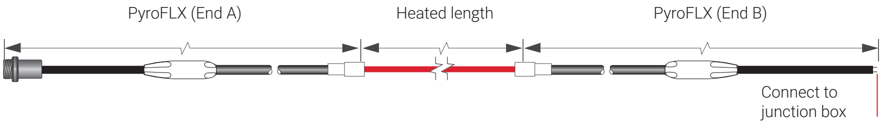
RKPN - Power/Nothing (PyroFLX cold lead with a Power connector on End A)

Note: D design configuration shown

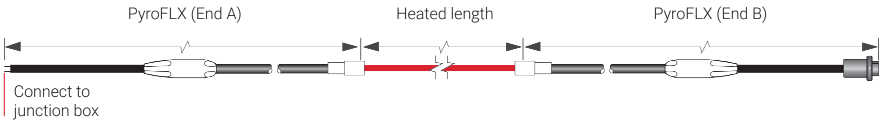
Design B (Single conductor)
Design E (Dual conductor)



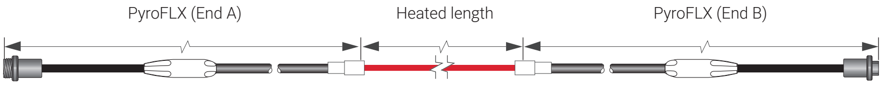
RNN - Nothing/Nothing (PyroFLX cold lead with no connector on End A and no connector on End B)



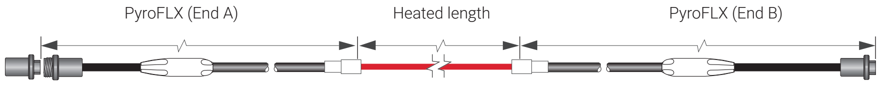
RKMN - Male/Nothing (PyroFLX cold lead with a Male connector on End A and no connector on End B)



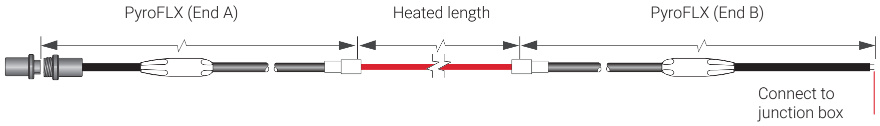
RKNF - Nothing/Female (PyroFLX cold lead with no connector on End A and a Female connector on End B)



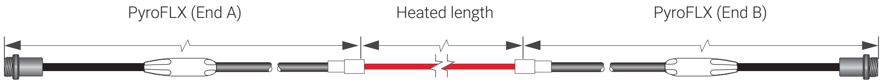
RKMF - Male/Female (PyroFLX cold lead with a Male connector on End A and a Female connector on End B)



RKPF - Power/Female (PyroFLX cold lead with a Power connector on End A and a Female connector on End B)



RKPN - Power/Nothing (PyroFLX cold lead with a Power connector on End A and no connector on End B)



RKMM - Male/Male (PyroFLX cold lead with a Male connector on End A and a Male connector on End B)

Note: E design configuration shown

EXAMPLES USING PYROFLX COLD LEAD, WITH AND WITHOUT TYPE K QUICK CONNECTORS

D/62SQ3100/200/9920/480/5/S25A/X/NG/T3/RKMN

- Configuration is Design D
- XMI-A62 heating cable (600 V rated, dual conductor cable), resistance at 20°C is 0.100 Ω/ft (0.328 Ω/m)
- Heating cable length is 200 ft (61 m)
- Heating cable wattage is 9920 W at 480 V
- MI cold lead length is 5 ft (1.5 m) on End A
- MI cold lead code is S25A (25 Amps)
- Hot-cold joint type is "X" for use with XMI-A Alloy 825 sheath cables
- Gland connector is NG (no gland)
- Flexible tray cable is 3 ft (0.9 m) on End A
- Type K Male connector on End A

E/32SQ3200/25M/840/120/1.5M/LS23A/X/NG/T2.4M-T3.0M/RKPF

- Configuration is Design E
- XMI-A32 heating cable (300 V rated, dual conductor cable), resistance at 20°C is 0.200 Ω/ft (0.656 Ω/m)
- Heating cable length is 25 m (82 ft)
- Heating cable wattage is 840 W at 120 V
- MI cold lead length is 1.5 m (5 ft) on both End A and End B
- MI cold lead code is LS23A (23 Amps)
- Hot-cold joint type is "X" for use with XMI-A Alloy 825 sheath cables
- Gland connector is NG (no gland)
- Flexible tray cable is 2.4 m (8 ft) on End A and 3 m (10 ft) long on End B
- Type K Power connector on End A and Female connector on End B

B/61SQ3118/250/6820/480/5-7/S29A/X/NG/T8/RKMF

- Configuration is Design B
- XMI-A61 heating cable (600 V rated, single conductor cable), resistance at 20°C is 0.118 Ω/ft (0.387 Ω/m)
- Heating cable length is 250 ft (76 m)
- Heating cable wattage is 6820 W at 480 V
- MI cold lead length is 5 ft (1.5 m) on End A and 7 ft (2.1 m) on End B
- MI cold lead code is S29A (29 Amps)
- Hot-cold joint type is "X" for use with XMI-A Alloy 825 sheath cables
- Gland connector is NG (no gland)
- Flexible tray cable is 8 ft (2.4 m) on both End A and End B
- Type K Male connector on End A and Female connector on End B

TABLE 2 MI COLD LEAD CODES FOR USE WITH PYROFLX COLD LEADS AND TYPE K QUICK CONNECTORS

Due to current rating limitations, only the standard MI cold lead codes shown in Table 2 may be used with PyroFLX cold leads and Type K connectors. The PyroFLX cold lead is supplied from the factory with no quick connectors or with one or more quick connectors assembled to the cold lead.

Cold lead code	Maximum voltage (V)	Maximum current (A)	Cold lead diameter (in)	(mm)	Gland size reference	Tray cable tail size (AWG)[8]
Design A, D, E						
LS23A	300	23	0.319	8.1	NG	10
S25A	600	25	0.355	9.0	NG	10
S34A	600	30	0.402	10.2	NG	10
Design B						
S29A	600	29	0.215	5.5	NG	10
S40A	600	30	0.273	6.9	NG	10

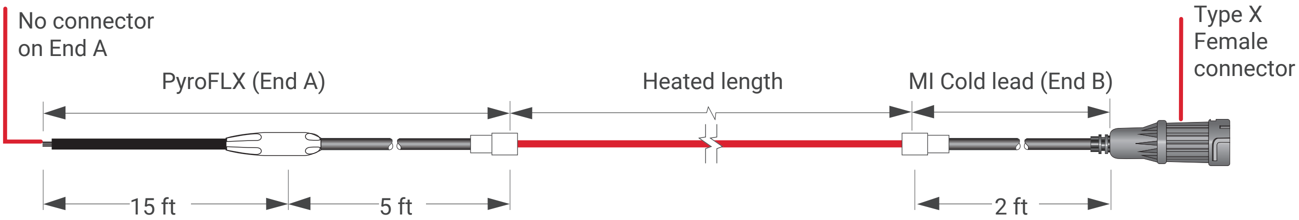
Note: MI cold lead minimum bending radius is 6 times the cable diameter.

[8] Tail size applies to cold leads without quick connectors (i.e. tray cable tails).

OTHER COLD LEAD OPTIONS

Other types of connectors are available to terminate mineral insulated cold leads. In addition, a heating cable can be terminated with a PyroFLX cold lead and Type K connector (or no connector) on one end and a mineral insulated cold lead and Type X connector on the other end as shown in the example below. For additional information on other optional connectors that are available for MI cold leads, contact your nVent representative or call (800) 545-6258.

EHU: E/32SQ3200/82/840/120/5-2/LS23A/X/N12/T15.0-T0.0/RNXF



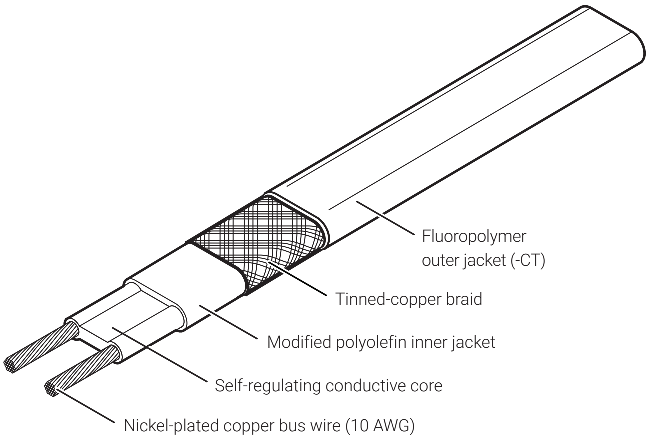
RNXF - PyroFLX cold lead with no connector on End A
and MI cold lead with Type X Female connector on End B

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

LBTV

SELF-REGULATING HEATING CABLES FOR FREEZE PROTECTION ON LONG PIPELINES IN HAZARDOUS AND NON-HAZARDOUS LOCATIONS



Heating cable construction

10 YEAR Product warranty

HEATING CABLE CONSTRUCTION

PRODUCT OVERVIEW

The nVent RAYCHEM LBTV self-regulating heating cables provide freeze protection and low-temperature maintenance for longline applications. The LBTV heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C).

The cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

The LBTV heating cables provide long circuit length capability. They can be used for continuous circuit lengths up to 1,250 feet (381 m) powered from a single source. LBTV cables are especially well suited for tracing long pipelines containing temperature-sensitive fluids or where high reliability is required.

LBTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code. For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal and plastics
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

200–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	150°F (65°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	185°F (85°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T6, 185°F (85°C)
Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

Hazardous Locations

FM APPROVED
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III
-W

Zone Approvals

FM APPROVED
CLI, ZN1, AEx e II T6

Ex e II T6
-W

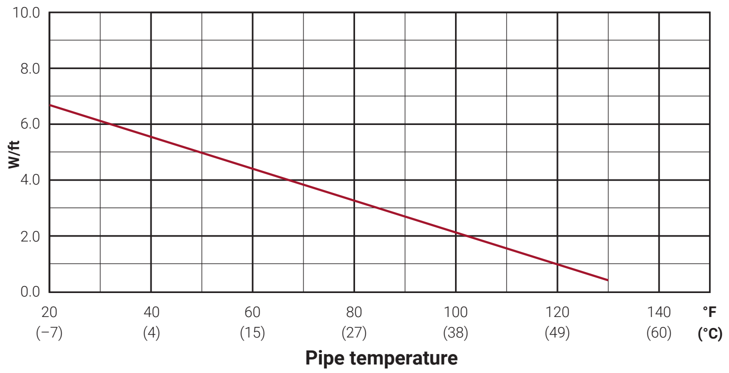
DESIGN AND INSTALLATION

For proper design and installation, use TraceCalc Pro design software or the Design section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550). Literature is available via nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES

	Adjustment Factor
	Power Output
208 V	0.94
277 V	1.04

POWER-TEMPERATURE DATA: LBTV2-CT



Note: To choose the correct heating cable for your application, use the Design section of the Industrial Heat Tracing Solutions Products & Services Catalogue (H56550). For more detailed information, use TraceCalc Pro design software.

MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up	Maximum circuit length (in feet) per circuit breaker			
		208 V			
		40 A	50 A	60 A	70 A
LBTV2-CT	40°F (4°C)	1015	1175	1175	1175
	20°F (−7°C)	610	1045	1175	1175
	0°F (−18°C)	450	680	1060	1175
	−20°F (−29°C)	360	510	740	1065
	−40°F (−40°C)	305	415	565	785

	Ambient temperature at start-up	Maximum circuit length (in feet) per circuit breaker			
		240 V			
		40 A	50 A	60 A	70 A
LBTV2-CT	40°F (4°C)	910	1250	1250	1250
	20°F (−7°C)	570	945	1250	1250
	0°F (−18°C)	425	625	975	1250
	−20°F (−29°C)	340	480	675	1000
	−40°F (−40°C)	290	390	525	720

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker			
			277 V			
			40 A	50 A	60 A	70 A
LBTV2-CT	40°F	(4°C)	845	1250	1250	1250
	20°F	(–7°C)	525	880	1250	1250
	0°F	(–18°C)	395	580	905	1250
	–20°F	(–29°C)	315	445	630	925
	–40°F	(–40°C)	270	365	490	665

PRODUCT CHARACTERISTIC

	LBTV2-CT
Minimum bend radius	@68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	1.7
Bus wire size	10 AWG
Outer jacket color	Black
Heating cable dimensions	0.71 in x 0.33 in (18 mm x 8.4 mm)

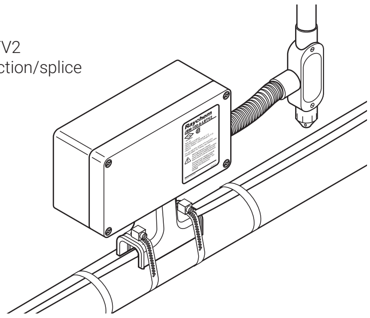
ORDERING DETAILS

Description	Part number
LBTV2-CT	486428-000

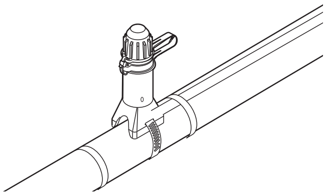
CONNECTION KITS

These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

JBM-100-LBTV2
Power connection/splice



E-100-LBTV2
End seal



GROUND-FAULT PROTECTION

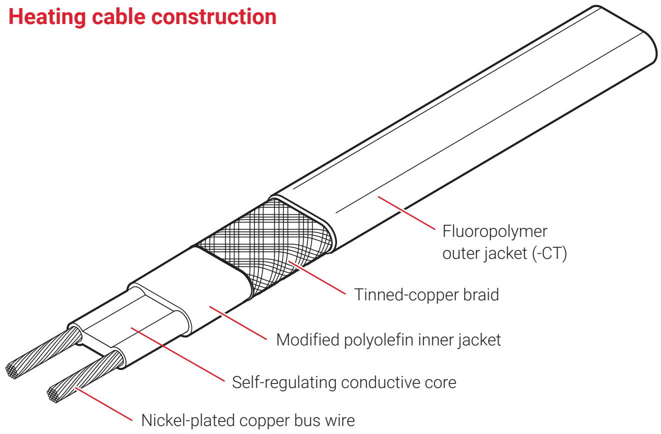
To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

SLBTV

nVent
RAYCHEM

SELF REGULATING HEATING CABLES FOR ELECTRICAL FREEZE PROTECTION ON LONGLINE SYSTEMS (HAZARDOUS AND NONHAZARDOUS)

Heating cable construction



10 YEAR Product warranty

PRODUCT OVERVIEW

nVent RAYCHEM SLBTV self-regulating heating cables provide freeze protection and low-temperature maintenance for longline applications. The SLBTV heating cables maintain process temperatures up to 150°F (65°C) and can withstand intermittent exposure to temperatures up to 185°F (85°C).

The cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

SLBTV heating cables provide long circuit length capability. They can be used for continuous circuit lengths up to 2,000 feet (610 m) powered from a single source. SLBTV cables are especially well suited for tracing long pipelines containing temperature-sensitive fluids or where high reliability is required.

SLBTV cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.
For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal and plastics
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

200 Vac–277 Vac

TEMPERATURE RATING

Maximum maintain or continuous exposure temperature (power on)	150°F (65°C)
Maximum intermittent exposure temperature, 1000 hours (power on or off)	185°F (85°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T6, 185°F (85°C)
Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

Hazardous Locations

FM APPROVED
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

CSA -W
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Zone Approvals

FM APPROVED
CLI, ZN1, AEx e II T6

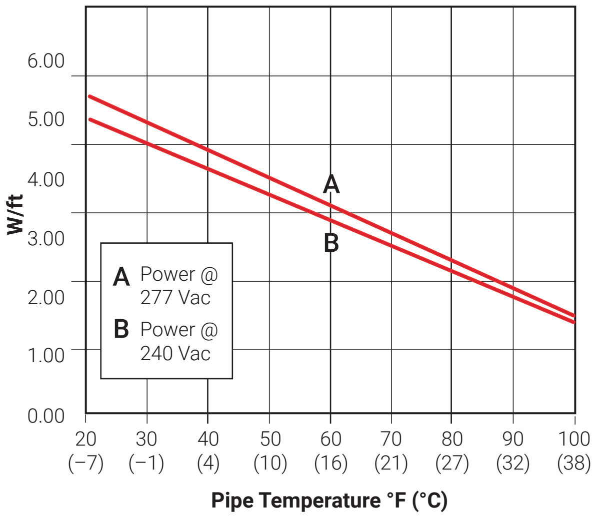
CSA -W
Ex e II T6

DESIGN AND INSTALLATION

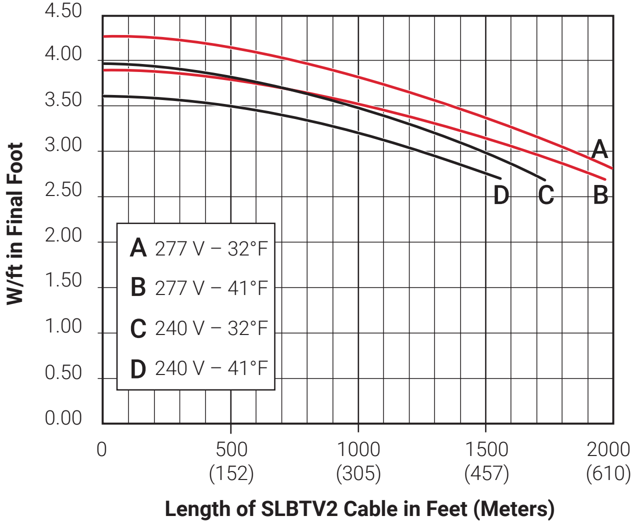
For proper design and installation, use TraceCalc Pro design software or the Design section of the nVent Products & Services Catalogue (H56550). Literature is available via the nVent web site, nVent.com.

NOMINAL POWER OUTPUT RATING ON METAL PIPES

Power Temperatutre Curve



Power – Length Curves



Adjustment Factors		
Power output		**Circuit length**
208 V	0.86	0.83
277 V	1.11	1.13

MAXIMUM CIRCUIT LENGTH BASED ON CIRCUIT BREAKER SIZES

	Ambient temperature at start-up		Maximum circuit length (in feet) per circuit breaker					
			240 V			277 V		
			40 A	50 A	70 A	40 A	50 A	70 A
SLBTV2-CT	32°F	(0°C)	1610	1720	1720	1700	2000	2000
	0°F	(−18°C)	1180	1600	1710	1240	1670	2000
	−20°F	(−29°C)	1010	1340	1700	1070	1410	2000
	−40°F	(−40°C)	880	1160	1630	940	1230	1700
	−60°F	(−51°C)	780	1030	1420	840	1100	1500

PRODUCT CHARACTERISTICS

	SLBTV2-CT
Minimum bend radius	@ 68°F (20°C): 0.5 in (12.7 mm)
Weight (lb per 10 ft, nominal)	1.7
Bus wire size	10 AWG
Outer jacket color	Black
Heating cable dimensions	0.71 in x 0.33 in (18 mm x 8.4 mm)

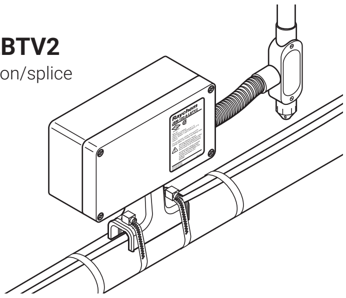
ORDERING DETAILS

Description	Part number
SLBTV2-CT	F57189-000

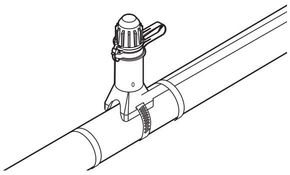
CONNECTION KITS

These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

JBM-100-LBTV2
Power connection/splice



E-100-LBTV2
End seal



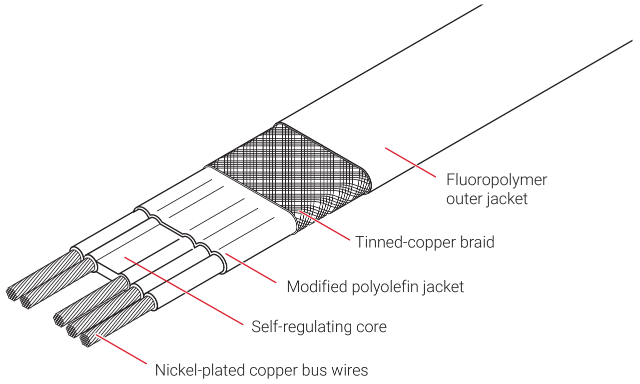
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

VLBTV

nVent
RAYCHEM

SELF-REGULATING HEATING CABLES FOR LONGLINE SYSTEMS ELECTRICAL FREEZE PROTECTION FOR VERY LONG PIPELINES IN BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM VLBTV provides basic freeze protection and low-temperature maintenance for longline applications. The VLBTV heating cables can withstand continuous exposure to temperatures up to 150°F (65°C), and are configured for use in hazardous locations or in areas exposed to corrosives. VLBTV provides very long circuit length capability. It can be used for continuous circuit lengths of 1,000 (305 m) to 12,000 feet (3660 m), powered from a single source. VLBTV is especially well suited for tracing long pipelines containing temperature-sensitive fluids.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

480–600 Vac 3-Phase, 4-Wire

TEMPERATURE RATING

Maximum continuous exposure	150°F (65°C)
Maximum intermittent exposure	185°F (85°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

T6, 185°F (85°C)
Temperature ID numbers are consistent with North America national electrical codes.

APPROVALS

Hazardous Locations

FM APPROVED

-W

Class I, Div. 2, Groups B, C, D
Class II, Div. 2, Groups F and G
Class III

CIRCUIT LENGTH

	480 Vac 3-Phase, 4-Wire	600 Vac 3-Phase, 4-Wire
Minimum length	1,000 ft (305 m)	4,000 ft (1,220 m)
Maximum length	10,000 ft (3,050 m)	12,000 ft (3,660 m)

DESIGN AND INSTALLATION

For proper design and installation of a VLBTV system and connection kit selection, contact nVent. Literature is available via the nVent web site nVent.com/thermal.

DESIGN AND INSTALLATION

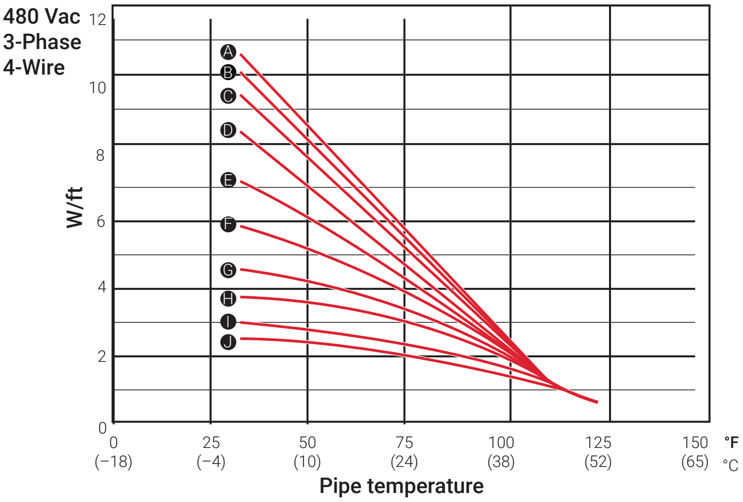
Power output on insulated metal pipes*

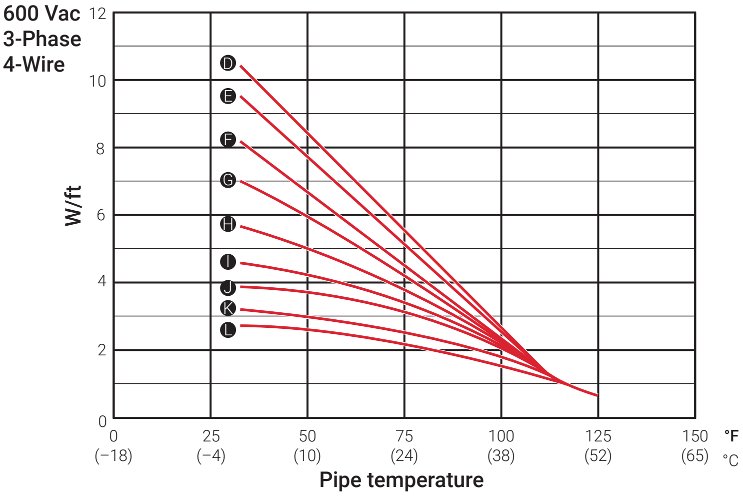
Circuit length

Ⓐ	1,000 ft
Ⓑ	2,000 ft
Ⓒ	3,000 ft
Ⓓ	4,000 ft
Ⓔ	5,000 ft
Ⓕ	6,000 ft
Ⓖ	7,000 ft
Ⓗ	8,000 ft
Ⓘ	9,000 ft
Ⓙ	10,000 ft
Ⓚ	11,000 ft
Ⓛ	12,000 ft

W/m = 3.28 x W/ft
°C = 5/9 (°F–32)

* For power output inside U-shaped channels consult nVent





ORDERING DETAILS

Description	Part number
VLBTV2-CT	409755-000

CONNECTION KITS

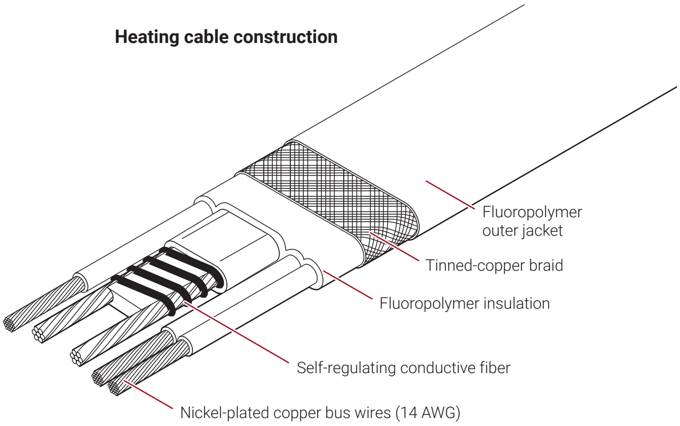
These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements: VBK-System, VBK-S (splice)

VLKTV

nVent
RAYCHEM

SELF-REGULATING HEATING CABLES FOR LONGLINE SYSTEMS ELECTRICAL FREEZE PROTECTION AND TEMPERATURE MAINTENANCE IN BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS

Heating cable construction



10
YEAR
Product
warranty

PRODUCT OVERVIEW

VLKTV provides high-temperature maintenance for longline applications. VLKTV can also be used to provide low-temperature maintenance for long lines that are exposed to high temperatures. The VLKTV heating cable can withstand continuous exposure to temperatures up to 300°F (150°C), and intermittent exposure to 420°F (215°C).

The cables are configured for use in nonhazardous and hazardous locations, including areas where corrosives may be present.

VLKTV2-CT provides very long circuit length capability. It can be used for continuous circuit lengths of 1,000 (305 m) to 6,000 feet (1830 m), powered from a single source. VLKTV is especially well suited for tracing long pipelines containing temperature-sensitive fluids or where extreme reliability is required.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Traced surface type	Metal
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

480–600 Vac 3-Phase, 4-Wire

TEMPERATURE RATING

Maximum continuous exposure	300°F (150°C)
Maximum intermittent exposure (power on or off)	420°F (215°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

	T2C: 446°F (230°C) Temperature ID numbers are consistent with North America national electrical codes.
Based on systems approach*	T3-T6

* VLKTV heating cables are approved for T3 – T6 temperature classes when stabilized or controlled designs are used according to the requirements of applicable national and international approvals standards. Use TraceCalc Pro design software or contact nVent.

CIRCUIT LENGTH

	480 Vac 3-Phase, 4-Wire	600 Vac 3-Phase, 4-Wire
Minimum length	1,000 ft (305 m)	2,000 ft (610 m)
Maximum length	5,000 ft (1,525 m)	6,000 ft (1,830 m)

APPROVALS

Hazardous Locations

FM APPROVED

Class I, Div. 2, Groups B, C, D
Class II, Div. 2, Groups F, G
Class III

Nonhazardous Locations

-W

DESIGN AND INSTALLATION

For proper design and installation of a VLKTV system and connection kit selection, contact nVent. Literature is available via the nVent web site, nVent.com.

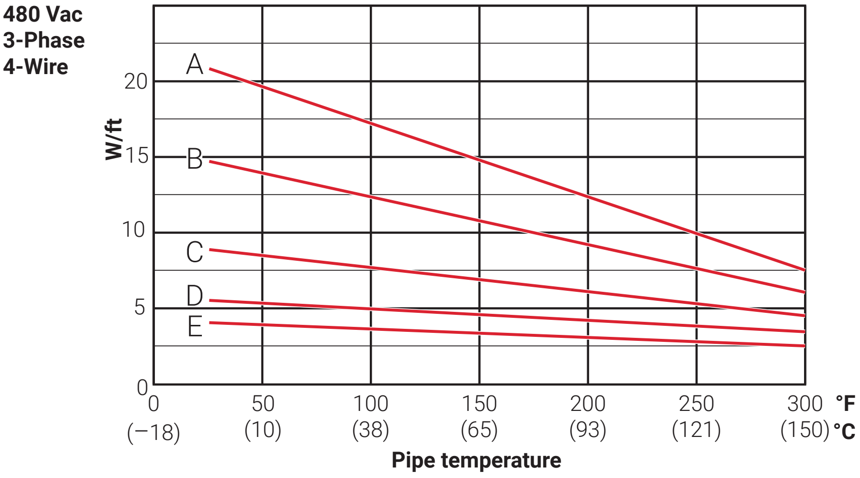
OMINAL POWER OUTPUT RATINGS ON INSULATED METAL PIPES

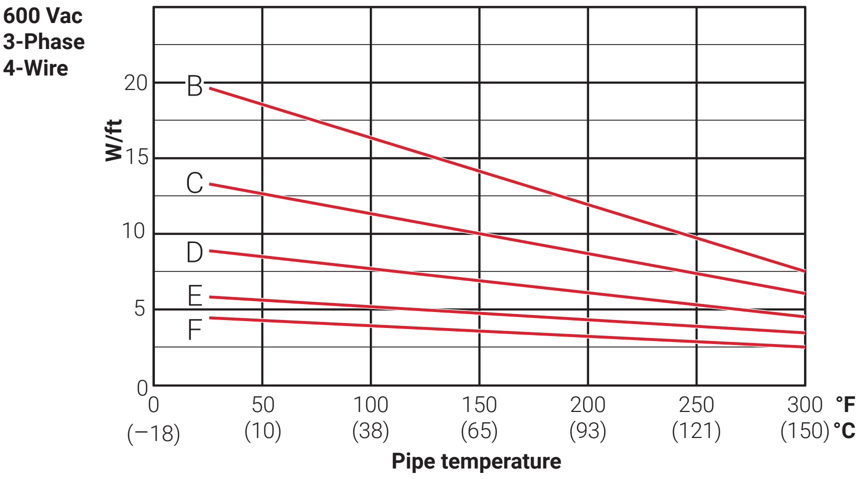
Circuit length

A	1,000 ft
B	2,000 ft
C	3,000 ft
D	4,000 ft
E	5,000 ft
F	6,000 ft

W/M = 3.28 X W/FT
°C = 5/9 (°F–32)

* For power output inside U-shaped channels, consult your nVent representative.





ORDERING DETAILS

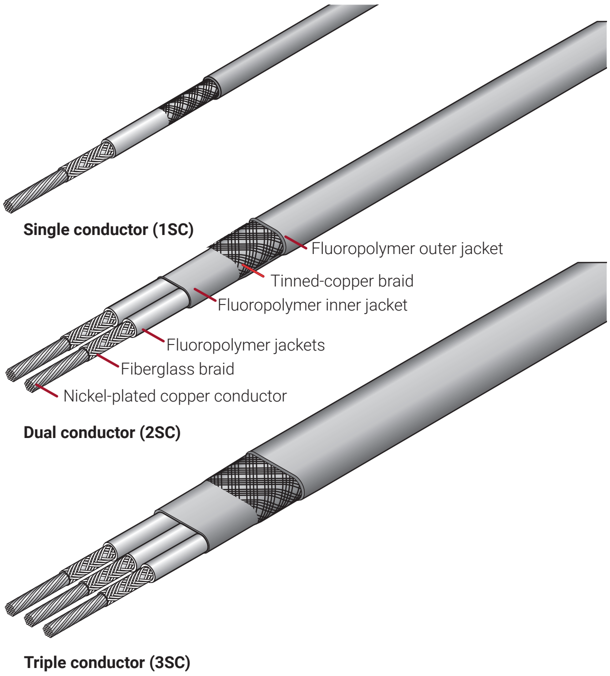
Description	Part number
VLKTV2-CT	429707-000

CONNECTION KITS

These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements: VKK-System, VKK-S (splice).

SC, SC/H

SERIES-RESISTANCE HEATING CABLES FOR LONGLINE SYSTEMS ELECTRICAL FREEZE PROTECTION FOR LONG PIPELINES IN BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS



Heating cable construction

PRODUCT OVERVIEW

SC and SC/H series-resistance technology provides freeze protection and high-temperature maintenance for longline applications.

This series-resistance type heating cable can withstand continuous exposure temperatures up to 482°F (250°C), and is suitable for use in hazardous locations and in areas exposed to corrosives. SC heating cables can be used for continuous circuit lengths to 12,000 feet (3659 m), powered from a single source.

nVent RAYCHEM brand SC heating cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.

For additional information, contact your nVent representative or call (800) 545-6258.

10 YEAR Product warranty

APPLICATION

Area classification	Nonhazardous and hazardous locations; 1SC cables for use in low mechanical abuse areas only.
Chemical resistance	Organic and aqueous inorganic chemicals and corrosives

SUPPLY VOLTAGE

Maximum 600 Vac

TEMPERATURE RATING

	SC	SC/H
Maximum continuous exposure (Power off)	400°F (204°C)	482°F (250°C)
Minimum installation temperature	–40°F (–40°C)	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

Established by calculating the maximum sheath temperature for the application. Contact nVent for assistance.

APPROVALS

1SC

Nonhazardous Locations

-W

Hazardous Locations

Ex e II T (1)(2)

-W

(1)for T-Rating, see design documentation
(2)for 1SC60-CT, 1SC70-CT, and 1SC80-CT only

2SC

Hazardous Locations

-W

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

For T-Rating, see design documentation

II 2GD Ex e II T* (see schedule) Ex tD A21 IP66
Baseefa06ATEX0189X

IECEx

Ex e II T* (see schedule) Ex tD A21 IP66
IECEx BAS 06.0049X

Ex e II T (1)

-W

Ex e IIC T* Gb

3SC

Hazardous Locations

-W

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

For T-Rating, see design documentation

II 2GD Ex e II T* (see schedule) Ex tD A21 IP66
Baseefa06ATEX0189X

IECEx

Ex e II T* (see schedule) Ex tD A21 IP66
IECEx BAS 06.0049X

Ex e II T (1)

-W

Ex e IIC T* Gb

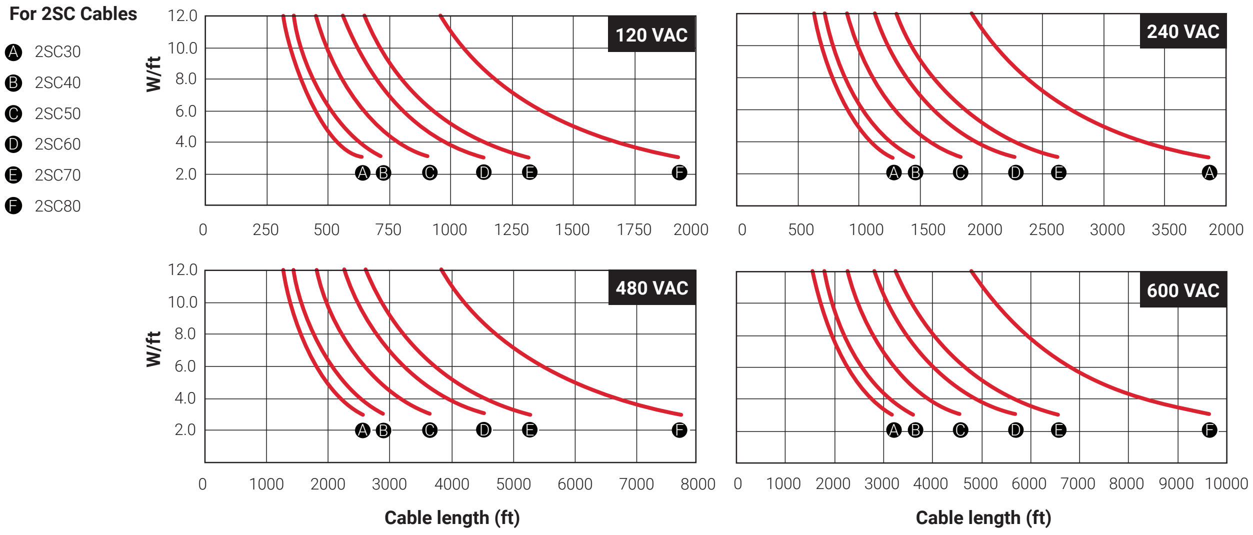
DESIGN AND INSTALLATION

SC and SC/H applications must be designed and approved by nVent. Series heating cable technology requires that SC cables must not be overlapped. The use of appropriate control and monitoring equipment specified by nVent is required.

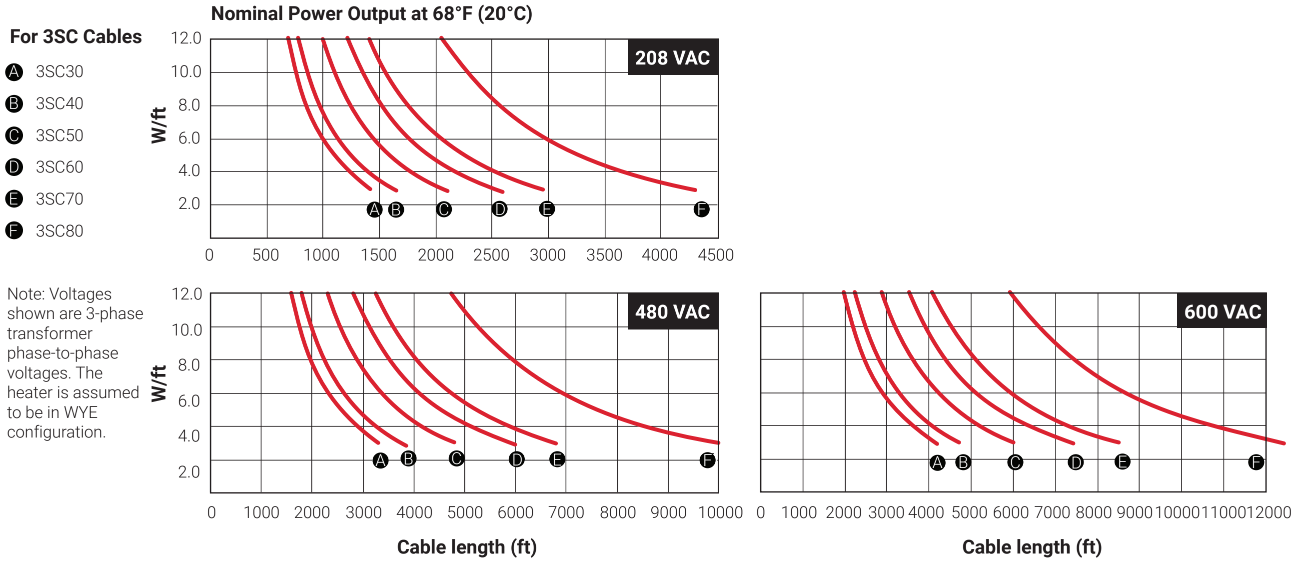
NOMINAL POWER OUTPUT RATING

These graphs are general guides to selection. Actual designs require consideration of other important variables and must be confirmed by nVent. Also, many other voltages and electrical configurations are possible.

Nominal Power Output at 68°F (20°C)



NOMINAL POWER OUTPUT RATING



Nominal Power Output at 68°F (20°C)

Note: Voltages shown are 3-phase transformer phase-to-phase voltages. The heater is assumed to be in WYE configuration.

PRODUCT CHARACTERISTICS

SC or SC/H	Conductor size	Cable resistance (nominal) @ 68°F (20°C) ohms/ft	ohms/m	Weight (nominal) lb/10 ft	Maximum circuit breaker size	Cable dimensions (nominal) (in)	Minimum bend radius (in)
(Single conductor cable)							
1SC30-CT	18	0.00590	0.01935	0.4	30	0.22 diameter	1
1SC40-CT	16	0.00458	0.01502	0.5	30	0.23 diameter	1
1SC50-CT	14	0.00290	0.00951	0.6	30	0.24 diameter	1
1SC60-CT	12	0.00187	0.00613	0.7	60	0.26 diameter	1
1SC70-CT	10	0.00120	0.00394	0.9	80	0.29 diameter	1
1SC80-CT	8	0.00065	0.00213	1.2	100	0.32 diameter	1
(Dual conductor cable)							
2SC30-CT	18	0.01180	0.03869	0.8	40	0.41 x 0.27	1
2SC40-CT	16	0.00916	0.03004	1.0	40	0.42 x 0.28	1
2SC50-CT	14	0.00580	0.01902	1.2	40	0.45 x 0.29	1
2SC60-CT	12	0.00374	0.01226	1.4	60	0.5 x 0.31	1
2SC70-CT	10	0.00240	0.00787	1.8	80	0.55 x 0.34	1
2SC80-CT	8	0.00130	0.00426	2.4	100	0.61 x 0.37	1
(Triple conductor cable, resistance per conductor)							
3SC30-CT	18	0.00590	0.01935	1.2	40	0.56 x 0.27	1
3SC40-CT	16	0.00458	0.01502	1.5	40	0.58 x 0.28	1
3SC50-CT	14	0.00290	0.00951	1.8	40	0.62 x 0.29	1
3SC60-CT	12	0.00187	0.00613	2.1	60	0.68 x 0.31	1
3SC70-CT	10	0.00120	0.00394	2.7	80	0.75 x 0.34	1
3SC80-CT	8	0.00065	0.00213	3.6	100	0.85 x 0.37	1

CONNECTION KITS

nVent offers a full range of connection kits for power connections, splices, and end termination. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

GROUND-FAULT PROTECTION

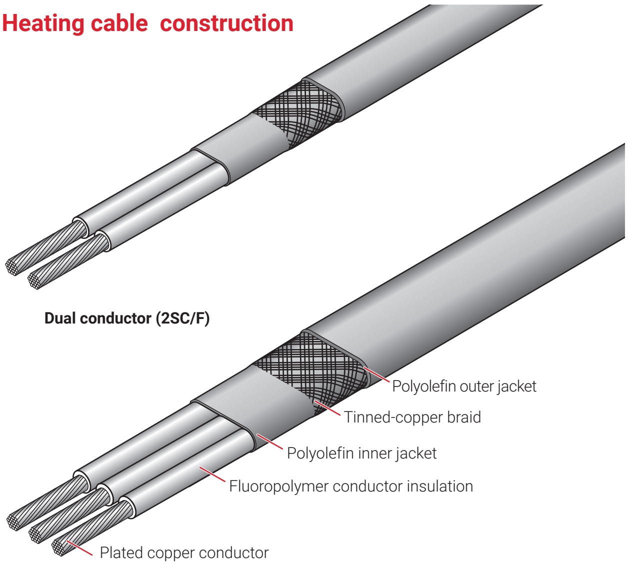
To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent RAYCHEM, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each eating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

SC/F

nVent
RAYCHEM

SERIES-RESISTANCE HEATING CABLES FOR LONGLINE SYSTEMS ELECTRICAL FREEZE PROTECTION FOR LONG PIPELINES IN BOTH NONHAZARDOUS AND HAZARDOUS LOCATIONS

Heating cable construction



Dual conductor (2SC/F)

Triple conductor (3SC/F)

10 YEAR Product warranty

PRODUCT OVERVIEW

nVent RAYCHEM SC/F series-resistance technology provides freeze protection for longline applications with minimal heat loss.

This series-resistance type heating cable can withstand continuous exposure temperatures up to 195°F (90°C), and is suitable for use in hazardous locations. SC/F heating cables can be used for continuous circuit lengths to 12,000 feet (3659 m), powered from a single source.

SC/F heating cables meet the requirements of the U.S. National Electrical Code and the Canadian Electrical Code.

For additional information, contact your nVent representative or call (800) 545-6258.

APPLICATION

Area classification	Nonhazardous and hazardous locations
Chemical resistance	Aqueous inorganic chemicals

SUPPLY VOLTAGE

TEMPERATURE RATING

Maximum continuous exposure (Power off)	195°F (90°C)
Minimum installation temperature	–40°F (–40°C)

TEMPERATURE ID NUMBER (T-RATING)

Established by calculating the maximum sheath temperature for the application. Contact nVent for assistance.

APPROVALS

1SC

Nonhazardous Locations

-W

Hazardous Locations

-W Ex e II T (1)(2)

(1)for T-Rating, see design documentation
(2)for 1SC60-CT, 1SC70-CT, and 1SC80-CT only

2SC

Hazardous Locations

-W APPROVED
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

For T-Rating, see design documentation

II 2 GD Ex e II T* (see schedule) Ex tD A21 IP66
Baseefa06ATEX0189X

IECEx Ex e II T* (see schedule) Ex tD A21 IP66
IECEx BAS 06.0049X

-W Ex e II T (1)

Ex e IIC T* Gb

(1)For T-Rating, see design documentation

3SC

Hazardous Locations

-W APPROVED
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

For T-Rating, see design documentation

II 2 GD Ex e II T* (see schedule) Ex tD A21 IP66
Baseefa06ATEX0189X

IECEx Ex e II T* (see schedule) Ex tD A21 IP66
IECEx BAS 06.0049X

-W Ex e II T (1)

Ex e IIC T* Gb

(1)For T-Rating, see design documentation

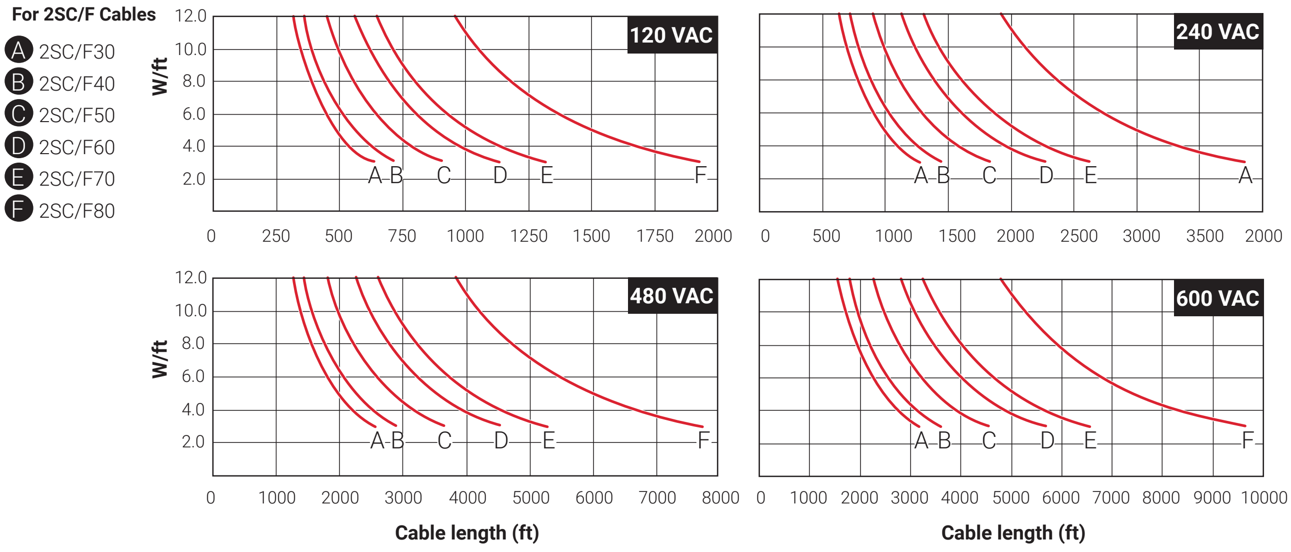
DESIGN AND INSTALLATION

SC/F applications must be designed and approved by nVent. Series heating cable technology requires that SC/F cables must not be overlapped. The use of appropriate control and monitoring equipment specified by nVent is required.

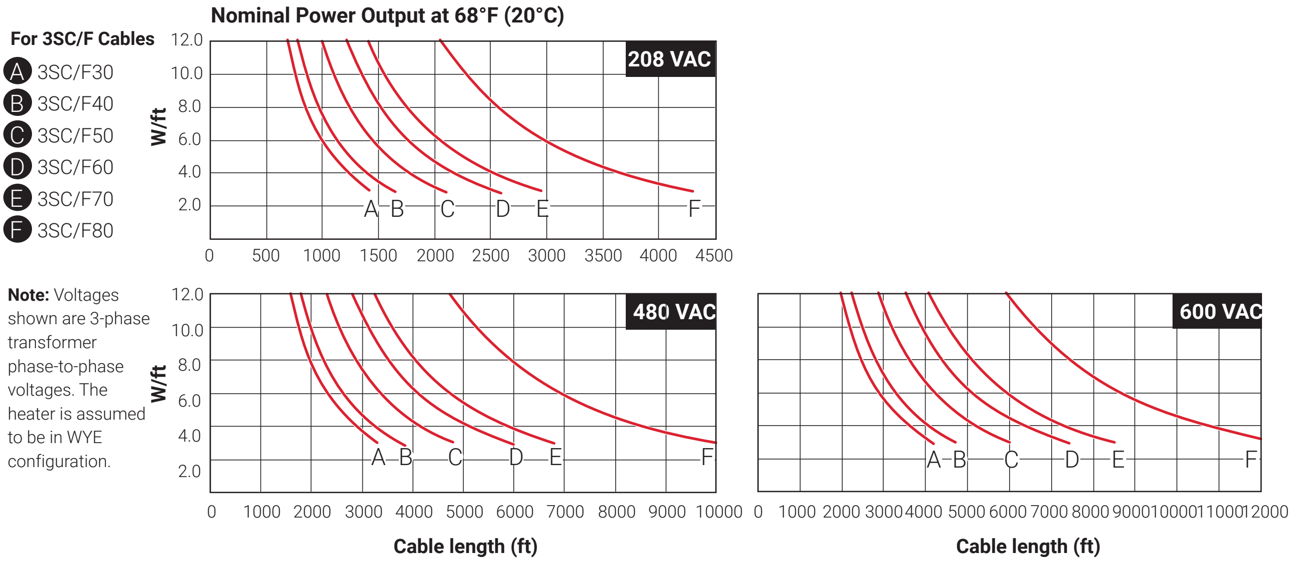
NOMINAL POWER OUTPUT RATING

These graphs are general guides to selection. Actual designs require consideration of other important variables and must be confirmed by Thermal Management. Also, many other voltages and electrical configurations are possible.

Nominal Power Output at 68°F (20°C)



NOMINAL POWER OUTPUT RATING



Note: Voltages shown are 3-phase transformer phase-to-phase voltages. The heater is assumed to be in WYE configuration.

PRODUCT CHARACTERISTICS

SC/F	Conductor size	Cable resistance (nominal) @ 68°F (20°C) ohms/ft	ohms/m	Weight (nominal) lb/10 ft	Maximum circuit breaker size	Cable dimensions (nominal) (in)	Minimum bend radius (in)
(Dual conductor cable)							
2SC/F30-CR	18	0.01180	0.03869	0.8	40	0.31 x 0.21	1
2SC/F40-CR	16	0.00916	0.03004	1.0	40	0.32 x 0.22	1
2SC/F50-CR	14	0.00580	0.01902	1.2	40	0.35 x 0.23	1
2SC/F60-CR	12	0.00374	0.01226	1.4	60	0.39 x 0.25	1
2SC/F70-CR	10	0.00240	0.00787	1.8	80	0.44 x 0.28	1
2SC/F80-CR	8	0.00130	0.00426	2.4	100	0.54 x 0.33	1
(Triple conductor cable, resistance per conductor)							
3SC/F30-CR	18	0.00590	0.01935	1.2	40	0.41 x 0.21	1
3SC/F40-CR	16	0.00458	0.01502	1.5	40	0.43 x 0.22	1
3SC/F50-CR	14	0.00290	0.00951	1.8	40	0.47 x 0.23	1
3SC/F60-CR	12	0.00187	0.00613	2.1	60	0.53 x 0.25	1
3SC/F70-CR	10	0.00120	0.00394	2.7	80	0.60 x 0.28	1
3SC/F80-CR	8	0.00065	0.00213	3.6	100	0.75 x 0.33	1

CONNECTION KITS

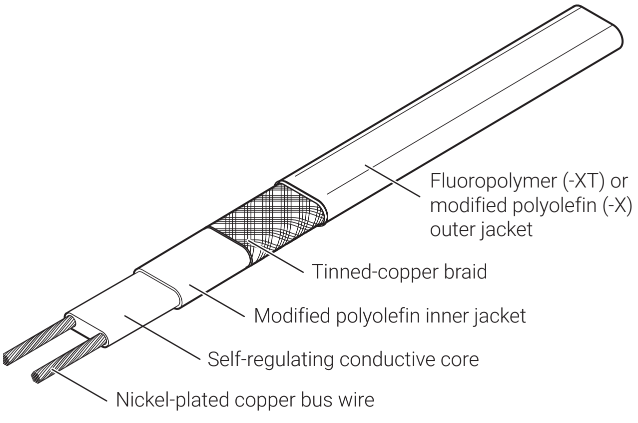
nVent offers a full range of connection kits for power connections, splices, and end seals. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

ICESTOP

SELF-REGULATING ROOF AND GUTTER DE-ICING HEATING CABLE



Heating cable construction

PRODUCT OVERVIEW

nVent RAYCHEM IceStop is a roof and gutter de-icing system that provides drain paths for the following applications:

- Roofs made from standard roofing materials, including shake, shingle, rubber, tar, wood, metal, and plastic.
- Gutters made from standard materials, including metal, plastic, and wood.
- Downspouts made from standard materials, including metal and plastic.

The heating element in the IceStop heating cable consists of a continuous core of conductive polymer extruded between two copper bus wires. As current flows through the core, the IceStop heating cable regulates its own heat output in response to ambient conditions.

This self-regulating feature eliminates hot spots and results in better temperature control to protect roof and gutter materials.

The IceStop heating cable is available with a fluoropolymer outer jacket (-XT) that provides maximum abrasion, chemical, and mechanical resistance; or a polyolefin outer jacket (-X) that is more economical for less demanding applications.

Low installed cost

The IceStop heating cable's parallel circuitry allows it to be cut to the exact length required, with no wasted cable.

All of these characteristics simplify and streamline the design of a roof and gutter de-icing system. Installation is quick and simple. The same features that make an IceStop system easy to install the first time also simplify additions or changes to the system during building renovations.

10 YEAR Product warranty

CATALOG NUMBER

GM-1XT and GM-1X	GM-2XT and GM-2X

POWER OUTPUT (NOMINAL)

12 W/ft (39 W/m) in ice or snow	12 W/ft (39 W/m) in ice or snow

VOLTAGE

120 Vac	208–277 Vac

MINIMUM INSTALLATION TEMPERATURE

0°F (–18°C)	0°F (–18°C)

MINIMUM BEND RADIUS

5/8 in (16 mm)	5/8 in (16 mm)

MAXIMUM CIRCUIT LENGTH IN FEET (METERS)

	Start-up temperature		Circuit breaker size				
			15 A		20 A	30 A	40 A*
GM-1XT and GM-1X at 120 volts	32°	(0°C)	100	(30)	135(41)	200(61)	—
	20°	(–7°C)	95	(29)	125(38)	185(56)	200(61)*
	0°	(–18°C)	80	(24)	100(30)	155(47)	200(61)*
GM-2XT and GM-2X at 208 volts	32°	(0°C)	190	(58)	250(76)	380(116)	—
	20°	(–7°C)	180	(55)	235(72)	355(108)	380(116)*
	0°	(–18°C)	145	(44)	195(59)	290(88)	380(116)*
GM-2XT and GM-2X at 240 volts	32°	(0°C)	200	(61)	265(81)	400(122)	—
	20°	(–7°C)	190	(58)	250(76)	370(113)	400(122)*
	0°	(–18°C)	155	(47)	205(62)	305(93)	400(122)*
GM-2XT and GM-2X at 277 volts	32°	(0°C)	215	(66)	290(88)	415(126)	—
	20°	(–7°C)	200	(61)	265(81)	400(122)	415(126)*
	0°	(–18°C)	165	(50)	225(69)	330(101)	415(126)*

* Only TC-P power connection kits may be used with 40-A circuits.

BUS WIRES

16 AWG nickel-plated copper

BRAID / OUTER JACKET

Tinned-copper braid with fluoropolymer (-XT) or modified polyolefin (-X) outer jacket

DIMENSIONS

Maximum width	0.54 in (14 mm)
Maximum thickness	0.24 in (6 mm)

NOMINAL WEIGHT

92 lb/1000 ft (137 kg/1000 m)

CONNECTION KITS

nVent RAYCHEM RayClic or FTC connection kits must be used with IceStop heating cables. Refer to the Roof and Gutter De-Icing Design Guide (H56070) for proper connection kit selection.

APPROVALS

UL LISTED 877Z De-icing and Snow-Melting Equipment

-WS

FM APPROVED

Nonhazardous and Hazardous Locations
Class 1, Div. 2, Groups A, B, C, D*
* For GM-1XT and GM-2XT

The IceStop heating cables are UL Listed, CSA Certified, and FM Approved only when used with the appropriate agency-approved Thermal Management connection kits and accessories.

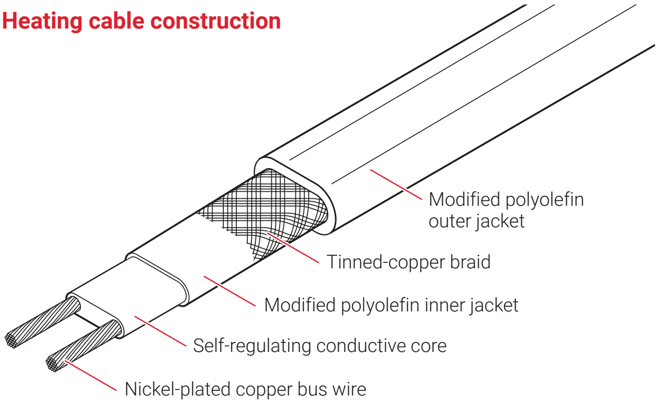
GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Thermal Management, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many Raychem control and monitoring systems meet the ground-fault protection requirement.

ELECTROMELT

SELF-REGULATING SURFACE SNOW-MELTING AND ANTI-ICING HEATING CABLE

Heating cable construction



PRODUCT OVERVIEW

ElectroMelt provides surface snow melting and anti-icing in concrete pavement.

Self-regulating

The polymer core of an ElectroMelt heating cable automatically adjusts power output at every point along its length in response to concrete pavement temperature. This response characteristic eliminates burnouts caused by overlapping cable and provides improved energy efficiency without the need for special controls.

Parallel circuitry

The crosslinked, conductive polymer core of the ElectroMelt heating cable is extruded between two 14 AWG copper bus wires, forming a parallel circuit. This allows ElectroMelt heating cables to be cut to length and to be spliced and repaired, if necessary, in the field.

RUGGED

Specifically designed for direct burial in concrete, ElectroMelt heating cables are protected by a tinned-copper braid encased in a 70-mil modified polyolefin outer jacket. With no exposed metal parts to corrode, no cold leads to fail, and no burnout due to overlaps or hot spots, rugged ElectroMelt heating cable offers an ideal solution for all types of concrete pavement snow melting and anti-icing.

10 YEAR Product warranty

CATALOG NUMBER

	EM2-XR		**EM3-XR**	
Power Output W/ft (W/m)	**Voltage**	**Power Output W/ft (W/m)**	**Voltage**	**Power Output W/ft (W/m)**
	208	30 (98)	347	24 (79)
	240	32 (105)		
	277	34 (112)		

DIMENSIONS

Maximum width	0.75 in (19 mm)	0.70 in (17.8 mm)
Maximum thickness	0.38 in (10 mm)	0.31 in (7.9 mm)

MINIMUM INSTALLATION TEMPERATURE

0°F (–18°C)	0°F (–18°C)

MINIMUM BEND RADIUS

2 in (50 mm)	2 in (50 mm)

MAXIMUM CIRCUIT LENGTH FOR STARTUP AT 20°F (–7°C) IN FEET (METERS)

Circuit breaker (A)	**Heating cable supply voltage**			
	208 V	**240 V**	**277 V**	**347 V**
15	80 (24)	85 (26)	100 (31)	120 (37)
20	105 (32)	115 (35)	130 (40)	165 (50)
30	160 (49)	170 (52)	195 (59)	250 (76)
40	210 (64)	230 (70)	260 (79)	330 (101)
50	265 (81)	285 (87)	325 (99)	†

MAXIMUM CIRCUIT LENGTH FOR STARTUP AT 0°F (–18°C) IN FEET (METERS)

	Heating cable supply voltage			
Circuit breaker (A)	**208 V**	**240 V**	**277 V**	**347 V**
15	75 (23)	80 (24)	90 (27)	107 (33)
20	100 (31)	110 (34)	120 (37)	148 (45)
30	145 (44)	160 (49)	180 (55)	225 (69)
40	200 (61)	210 (64)	240 (73)	288 (88)
50	245 (75)	265 (81)	300 (91)	†
† Not permitted				

BUS WIRES

14 AWG nickel-plated copper

BRAID / OUTER JACKET

Heavy tinned-copper braid encased in a 70-mil modified polyolefin outer jacket

NOMINAL WEIGHT

180 lb/1000 ft (268 kg/1000 m)

CONNECTION KITS

ElectroMelt connection kits must be used to terminate ElectroMelt heating cables. Refer to the Surface Snow Melting and Anti-Icing Design Guide – ElectroMelt (H53393) for proper connection kit selection.

APPROVALS

877Z De-icing and
Snow-melting
Equipment
(for EM2-XR only)

-W

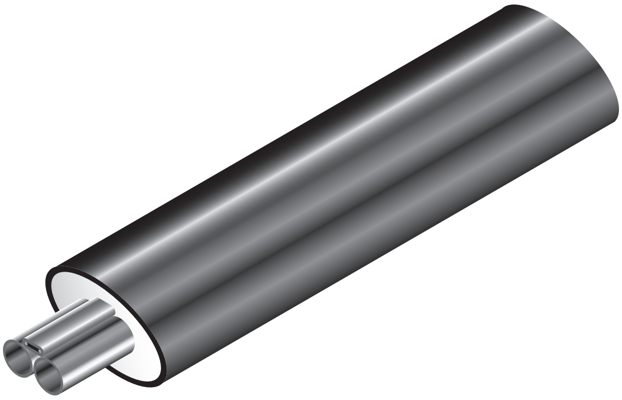
The EM2-XR and EM3-XR heating cables are UL Listed and CSA Certified only when used with the appropriate agency-approved nVent RAYCHEM connection kits and accessories.

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent RAYCHEM, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

nVent
RAYCHEM

ELECTRIC TRACED BUNDLES



PRODUCT OVERVIEW

nVent RAYCHEM RTB tubing bundles utilizing electric tracing are designed to maintain freeze protection, close temperature tolerances, or viscosity control.

They provide an excellent means of maintaining very long, continuous lengths of impulse lines and piping at consistent temperatures end-to-end.

These bundles are used when the maintain temperature ranges from 10°C (50°F) to 121°C (250°F). Utilizing nVent RAYCHEM self-regulating heater technology, this system will lower its heat output as the process tube gets warmer. Optional line sensing controllers allow for close temperature control, if necessary.

ELECTRIC HEATING CABLE

RTB Electric Traced tubing bundles utilize nVent RAYCHEM self-regulating technology.

Low temperature maintain and exposure temperature applications are fabricated using nVent RAYCHEM BTV product, while high temperature maintain and exposure utilize XTV product.

High temperature XTV self-regulating heating cable:

- Withstands 250°C (482°F) intermittent blowdown temperatures.
- Maintains temperatures up to 121°C (250°F).

BTV Self-Regulating heating cable:

- Withstands up to 85°C (185°F) blowdown temperatures.
- Maintains temperatures up to 65°C (150°F).

The choice between high and low temperature heating cable must be made based on the desired performance and the conditions of the application.

Refer to the appropriate heating cable data sheet for specific heater specifications.

TYPICAL PERFORMANCE

The graphs beginning on page 270 show typical performance splitting summer/winter ambient conditions. Each line is separated at 16°C (60°F) to designate the seasonal differences.

Winter ambients, below 16°C (60°F), assume a 40 km/h (25 mph) wind and summer ambients, above 16°C (60°F), assume a 16 km/h (10 mph) wind. For freeze protection, use 10°C (50°F) as the minimum allowable process tube temperature. This will provide a sufficient factor of safety.

The information presented represents typical performance data for the conditions given and at the rated voltage.

Actual results may vary with the conditions of installation.

For critical applications, consult the factory for specific performance data.

MATERIAL SPECIFICATIONS

RTB standard jacket material, TPU, is a thermoplastic polyurethane jacket that offers excellent abrasion resistance and extreme cold temperature workability. TPU also contains no chlorides, so it should be selected for applications where chloride stress cracking is a problem.

Optional Arctic PVC is a proprietary thermoplastic formulation that exceeds the requirements of 105°C PVC and outperforms other PVC jacket materials in UV resistance, as well as providing low temperature flexibility to –35°C (30°F).

	STANDARD 105°C PVC	ARCTIC PVC	TPU
Abrasion resistance	G	G	E
Tensile strength PSI	18–1900	2200	3800
Elongation %	250%	350%	700%
Hardness, Shore A	85–90	80	80
Minimum service temperature	None stated	–35°C (–30°F)	–58°C (–67°F)
Minimum installation temperature	–9°C (15°F)	–23°C (–10°F)	–40°C (–40°F)
UL94 flame	V2	V2	V0 to V2
Halogenated (chlorides)	Yes	Yes	No
Maximum temperature	105°C (220°F)	105°C (220°F)	120°C (250°F)
Water absorption %	0.1%	0.1%	1.2–1.4%
Aromatic hydrocarbons	F	F	G
Weathering	G	G	E
UV resistance	F	G	E
Insulation	Fibrous glass Water soluble chlorides less than 100 ppm Nonhygroscopic		
	E = Excellent G = Good F = Fair P = Poor		

TEMPERATURE LIMITS

Maximum process temperature	204°C (400°F)
Maximum jacket surface temperature	60°C (140°F) at ambient temperature of 27°C (80°F) with 10 mph (16 km/h) wind

TUBING SPECIFICATIONS

Designation	Material	Construction	O.D. (mm)	Wall (mm)	Maximum pressure* (Bar)	Maximum continuous length possible ** (m)	Specifications
Metric							
-6-S-10-	316/316L SS	Seamless	6	1	460	300	A269, A213-EAW, DIN 17458 1.4401/1.4404
-8-S-10-	316/316L SS	Seamless	8	1	330	210	A269, A213-EAW, DIN 17458 1.4401/1.4404
-10-S-10-	316/316L SS	Seamless	10	1	260	165	A269, A213-EAW, DIN 17458 1.4401/1.4404
-12-S-10-	316/316L SS	Seamless	12	1	210	150	A269, A213-EAW, DIN 17458 1.4401/1.4404
-10-S-15-	316/316L SS	Seamless	10	1.5	410	150	A269, A213-EAW, DIN 17458 1.4401/1.4404
-12-S-15-	316/316L SS	Seamless	12	1.5	330	120	A269, A213-EAW, DIN 17458 1.4401/1.4404
-12-W-10-	316/316L SS	Welded	12	1	170	300	ASTM, A269
-6-C-10-	Copper	Seamless	6	1	95	600	B68, B75
-8-C-10-	Copper	Seamless	8	1	60	455	B68, B75
-12-C-10-	Copper	Seamless	12	1	55	300	B68, B75
-6-P-10-	PFA Teflon	Extruded	6	1	10	300	
-8-P-10-	PFA Teflon	Extruded	8	1	8	300	
-10-P-10-	PFA Teflon	Extruded	10	1	7	300	
-12-P-10-	PFA Teflon	Extruded	12	1	4	300	
Fractional							
-1/8-S-.035-	316/316L SS	Seamless	1/8	0.035	10,900	900	A269, A213-EAW
-1/4-S-.035-	316/316L SS	Seamless	1/4	0.035	5,100	1,000	A269, A213-EAW
-3/8-S-.035-	316/316L SS	Seamless	3/8	0.035	3,300	1,200	A269, A213-EAW
-1/2-S-.035-	316/316L SS	Seamless	1/2	0.035	2,600	700	A269, A213-EAW
-3/8-S-.049-	316/316L SS	Seamless	3/8	0.049	4,800	500	A269, A213-EAW
-1/2-S-.049-	316/316L SS	Seamless	1/2	0.049	3,700	460	A269, A213-EAW
-1/2-S-.065-	316/316L SS	Seamless	1/2	0.065	5,100	250	A269, A213-EAW
-1/4-W-.035-	316/316L SS	Welded	1/4	0.035	4,080	1,000	A269
-3/8-W-.035-	316/316L SS	Welded	3/8	0.035	2,640	1,000	A269
-1/2-W-.035-	316/316L SS	Welded	1/2	0.035	2,080	700	A269
-1/4-C-.030-	Copper	Seamless	1/4	0.030	1,400	1,000	B68, B75
-3/8-C-.032-	Copper	Seamless	3/8	0.032	900	1,500	B68, B75
-1/2-C-.035-	Copper	Seamless	1/2	0.035	800	1,000	B68, B75
-1/2-C-.049-	Copper	Seamless	1/2	0.049	1,100	500	B68, B75
-1/4-P-.030-	PFA Teflon	Extruded	1/4	0.030	155	1,000	
-3/8-P-.030-	PFA Teflon	Extruded	3/8	0.030	95	1,000	
-1/4-M-.035-	Monel	Seamless	1/4	0.035	4,800	1,000	B163, B165
-3/8-M-.035-	Monel	Seamless	3/8	0.035	3,100	600	B163, B165
-1/4-M-.049-	Monel	Seamless	1/2	0.049	3,210	600	B163, B165
-1/2-P-.062-	PFA Teflon	Extruded	1/2	0.062	155	1,000	

PRESSURE CORRECTION FOR ELEVATED TEMPERATURES

	PFA TEFLON	COPPER	316SS	MONEL
93°C (200°F)	0.84	0.80	1.00	0.88
204°C (400°F)	0.30	0.50	0.95	0.79
316°C (600°F)	–	–	0.82	0.79
427°C (800°F)	–	–	0.79	0.76

ELECTRIC HEATING CABLE DATA: NOMINAL POWER OUTPUT AT 10°C (50°F)

Code	V	W/ft	W/m	Max. continuous exposure* and maintain	Max. intermittent exposure**	T-rating	nVent RAYCHEM heating cable	Approvals***	
5B1	120	5	16	65°C (150°F)	85°C (185°F)	T6	5BTV1-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
8B1	120	8	26	65°C (150°F)	85°C (185°F)	T6	8BTV1-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
10B1	120	10	33	65°C (150°F)	85°C (185°F)	T6	10BTV1-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
5B2	240	5	16	65°C (150°F)	85°C (185°F)	T6	5BTV2-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
8B2	240	8	26	65°C (150°F)	85°C (185°F)	T6	8BTV2-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
10B2	240	10	33	65°C (150°F)	85°C (185°F)	T6	10BTV2-CT	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T6; CL I, ZN 1, AEx e II T6 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T6 Ex e II T6 Baseefa06ATEX0183X [Ex] II 2 GD Ex e II T6 Ex tD A21 IP66
5X1	120	5	–	121°C (250°F)	215°C (420°F)	T3	5XTV1-CT-T3	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2 Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
10X1	120	10	–	121°C (250°F)	215°C (420°F)	T3	10XTV1-CT-T3	FM: CSA: Baseefa:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2 CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2 Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66

Code	V	W/ft	W/m	Max. continuous exposure* and maintain	Max. intermittent exposure**	T-rating	nVent RAYCHEM heating cable	Approvals***	
15X1	120	15	–	121°C (250°F)	215°C (420°F)	T2D	15XTV1-CT-T2	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
20X1	120	20	–	121°C (250°F)	215°C (420°F)	T2C	20XTV1-CT-T2	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
5X2	240	5	–	121°C (250°F)	215°C (420°F)	T3	5XTV2-CT-T3	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
10X2	240	10	–	121°C (250°F)	215°C (420°F)	T3	10XTV2-CT-T3	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
15X2	240	15	49	121°C (250°F)	215°C (420°F)	T3	15XTV2-CT-T3	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2D, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66
20X2	240	20	66	121°C (250°F)	215°C (420°F)	T2	20XTV2-CT-T2	FM:	CL I, Div. 2, Grps. B,C,D; CL II, Div. 2, Grps. F, G; CL III; T3, T2C CL I, ZN 1, AEx e II T3/T2
								CSA:	CL I, Div. 1 & 2, Grps. A,B,C,D; CL II, Div. 1 & 2, Grps. E, F,G; CL III; T3, T2D, T2C Ex e II T3/T2
								Baseefa:	Baseefa06ATEX0184X [Ex] II 2 GD Ex e II T* (See Schedule) Ex tD A21 IP66

* Continuous power on/off

** 1,000 hours cumulative power on or off

*** Approvals – For specific approval information, refer to the Tubing Bundles Selection and Installation Guide (H55626) and the Design Guide for Tubing Bundles (H56886).

DIMENSIONS

	Nominal weight		Nominal dimensions			
	kg/m(lb/ft)		A cm	(in)	B cm(in)	
Single 1/4" process tube	0.45	(0.3)	2.8	(1.1)	2.5	(1.0)
Single 3/8" process tube	0.60	(0.4)	3.3	(1.3)	2.5	(1.0)
Single 1/2" process tube	0.74	(0.5)	3.6	(1.4)	2.8	(1.1)
Dual 1/4" process tubes	0.60	(0.4)	3.3	(1.3)	2.8	(1.1)
Dual 3/8" process tubes	0.89	(0.6)	3.8	(1.5)	3.0	(1.2)
Dual 1/2" process tubes	1.19	(0.8)	4.3	(1.7)	3.6	(1.4)

Minimum bending radius 20 cm (8 in)
Maximum support centers-ft. Horizontal 2 m (6 ft) Vertical 4 m (15 ft)

MAXIMUM CIRCUIT LENGTH VS. CIRCUIT BREAKER RATING: 120 VAC

	Start-up temp.		15 A		20 A		30 A		40 A		50 A	
	°C	°F	m	ft	m	ft	m	ft	m	ft	m	ft
5XTV1-CT-T3	10	50	55	180	73	240	110	360	117	385	117	385
	−18	0	49	160	64	210	98	320	117	385	117	385
	−29	−20	46	150	61	200	93	305	117	385	117	385
	−40	−40	44	145	59	195	88	290	117	385	117	385
10XTV1-CT-T3	10	50	34	110	44	145	67	220	82	270	82	270
	−18	0	29	95	40	130	59	195	79	260	82	270
	−29	−20	29	95	38	125	58	190	76	250	82	270
	−40	−40	27	90	37	120	55	180	73	240	82	270
15XTV1-CT-T2	10	50	23	75	30	100	46	150	61	200	67	220
	−18	0	20	65	27	90	41	135	55	180	67	220
	−29	−20	20	65	26	85	40	130	52	170	66	215
	−40	−40	18	60	24	80	38	125	50	165	62	205
20XTV1-CT-T2	10	50	15	50	2	6	37	120	49	160	58	190
	−18	0	15	50	21	70	32	105	43	140	55	180
	−29	−20	15	50	20	65	32	105	43	140	52	170
	−40	−40	15	50	20	65	30	100	40	130	50	165
5BTV1-CT	10	50	70	230	82	270	82	270	82	270	–	–
	−18	0	43	140	58	190	82	270	82	270	–	–
	−29	−20	38	125	50	165	76	250	82	270	–	–
	−40	−40	34	110	44	145	67	220	82	270	–	–
8BTV1-CT	10	50	46	150	61	200	64	210	64	210	–	–
	−18	0	30	100	40	130	61	200	64	210	–	–
	−29	−20	26	85	35	115	53	175	64	210	–	–
	−40	−40	24	80	32	105	47	155	64	210	–	–
10BTV1-CT	10	50	37	120	49	160	55	180	55	180	–	–
	−18	0	24	80	34	110	49	160	55	180	–	–
	−29	−20	21	70	29	95	43	140	55	180	–	–
	−40	−40	20	65	26	85	38	125	52	170	–	–

TYPICAL PERFORMANCE

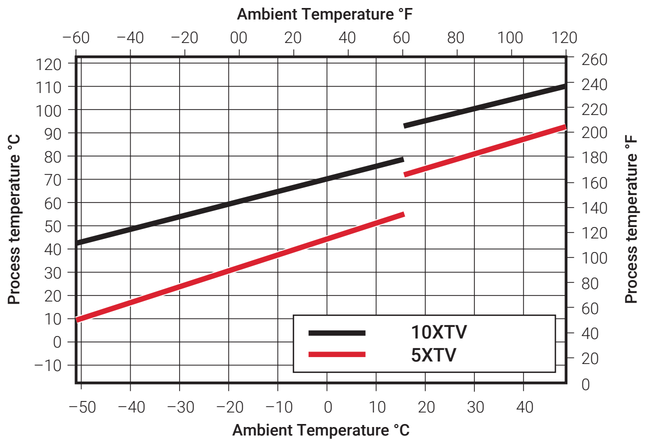
The information presented represents typical performance data for the conditions given and at the rated voltage. Actual results may vary with the conditions of installation.

For critical applications, consult the factory for specific performance data.

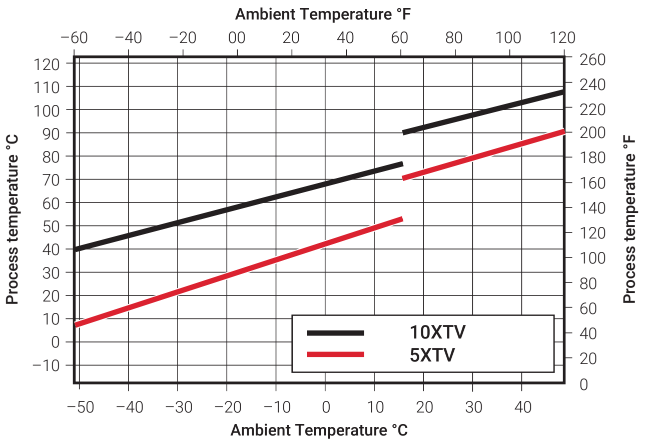
Winter ambients, below 16°C (60°F), assume a 40 km/h (25 mph) wind and summer ambients, above 16°C (60°F), assume a 16 km/h (10 mph) wind. For freeze protection use 10°C (50°F) as the minimum allowable process tube temperature. This will provide sufficient factor of safety.

TYPICAL PERFORMANCE FOR HIGH TEMPERATURE

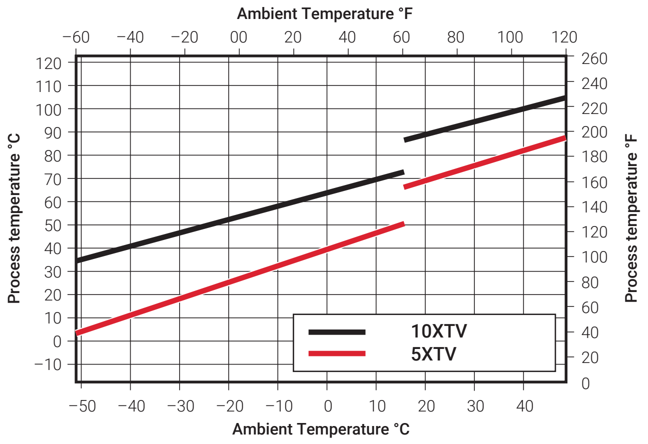
Single 1/4" Process



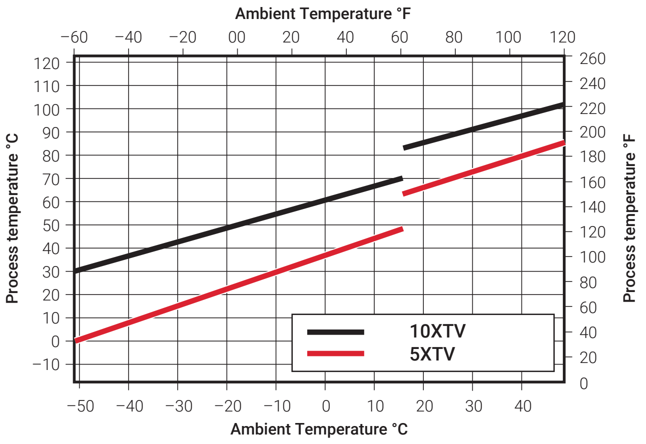
Dual 1/4" Process



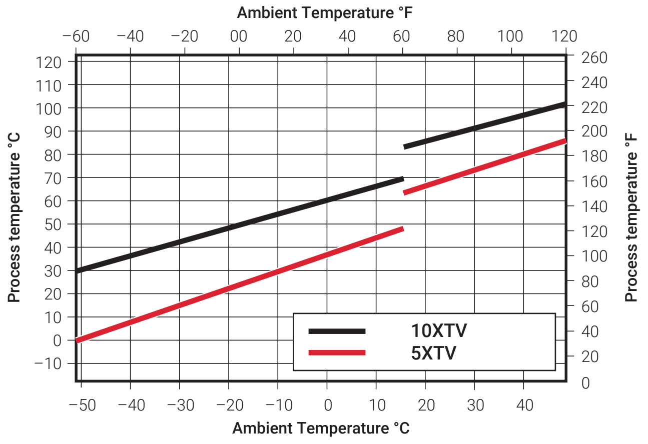
Single 3/8" Process



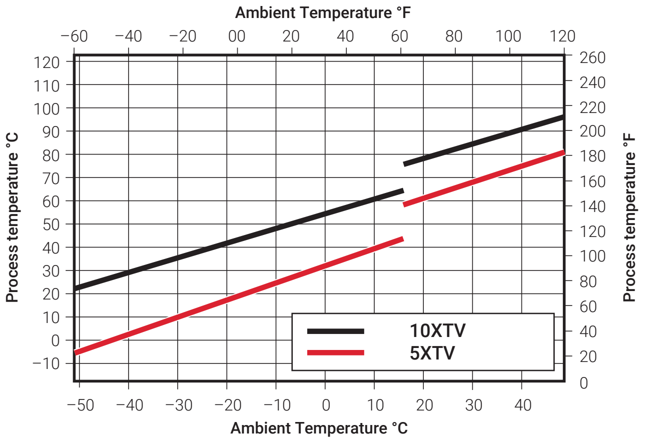
Dual 3/8" Process



Single 1/2" Process

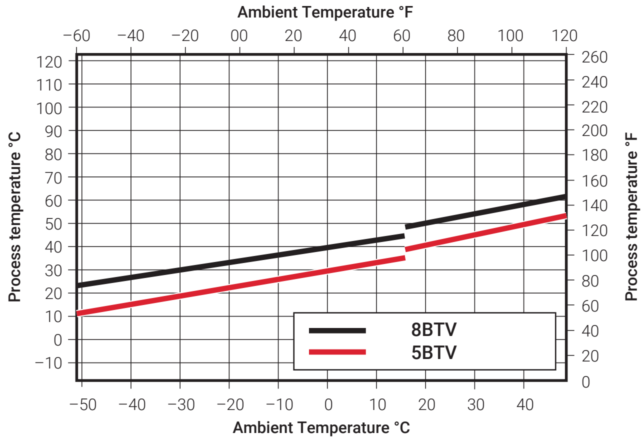


Dual 1/2" Process

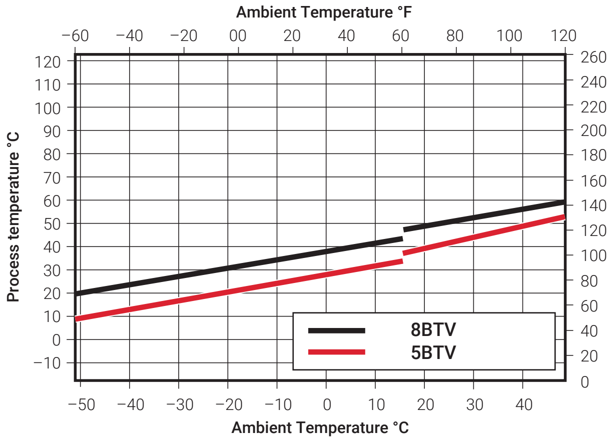


TYPICAL PERFORMANCE FOR FREEZE PROTECTION

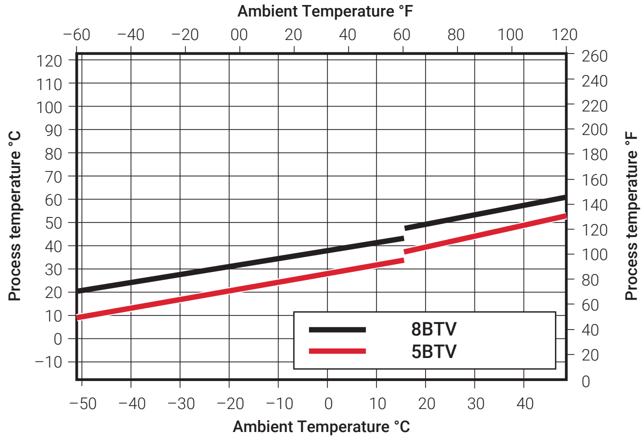
Single 1/4" Process



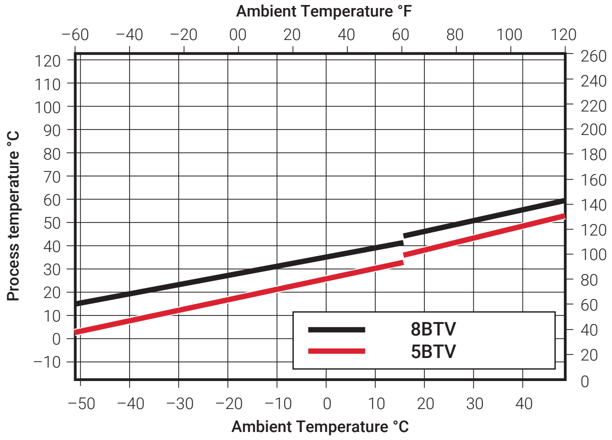
Dual 1/4" Process



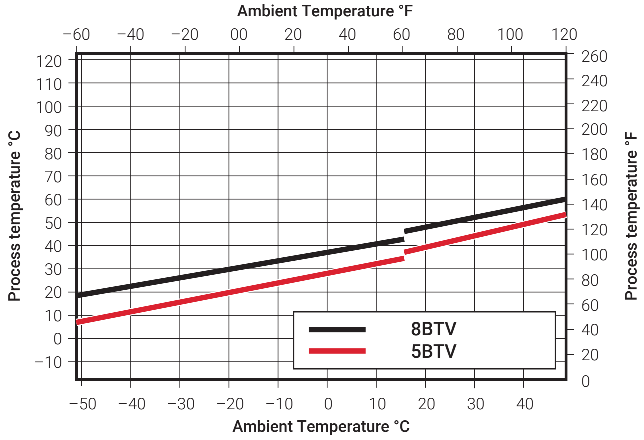
Single 3/8" Process



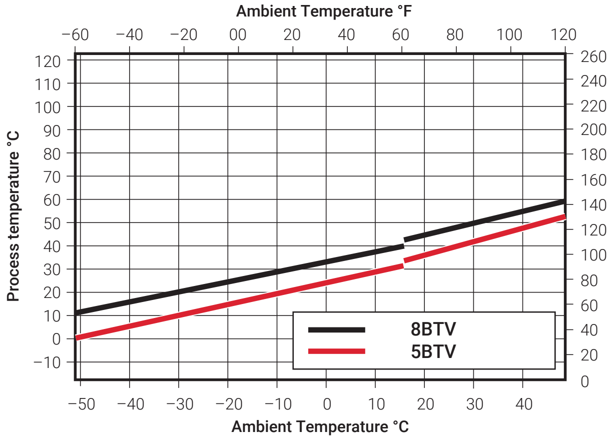
Dual 3/8" Process



Single 1/2" Process



Dual 1/2" Process



TUBING BUNDLE ORDERING DETAILS

RTB comes in a variety of configurations. The following chart outlines the elements that constitute a bundle configuration and the corresponding catalog number. Other configurations are available on request.

RTB* - X - XXX - X - XXX - XXX

Electric Traced heating options

5B1 = 5BTV1-CT
8B1 = 8BTV1-CT
10B1 = 10BTV1-CT
5B2 = 5BTV2-CT
8B2 = 8BTV2-CT
10B2 = 10BTV2-CT
5X1 = 5XTV1-CT-T3
10X1 = 10XTV1-CT-T3
15X1 = 15XTV1-CT-T2
20X1 = 20XTV1-CT-T2
5X2 = 5XTV2-CT-T3
10X2 = 10XTV2-CT-T3
15X2 = 15XTV2-CT-T3
20X2 = 20XTV2-CT-T2

Process tube wall thickness

030 = 0.030 in
032 = 0.032 in
035 = 0.035 in
049 = 0.049 in
062 = 0.062 in
065 = 0.065 in
10 = 1.0 mm
15 = 1.5 mm

Process tube material

S = Seamless 316 SS
W = Welded 316 SS
M = Monel
C = Copper
P = PFA

Process tubing size

1/8 = 1/8 in
1/4 = 1/4 in
3/8 = 3/8 in
1/2 = 1/2 in
3/4 = 3/4 in
6 = 6 mm
8 = 8 mm
10 = 10 mm
12 = 12 mm

Number of process tubes

1 = Single-tube
2 = Dual-tube

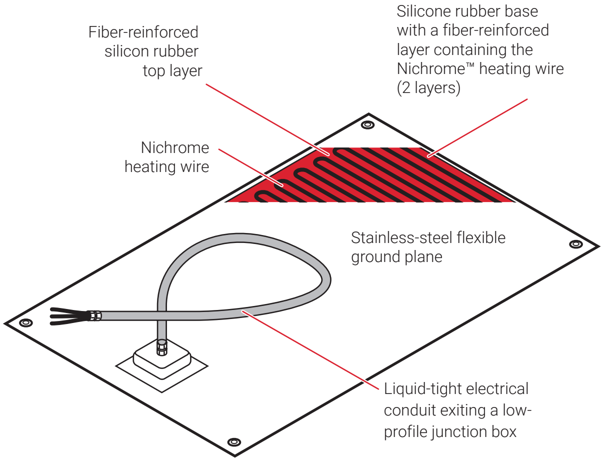
* For optional Arctic PVC jacket add suffix "C" example RTBC

Examples:

Electric Traced	RTB-2-1/2-S-049-10X1

RHS

TANK HEATING PADS



PRODUCT OVERVIEW

nVent RAYCHEM brand tank heating pads nVent RAYCHEM (RHS) are designed for applications ranging from freeze protection to process-temperature maintenance of tanks.

nVent offers RHS tank heating pads with two power densities, making them ideal for metal tanks (lined and unlined) and plastic tanks.

FM Approvals and CSA International (CSA) have approved RHS tank heating pads for use in both nonhazardous and hazardous locations.

Compared to self-regulating heating cables, they offer a cost-effective solution in applications where even heat distribution is not required. They are not recommended for highly temperature-sensitive fluids.

RHS-L may be used on tank walls capable of a maintain temperature up to 120°F (49°C), and RHS-H may be used on tanks with walls capable of up to 200°F (93°C).

RHS is offered with two power densities, 1.9 W/in^2 and 0.6 W/in^2.

Durable components make RHS tank heating pads:

- Easy to design and install
- Approved for use in nonhazardousand hazardous locations
- Highly reliable in the rugged environments of industrial plants

DESCRIPTION

RHS-H	RHS-L
Flexible tank heating pad for unlined metal tanks	Flexible tank heating pad for metal and plastic tanks (lined and unlined)

KIT CONTENTS

One heating pad (1.9 W/in^2) with stainless-steel junction box and flexible conduit	One heating pad (0.6 W/in^2) with stainless-steel junction box and flexible conduit

APPROVALS

Hazardous Locations

FM APPROVED

-G

Class I, Div. 2, Groups B, C, D
Class II(1), Div. 1 and 2, Groups E, F, G
Class III(1)

(1) Applications must be reviewed by nVent.

PRODUCT SPECIFICATIONS (NOMINAL)

RHS-H

Catalog number	Overall dimensions	Voltage (Vac)	Power output (W)	Current draw (A)
RHS-H-500-1	14" x 24" (356 mm x 610 mm)	120	500	4.2
RHS-H-1000-1	24" x 26" (610 mm x 660 mm)	120	1000	8.3
RHS-H-1400-1	24" x 36" (610 mm x 914 mm)	120	1400	11.7
RHS-H-500-2	14" x 24" (356 mm x 610 mm)	240	500	2.1
RHS-H-1000-2	24" x 26" (610 mm x 660 mm)	240	1000	4.2
RHS-H-1400-2	24" x 36" (610 mm x 914 mm)	240	1400	5.8

RHS-L

Catalog number	Overall dimensions	Voltage (Vac)	Power output (W)	Current draw (A)
RHS-L-150-1	14" x 24" (356 mm x 610 mm)	120	150	1.3
RHS-L-300-1	24" x 26" (610 mm x 660 mm)	120	300	2.5
RHS-L-420-1	24" x 36" (610 mm x 914 mm)	120	420	3.5
RHS-L-150-2	14" x 24" (356 mm x 610 mm)	240	150	0.6
RHS-L-300-2	24" x 26" (610 mm x 660 mm)	240	300	1.3
RHS-L-420-2	24" x 36" (610 mm x 914 mm)	240	420	1.8

	RHS-H		RHS-L	
Model	**RHS-H-1**	**RHS-H-2**	**RHS-L-1**	**RHS-L-2**
Nominal voltage (Vac)	120	240	120	240
Voltage range (Vac)	100–130	200–277	100–130	200–277
Power adjustment factor		208 Vac = 0.75 277 Vac = 1.33		
Watt density	1.9 W / in^2		0.6 W / in^2	
T-rating	T2C: 446°F (230°C)		T4A: 248°F (120°C)	
Maximum maintain temperature (power on)	200°F (93°C)		120°F (49°C)	
Maximum exposure temperature (power off)	366°F (186°C)		366°F (186°C)	
Minimum usage temperature	–40°F (–40°C)		–40°F (–40°C)	
Conduit length	4 ft (1.2 m)		4 ft (1.2 m)	
Application (See Design guide Doc# H56887 for limitations)	For use on metal tanks only		For use on metal, polypropylene, and fiber-reinforced plastic tanks	

MATERIALS OF CONSTRUCTION

Flexible grounding plane	Stainless steel
Rubber sheet	Vulcanized silicone rubber
Heating elements	Metal, embedded in glass-reinforced silicone rubber
Conduit material	Stainless steel

ADDITIONAL MATERIALS REQUIRED

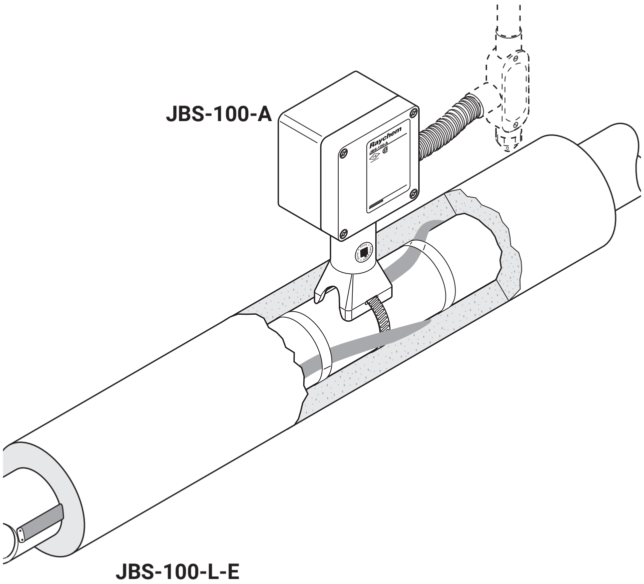
RHS-INSTALLATION-KIT (P/N 844869-001)	The RHS installation kit contains a caulking gun, two RTV adhesive tubes, a wedge, one 30-foot roll of AT-180 aluminum tape, and a trowel for mounting up to two RHS tank heating pads. The kit is FM Approved and CSA Certified for use with RHS tank heating pads.
Temperature control device	Thermostat or other control system must be used.

JBS-100

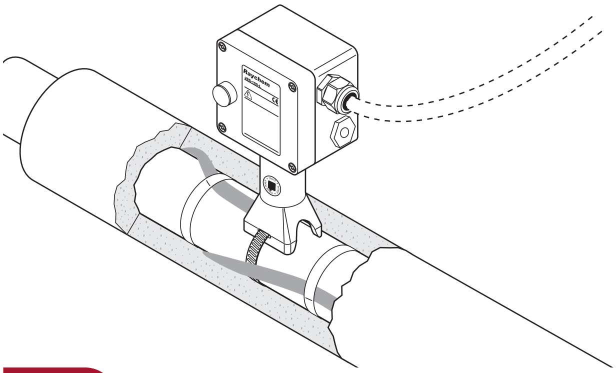
nVent
RAYCHEM

SINGLE-ENTRY POWER CONNECTION WITH JUNCTION BOX

JBS-100-A



JBS-100-L-E
(Shown with light)



10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM JBS-100 kit is designed to connect power to a single nVent RAYCHEM brand BTV, QTVR, XTV, KTV, or VPL heating cable. It is approved by FM, CSA, PTB and IEx for use in hazardous locations.

The JBS-100 integrates the functions of connection kits and insulation entries. The rugged stand protects the heating cable and allows for up to four inches (100 mm) of thermal insulation.

The cold-applied core sealer does not require a heat gun or torch for installation, so no hot work permit is necessary. The silicone-free, noncuring sealant allows easy installation and re-entry for maintenance.

Innovative spring clamp terminals provide fast installation and safe, reliable, maintenance-free operation.

Compared with other systems, this connection kit significantly reduces installation time. The kit is offered in three versions, customized for local installation practices, and is also available with a plug-in LED light (-L) that indicates when power is supplied to the heating cable circuit.

The kit contains all the necessary materials for a complete installation except for one pipe strap, which must be ordered separately.

DESCRIPTION

	JBS-100-A, A6 JBS-100-L-A* *Not for use with 480 V VPL	JBS-100-E JBS-100-L-E*	JBS-100-EP JBS-100-L-EP*
	This kit has a junction box with one through hole.	This kit has a junction box with two M25 threaded entries, one stopping plug and one plastic power cable gland.	This kit has a junction box with two M25 threaded entries, an earthing plate and an external earthing stud. It is designed for use with armored power cables.

KIT CONTENTS

	JBS-100-A, A6 JBS-100-L-A* *Not for use with 480 V VPL	JBS-100-E JBS-100-L-E*	JBS-100-EP JBS-100-L-EP*
Note: Order appropriate pipe strap separately (one per kit)	1 junction box with terminals 1 stand assembly 1 core sealer 1 green/yellow tube 1 light module (for -L only) 1 cable tie	1 junction box with terminals 1 stand assembly 1 core sealer 1 green/yellow tube 1 M25 gland for power cable 8–17 mm in diameter 1 M25 stopping plug 1 light module (for -L only) 1 cable tie	1 junction box with terminals, earth continuity plate, and stud 1 stand assembly 1 core sealer 1 green/yellow tube 1 M25 stopping plug 1 light module (for -L only) 1 cable tie

APPROVALS

Hazardous Locations

Class I, Div. 2, Groups A, B, C, D(2)
Class II, Div. 2, Groups E, F, G(2)
Class III(2)
-WS

(1)
CLI, ZN1, AEx e II T(2)
CLI, ZN1, AEx em II T(2) (for -L only)

Ex e II T(2)
Ex em II T(2) (for -L only)
-WS

Ex e IIC T* Gb
Ex em IIC T* Gb

PTB 09 ATEX 1059U
II 2G Ex e (e mb) II
II 2D Ex tD (tD mbD) A21 IP66
IECEx PTB09.0037U
Ex e (e mb) II
Ex tD (tD mbD) A21 IP66

Ex e II T(2)
-WS

Ex e IIC T* Gb
Ex em IIC T* Gb

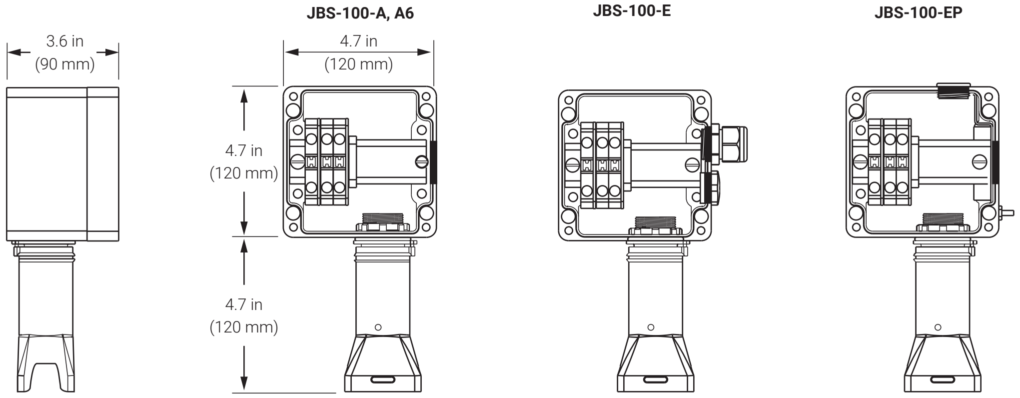
PTB 09 ATEX 1059U
II 2G Ex e (e mb) II
II 2D Ex tD (tD mbD) A21 IP66
IECEx PTB09.0037U
Ex e (e mb) II
Ex tD (tD mbD) A21 IP66

Ex em II T(2)
-WS

Ex em IIC T* Gb
Ex e IIC T* Gb

(1)Except VPL
(2)For T-rating, see heating cable or design documentation

DIMENSIONS



PRODUCT SPECIFICATIONS

	JBS-100-A, A6	JBS-100-E	JBS-100-EP
Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT		
Ingress protection	Type 4X	IP66	IP66
Entries	1 x 3/4 in	2 x M25	2 x M25
Minimum installation temperature	–40°F (–40°C)	–40°F (–40°C)	–40°F (–40°C)
Minimum ambient temperature	–75°F (–60°C)*	–60°F (–50°C)*	–60°F (–50°C)*
Maximum ambient temperature	132°F (56°C)*	132°F (56°C)*	132°F (56°C)*
	* For –L lighted kits, the ambient temperature range is –40°F (–40°C) to 104°F (40°C). For non-lighted kits, use a power wire with continuous temperature rating of > 194°F (90°C). For –E and –EP kits use a metallic power cable gland.		
Maximum pipe temperature	500°F (260°C)	500°F (260°C)	500°F (260°C)
Terminals	Spring clamp Ex e 2 line, 1 ground	Spring clamp Ex e 1 phase, 1 neutral, 1 earth	Spring clamp Ex e 1 phase, 1 neutral, 1 earth
Maximum conductor size	8 AWG (A6 to 6 AWG)	10 mm^2	10 mm^2
Maximum operating voltage	480 Vac	480 Vac	480 Vac
Maximum circuit breaker rating	50 A	40 A	40 A

MATERIALS

Enclosure	Electrostatic charge-resistant glass-filled engineered polymer, black	Electrostatic charge-resistant glass-filled engineered polymer, black	Electrostatic charge-resistant glass-filled engineered polymer, black
Lid screws	Stainless steel	Stainless steel	Stainless steel
Lid gasket	Silicone rubber	Silicone rubber	Silicone rubber
Earth continuity plate	n/a	n/a	Steel, zinc-plated and yellow-chromated

OPTIONAL LED INDICATOR LIGHT

Color	Red	Green	Green
Voltage rating	100–277 Vac	100–277 Vac	100–277 Vac
Power consumption	< 1 W	< 1 W	< 1 W

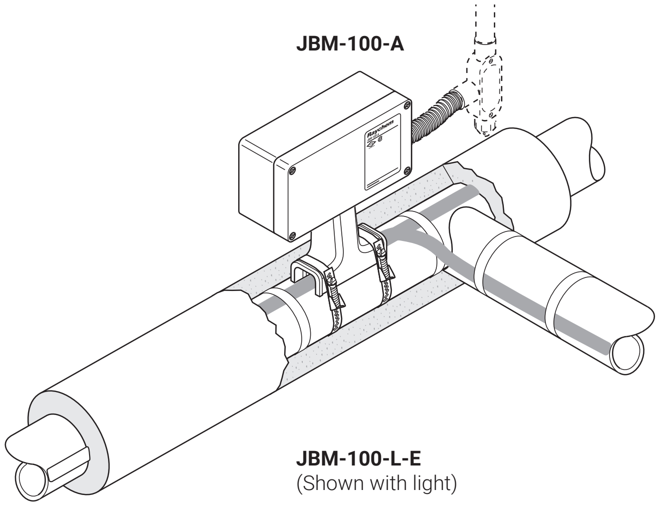
ORDERING DETAILS

Power connection			
Catalog number	JBS-100-A / JBS-100-A6	JBS-100-E	JBS-100-EP
Part number	085947-000 / C26470-000	829939-000	158251-000
Weight	2.5 lb (1.1 kg)	1.2 kg (2.6 lb)	1.3 kg (2.9 lb)
Power connection with light			
Catalog number	JBS-100-L-A	JBS-100-L-E	JBS-100-L-EP
Part number	944699-000	054363-000	075249-000
Weight	3.5 lb (1.6 kg)	1.6 kg (3.5 lb)	1.7 kg (3.7 lb)

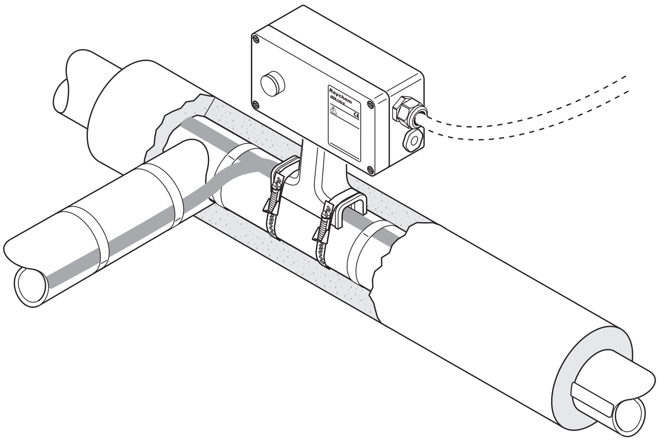
JBM-100

MULTIPLE-ENTRY POWER/SPLICE/TEE CONNECTION WITH JUNCTION BOX

JBM-100-A



JBM-100-L-E
(Shown with light)



10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM JBM-100 kit serves as a power connection, splice, or tee for up to three nVent RAYCHEM brand BTV, QTVR, XTV, KTV, or VPL heating cables. It is approved by FM, CSA, PTB and IEx for use in hazardous locations.

The JBM-100 integrates the functions of connection kits and insulation entries. The rugged stand protects the heating cable and allows for up to four inches (100 mm) of thermal insulation.

The cold-applied core sealer does not require a heat gun or torch for installation, so no hot work permit is necessary.
The silicone-free, noncuring sealant allows easy installation and re-entry for maintenance.

Innovative spring clamp terminals provide fast installation and safe, reliable, maintenance-free operation.

Compared with other systems, this connection kit significantly reduces installation time. The kit is offered in three versions, customized for local installation practices. All kits are also available with a plug-in LED light (-L) that indicates when power is supplied to the heating cable circuit.

The kit contains all the necessary materials for a complete installation except for the pipe straps, which must be ordered separately.

DESCRIPTION

	JBM-100-A, A6 **JBM-100-L-A*** ***Not for use with 480 V VPL**	**JBM-100-E** **JBM-100-L-E***	**JBM-100-EP** **JBM-100-L-EP***
	This kit has a junction box with one through hole. The kit includes one stopping plug.	This kit has a junction box with two M25 threaded entries, one stopping plug and one plastic power cable gland.	This kit has a junction box with two M25 threaded entries, an earthing plate and an external earthing stud. It is designed for use with armored power cables.

KIT CONTENTS

Note: Order appropriate pipe straps separately (two straps per kit)	1 junction box with terminals 1 stand assembly 3 core sealers 3 green/yellow tubes 1 3/4 in stopping plug assembly 1 light module (for -L only) 2 grommet plugs	1 junction box with terminals 1 stand assembly 3 core sealers 3 green/yellow tubes 1 M25 gland for power cable 8–17 mm in diameter 2 M25 stopping plugs 1 light module (for -L only) 2 grommet plugs	1 junction box with terminals, earth continuity plate, and stud 1 stand assembly 3 core sealers 3 green/yellow tubes 2 M25 stopping plugs 1 light module (for -L only) 2 grommet plugs

APPROVALS

*Not for use with 480 V VPL

Hazardous Locations

FM APPROVED
-WS
Class I, Div. 2, Groups A, B, C, D(2)
Class II, Div. 2, Groups E, F, G(2)
Class III(2)

FM APPROVED (1)
CLI, ZN1, AEx e II T(2)
CLI, ZN1, AEx em II T(2) (for -L only)

-WS
Ex e II T(2)
Ex em II T(2) (for -L only)

IECEx
Ex e IIC T* Gb
Ex em IIC T* Gb

PTB 09 ATEX 1056U
II 2G Ex e (e mb) II
II 2D Ex tD (tD mbD) A21 IP66
IECEx PTB09.0027U
Ex e (e mb) II
Ex tD (tD mbD) A21 IP66

-WS
Ex e II T(2)

IECEx
Ex e IIC T* Gb
Ex em IIC T* Gb

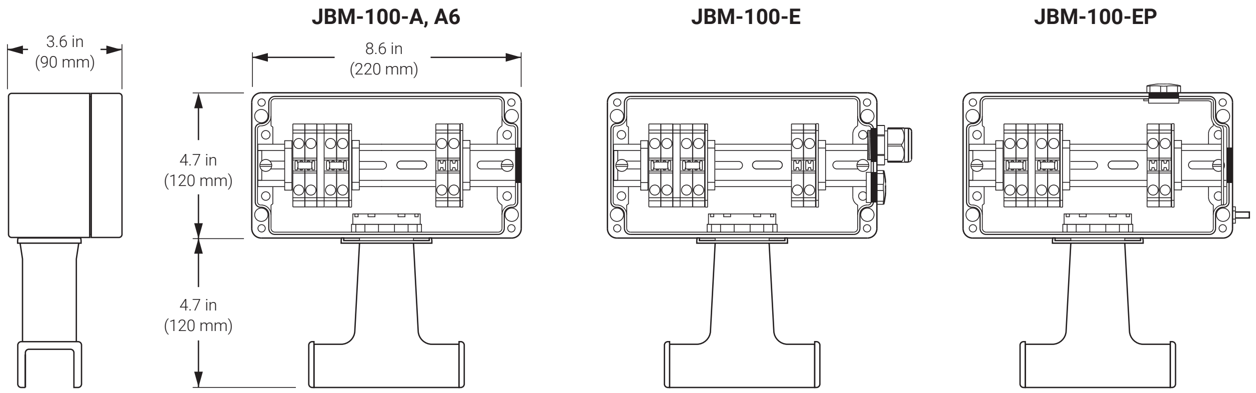
PTB 09 ATEX 1056U
II 2G Ex e (e mb) II
II 2D Ex tD (tD mbD) A21 IP66
IECEx PTB09.0027U
Ex e (e mb) II
Ex tD (tD mbD) A21 IP66

-WS
Ex em II T(2)

IECEx
Ex em IIC T* Gb
Ex e IIC T* Gb

(1)Except VPL
(2)For T-rating, see heating cable or design documentation

DIMENSIONS



PRODUCT SPECIFICATIONS

	JBM-100-A, A6	JBM-100-E	JBM-100-EP
Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT		
Ingress protection	Type 4X	IP66	IP66
Entries	1 x 0.75 in (1 x 1 in for A6)	2 x M25	2 x M25
Minimum installation temperature	–40°F (–40°C)	–40°F (–40°C)	–40°F (–40°C)
Minimum ambient temperature	–75°F (–60°C)*	–60°F (–50°C)*	–60°F (–50°C)*
Maximum ambient temperature	132°F (56°C)*	132°F (56°C)*	132°F (56°C)*
	*For –L lighted kits, the ambient temperature range is –40°F (–40°C) to 104°F (40°C). For non-lighted kits, use a power wire with continuous temperature rating of > 194°F (90°C). For –E and –EP kits use a metallic power cable gland.		
Maximum pipe temperature	500°F (260°C)	500°F (260°C)	500°F (260°C)
Terminals	Spring clamp Ex e 4 line, 2 ground	Spring clamp Ex e 2 phase, 2 neutral, 2 earth	Spring clamp Ex e 2 phase, 2 neutral, 2 earth
Maximum conductor size	8 AWG (A6 to 6 AWG)	10 mm^2	10 mm^2
Maximum operating voltage	480 Vac	480 Vac	480 Vac
Maximum circuit breaker rating	50 A	40 A	40 A

MATERIALS

Enclosure	Electrostatic charge-resistant glass-filled engineered polymer, black	Electrostatic charge-resistant glass-filled engineered polymer, black	Electrostatic charge-resistant glass-filled engineered polymer, black
Lid screws	Stainless steel	Stainless steel	Stainless steel
Lid gasket	Silicone rubber	Silicone rubber	Silicone rubber
Earth continuity plate	n/a	n/a	Steel, zinc-plated and yellow-chromated

OPTIONAL LED INDICATOR LIGHT

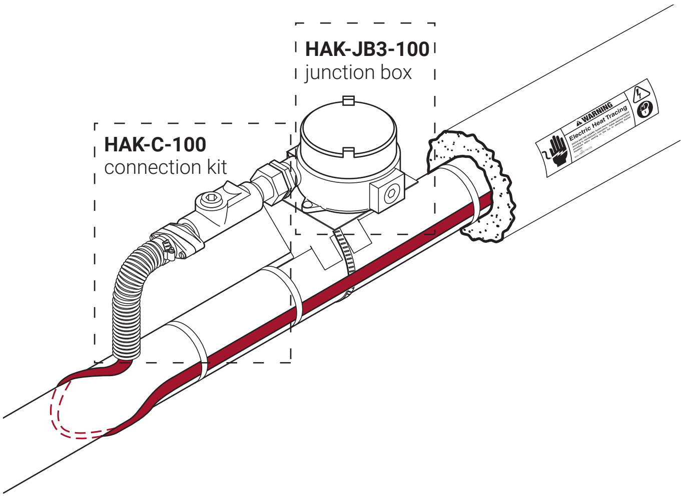
Color	Red	Green	Green
Voltage rating	100–277 Vac	100–277 Vac	100–277 Vac
Power consumption	< 1 W	< 1 W	< 1 W

ORDERING DETAILS

Multiple-entry power / splice / tee connection			
Catalog number	JBM-100-A / JBM-100-A6	JBM-100-E	JBM-100-EP
Part number	179955-000 / P000001376	831519-000	986415-000
Weight	4.3 lb (1.95 kg)	1.9 kg (4.2 lb)	2.1 kg (4.6 lb)
Multiple-entry power / splice / tee connection with light			
Catalog number	JBM-100-L-A	JBM-100-L-E	JBM-100-L-EP
Part number	656081-000	395855-000	300273-000
Weight	5.3 lb (2.4 kg)	2.3 kg (5.1 lb)	2.5 kg (5.5 lb)

HAK-C-100, HAK-JB3-100

CONNECTION KIT AND JUNCTION BOX FOR CID1 HAZARDOUS LOCATIONS



PRODUCT OVERVIEW

The nVent RAYCHEM HAK-C-100 connection system is FM approved for use with nVent RAYCHEM brand HBTV, HQTV, HXTV, and FHP heating cables in Class I, Division 1 hazardous locations. It is also CSA certified for use with nVent RAYCHEM brand BTV-CT, QTVR-CT, XTV-CT, VPL-CT, and LBTV2-CT heating cables in Class I, Division 1 locations.

The HAK-C-100 is a cold-applied connection kit that contains all of the materials required for sealing one heating cable entry into a junction box.

The HAK-JB3-100 is an explosion-proof, corrosion-resistant junction box that serves as a power connection, splice, tee, or end termination.

Each kit contains all the necessary materials for a complete installation except for the pipe straps and a UMB mounting bracket, which must be ordered separately.

KIT DESCRIPTION

	HAK-C-100	HAK-JB3-100
Note: Connection kit, junction box, mounting bracket, and pipe strap sold separately	1 HAK subassembly: sealing fitting, nipple, and plugs 1 union 1 packing fiber 1 sealing compound 1 tubing clamp 1 compression gland with screws 1 compression gland with threaded inserts 5 grommets (B,C,E,K,R) 1 flex tube 1 terminal block (maximum: 6 AWG wire) 2 black heat-shrinkable tubes 1 clear yellow heat-shrinkable tube 1 green/yellow tube 1 CS-100 core sealer	1 coated aluminum housing 3 3/4-in (19 mm) NPT entries 2 plugs 1 grounding bar kit

APPROVALS

Hazardous Locations

Class I, Div. 1, Groups B, C, D
Class II, Div. 1, Groups E, F, G
Class III

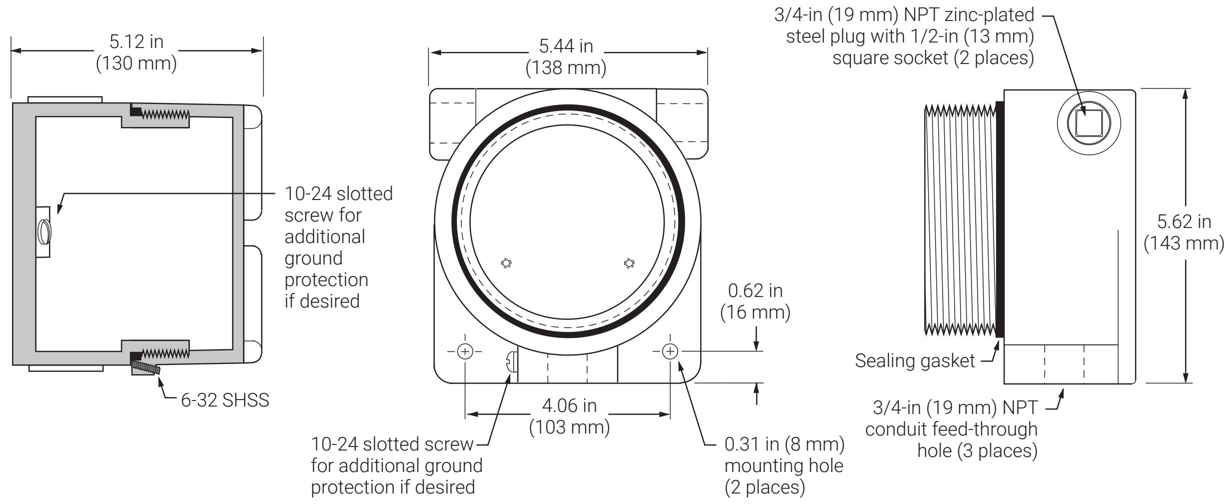
Hazardous Locations

Class I, Div. 1, Groups B, C, D
Class II, Div. 1, Groups E, F, G
Class III

ORDERING DETAILS

Catalog number	HAK-C-100	HAK-JB3-100
Part number	014385-000	325925-000
Weight	3.0 lb (1.36 kg)	3.1 lb (1.4 kg)

HAK-JB3-100 JUNCTION BOX DIMENSIONS



MATERIALS REQUIRED PER CONNECTION TYPE

	Number of HAK-C-100 kits required	Number of holes used on the junction box	Universal mounting bracket (UMB)	Pipe strap
Power	1	2	1	1
Splice	2	2	1	1
Tee	3	3	1	1
End seal	1	1	1	1

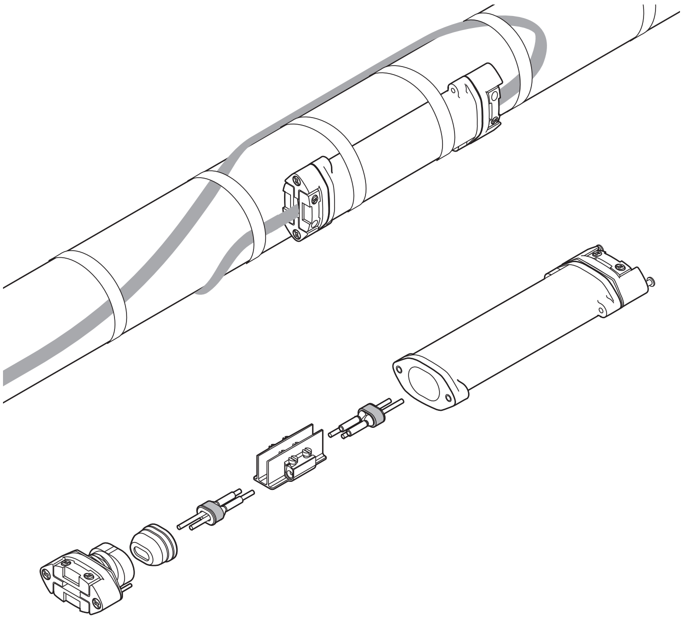
MATERIALS OF CONSTRUCTION

Junction box	Copper-free aluminum with corrosion-resistant polyester powder coating

S-150

nVent
RAYCHEM

LOW-PROFILE SPLICE KIT



PRODUCT OVERVIEW

The nVent RAYCHEM S-150 is a cold-applied, low-profile splice for in-line connection. It is designed for use with the following nVent RAYCHEM brand heating cables: BTV, QTVR, XTV, and KTV. Use the S-150 in applications with temperatures ranging from −60°F to 420°F (−50°C to 215°C). It is approved by FM,CSA and PTB for use in hazardous locations.

The unique design of the S-150 suits the demanding requirements of the industrial environment. The low-profile housing can be installed on pipes and other surfaces. Spring-loaded grommets make a first seal to maintain a watertight connection, while the noncuring silicone-free sealant used in the nVent RAYCHEM cold-applied core sealers add a second seal, providing additional protection.

The rugged construction makes it resistant to impact and suitable for high-temperature and chemical exposure.

The splice requires no heat source for installation, and it is re-enterable, making maintenance fast and easy. Each kit contains all the necessary materials to do one in-line splice connection.

10 YEAR Product warranty

DESCRIPTION

Cold-applied in-line splice kit for use with BTV, QTVR, XTV, and KTV heating cables

KIT CONTENTS

1 splice housing

2 sealing grommet assemblies

2 core sealers

1 spacer including screw terminals

1 identification label

APPROVALS

Hazardous Locations

FM APPROVED SP -W
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

FM APPROVED
CLI, ZN2, AEx e II T(1)

SP -W
Ex e II T(1)

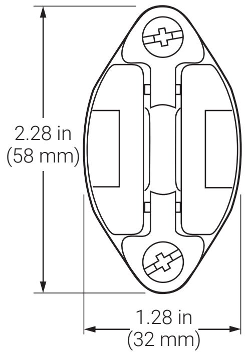
Ex
II 2G Ex e II
II 2D Ex tD A21 IP66
PTB 09 ATEX 1068U

IEx
Ex e IIC T* Gb

IECEx
IECEx PTB 09.0043U
Ex e II
Ex tD A21 IP66

(1) For T-rating, see heating cable or design documentation

DIMENSIONS



PRODUCT SPECIFICATIONS

Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT
Ingress protection	Type 4X (IP66)
Minimum installation temperature	–40°F (–40°C)
Minimum usage temperature	–60°F (–50°C)
Maximum pipe temperature	420°F (215°C)
Connection method	Screw terminals
Maximum operating voltage	277 Vac for FM, CSA 254 Vac for PTB
Maximum circuit breaker rating	50 A for FM, CSA 40 A for PTB

MATERIALS OF CONSTRUCTION

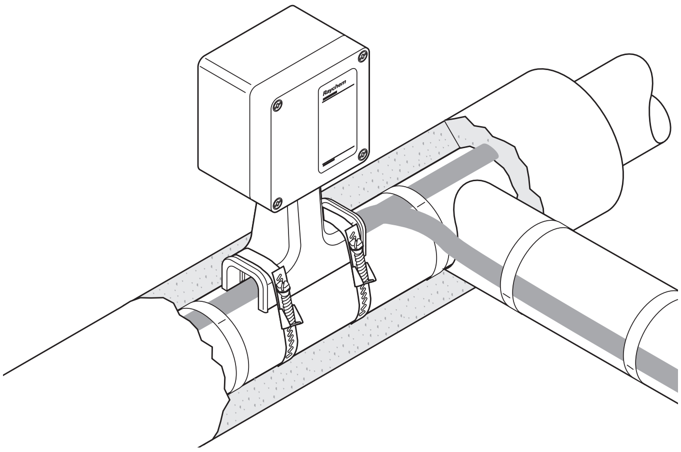
Enclosure, end plate, and shim	Engineered polymer, black
Sealing grommet	Silicone rubber
Screws, compression spring, reinforcement plate	Stainless steel
Terminals	Nickel-plated brass, stainless steel, zinc-plated steel

ORDERING DETAILS

Catalog number	S-150
Part number	497537-000
Weight	0.8 lb (0.4 kg)

T-100

SPLICE OR TEE CONNECTION KIT



PRODUCT OVERVIEW

The nVent RAYCHEM T-100 serves as an above-insulation splice or tee for up to three nVent RAYCHEM brand BTV, QTVR, XTV, KTV, or VPL heating cables. It is approved by FM, CSA, and PTB(1) for use in hazardous locations.

The T-100 integrates the functions of connection kits and insulation entries. The rugged stand protects the heating cable and allows for up to four inches (100 mm) of thermal insulation.

The cold-applied core sealer does not require a heat gun or torch for installation, so no hot work permit is necessary. The silicone-free, noncuring sealant in the core sealer allows easy installation and re-entry for maintenance.

The electrical connections in the T-100 are made with insulated crimps. For a splice or tee connection with terminal blocks, use the nVent RAYCHEM JBM-100.

Each kit contains all the necessary materials for a complete installation except for the pipe straps, which must be ordered separately.

DESCRIPTION

Above-insulation splice / tee kit appropriate for use in hazardous locations

KIT CONTENTS

1 splice / tee enclosure and lid
1 stand assembly
3 core sealers
3 green / yellow tubes
3 compression crimps
3 crimp insulating boots
2 grommet plugs
1 spanner wrench
1 strain relief assembly
Note: Order appropriate pipe straps separately (two straps per kit).

APPROVALS

Hazardous Locations

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Ex e IIC T* Gb

(1)
CLI, ZN1, AEx e II T(2)

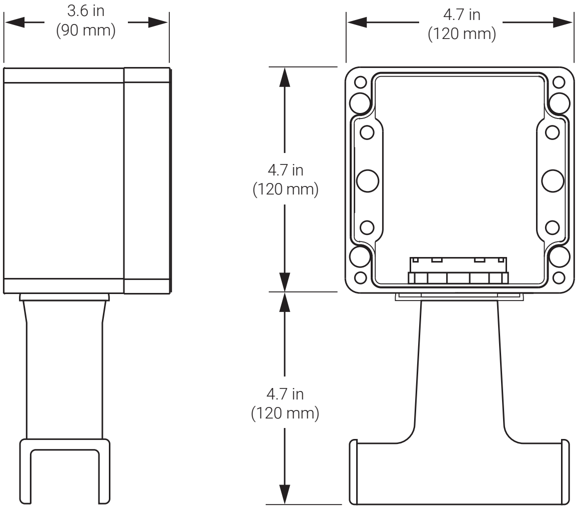
Ex e II T(2)

II 2G Ex e II
II 2D Ex tD A21 IP66
PTB 09 ATEX 1043U

IECEx PTB 09.0023U
Ex e II
Ex tD A21 IP66

(1) Except VPL
(2) For T-rating, see heating cable or design documentation
(3) Except KTV

DIMENSIONS (NOMINAL)



PRODUCT SPECIFICATIONS

Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT, and VPL-CT
Ingress protection	Type 4X / IP66 / IP67
Minimum installation temperature	–40°F (–40°C)
Minimum ambient temperature	–75°F (–60°C)
Maximum ambient temperature	132°F (56°C)
Maximum pipe temperature	500°F (260°C)
Maximum operating voltage	480 Vac
Maximum circuit breaker rating	50 A for FM, CSA; 40 A for PTB

MATERIALS

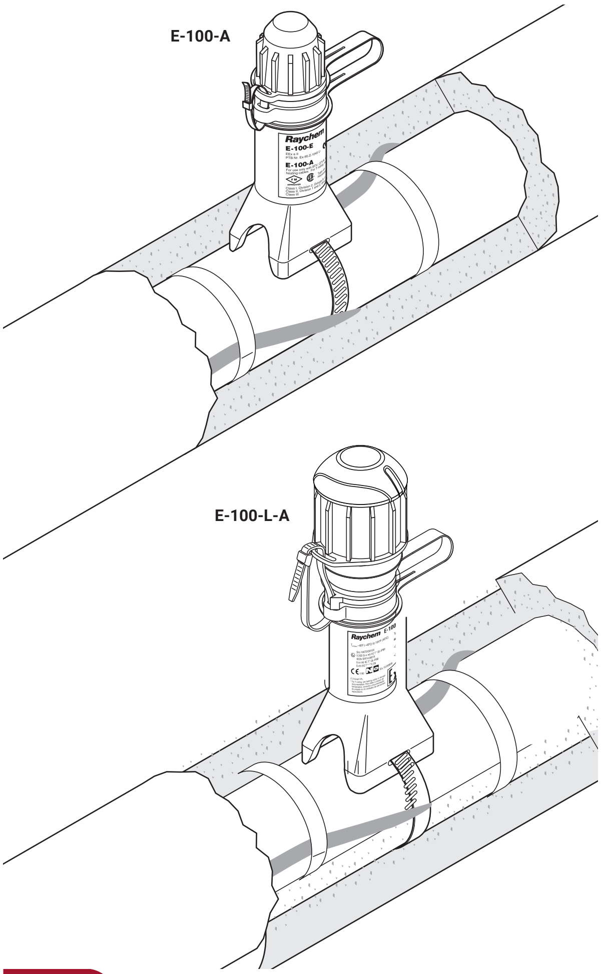
Enclosure	Electrostatic charge-resistant glass-filled engineered polymer, black
Lid screws	Stainless steel
Lid gasket	Silicone rubber

ORDERING DETAILS

Catalog number	T-100
Part number	447379-000
Weight	2.5 lb (1.2 kg)
Crimp tool	T-100-CT (not included in kit; equivalent to Panduit CT-1570) PN 954799-000
Spare crimps and insulating tubes	T-100-CRIMP-KIT PN 577853-000

E-100-A & E-100-L-A

END SEAL AND LIGHTED END SEAL KITS



PRODUCT OVERVIEW

The nVent RAYCHEM E-100-A and E-100-L-A serve as above-insulation end seal kits for nVent RAYCHEM brand BTV, QTVR, XTV, KTV, or VPL heating cables. They are approved by FM and CSA for use in hazardous locations.

Both the E-100-A and the E-100-L-A are mounted on the pipe and project through the thermal insulation and cladding for ease of maintenance. The E-100-L-A end seal with signal light uses an array of bright LEDs for exceptional visibility and long product life.

These rugged end seals are made from high-performance engineering polymer and resist impact, high temperature, and chemical and UV exposure. The stand allows for up to four inches (100 mm) of thermal insulation. The encapsulated light and boot reliably prevent moisture and dust ingress. The industrial-grade electronics used in the E-100-L-A are encapsulated.

Both the E-100-A and E-100-L-A are re-enterable, allowing easy access for testing. Voltage and continuity checks can be done by simply unscrewing the E-100-A cap and removing the reusable sealing boot. The E-100-L-A makes maintenance even easier by allowing for visual inspection of heating circuit continuity. The E-100-L-A can be retrofitted into previously installed E-100-A end seals. The light module is replaceable.

The kits contain all the necessary materials for a complete installation except for one pipe strap, which must be ordered separately.

DESCRIPTION

	E-100-A	E-100-L-A
	Above-insulation end seal, cold-applied	Above-insulation end seal with red indicator light, cold-applied *Not for use with 480 V VPL

KIT CONTENTS

Note: Order appropriate pipe strap separately (one per kit)	1 end seal	1 end seal with red indicator light

APPROVALS

	E-100-A	E-100-L-A
	Hazardous Locations	**Hazardous Locations**
	Class I, Div. 2, Groups A, B, C, D Class II, Div. 1 and 2, Groups E, F, G Class III (1)	Class I, Div. 2, Groups A, B, C, D Class II, Div. 1 and 2, Groups E, F, G Class III (1)
	CLI, ZN1, AEx e II T(2)	CLI, ZN1, AEx e mb IIC T(2) Gb ZN21 AEx tb IIIC T*
	Ex e II T(2)	Ex e mb IIC T(2) Gb Ex tb IIIC T*
	IECEx PTB 09.0038U Ex e II Ex tD A21 IP66	IECEx SIR 14.0007X Ex e mb IIC T* Gb IP66 Ex tb IIIC T***°C Db
	09-IEx-0004X 09-IEx-0005X 09-IEx-0006X 09-IEx-0007X Ex e IIC T* Gb	09-IEx-0004X 09-IEx-0005X 09-IEx-0006X 09-IEx-0007X Ex em IIC T* Gb(3)

(1) Except VPL

(2) For T-rating, see heating cable or design documentation

(3) Except KTV-CT

* For system Temperature Code, see heating cable or design documentation.

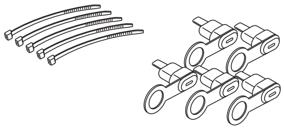
PRODUCT SPECIFICATIONS

	E-100-A	E-100-L-A
Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT	
Ingress protection	Type 4X (IP66)	Type 4X (IP66)
Minimum installation temperature	–40°F (–40°C)	–40°F (–40°C)
Minimum ambient temperature	–75°F (–60°C)	–40°F (–40°C)
Maximum ambient temperature	132°F (56°C)	104°F (40°C)
Maximum pipe temperature	500°F (260°C)	500°F (260°C)
Maximum operating voltage	480 Vac	277 Vac
Overall height	7 in (175 mm)	8 in (200 mm)
Outer diameter at insulation	2 in (50 mm) Usable with up to 4 in (100 mm) thermal insulation	3 in (75 mm)
Materials	High-performance glass-filled engineered polymer	High-performance glass-filled engineered polymer
Light source		Super-bright light-emitting diodes (LEDs), red
Light source power supply	Not applicable	Linear (nonswitching)
Power consumption	N/A	< 2 W

ORDERING DETAILS

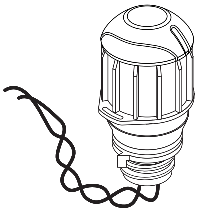
	E-100-A	E-100-L-A
End seal		
Catalog number	E-100-A (100–480 Vac)	E-100-L-A (100–277 Vac)
Part number	046567-000	P000001582
Weight	0.6 lb (272 g)	0.65 lb (295 g)

Spare boot pack for E-100



Catalog number	E-100-BOOT-5-PACK	
Part number	281053-000	
Pack weight	0.25 lb (140 g)	
Pack contents	Five sealant-filled boots and five cable ties	

Replacement indicator light for E-100-LR-A

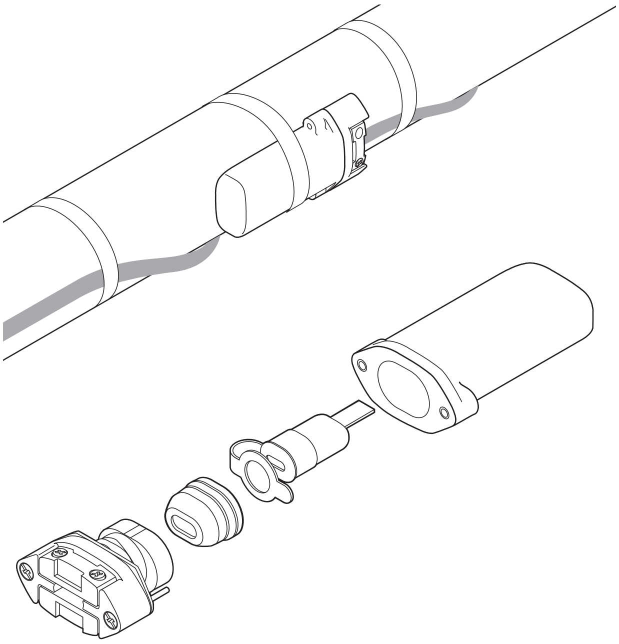


Catalog number		E-100-LR-A (100–277 Vac)
Part number		P000001584
Weight		0.33 lb (150 g)

E-150

nVent
RAYCHEM

LOW-PROFILE END SEAL KIT



10 YEAR Product warranty

PRODUCT OVERVIEW

The nVent RAYCHEM E-150 is a cold-applied low-profile end seal. It is designed for use with the following nVent RAYCHEM brand heating cables: BTV, QTVR, XTV, and KTV. Use the E-150 in applications with temperatures ranging from –60°F to 420°F (–50°C to 215°C). It is approved by FM, CSA, and PTB for use in hazardous locations.

The unique design of the E-150 suits the demanding requirements of the industrial environment. The low-profile housing can be installed on pipes and other surfaces. A spring-loaded grommet makes a first seal to maintain a watertight connection, while the silicone-free, noncuring sealant used in the nVent RAYCHEM sealing boot adds a second seal, providing additional protection.

The rugged construction makes the E-150 resistant to impact and suitable for high-temperature and chemical exposure.

The end seal requires no heat source for installation and it is re-enterable, making maintenance fast and easy. Each kit contains all the necessary materials to do one end termination.

DESCRIPTION

Cold-applied end seal for use with BTV, QTVR, XTV and KTV heating cables

KIT CONTENTS

1 end seal enclosure housing

1 sealing grommet assembly

1 sealing boot

1 identification label

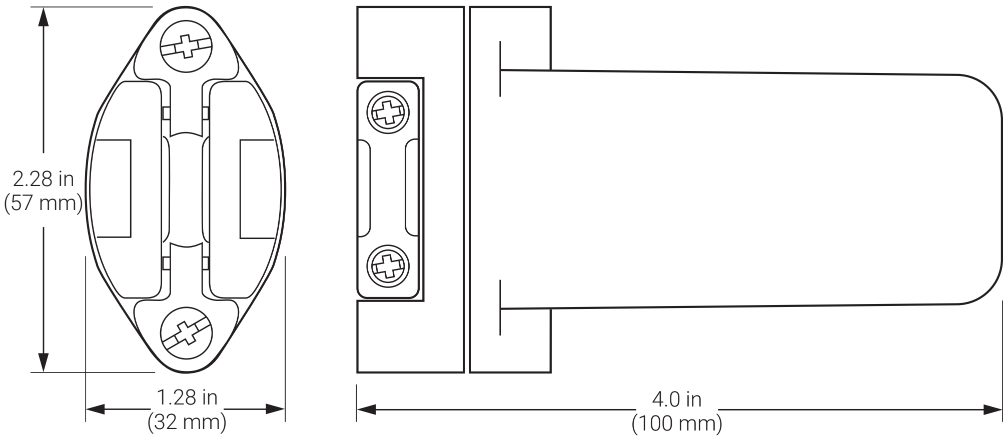
APPROVALS

Hazardous Locations

FM APPROVED CSA -W	Class I, Div. 2, Groups A, B, C, D Class II, Div. 2, Groups F, G Class III	Ex	II 2G Ex e II II 2D Ex tD A21 IP66 PTB 09 ATEX 1068U
		IEx	Ex e IIC T* Gb
FM APPROVED	CLI, ZN2, AEx e II T(1)	IECEx	IECEx PTB 09.0043U Ex e II Ex tD A21 IP66
CSA -W	Ex e II T(1)		

(1) For T-rating, see heating cable or design documentation

DIMENSIONS



PRODUCT SPECIFICATIONS

Heating cable capability	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT
Ingress protection	NEMA 4X (IP66)
Minimum installation temperature	–40°F (–40°C)
Minimum usage temperature	–60°F (–50°C)
Maximum pipe temperature	420°F (215°C)
Operating voltage	277 Vac for FM, CSA; 254 Vac for PTB

MATERIALS OF CONSTRUCTION

Enclosure, end plate, and shim	Engineered polymer, black
Sealing grommet and core sealer	Silicone rubber
Screws, compression spring, reinforcement plate	Stainless steel

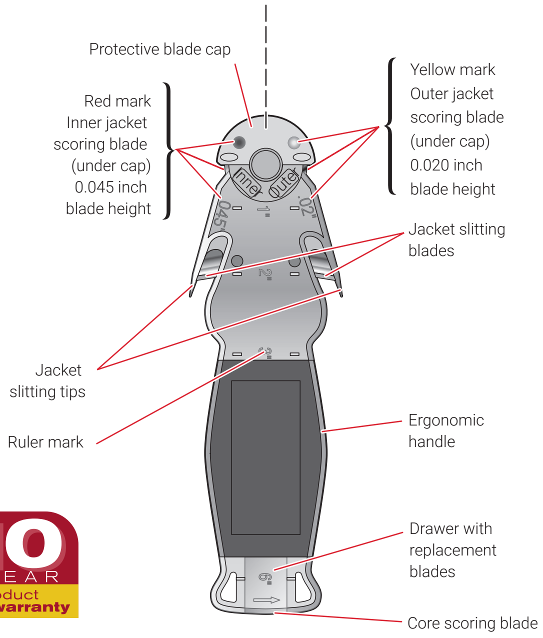
ORDERING DETAILS

Catalog number	E-150
Part number	979099-000
Weight	0.6 lb (0.3 kg)

STRIPPING-TOOL-SR-CABLE

nVent
RAYCHEM

STRIPPING TOOL FOR SELF-REGULATING CABLES



10 YEAR Product warranty

PRODUCT OVERVIEW

The STRIPPING-TOOL-SR-CABLE is designed for use with nVent RAYCHEM BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT, HWAT, XL-Trace, IceStop and RaySol self-regulating heat-tracing cables. The tool is designed for faster, safer and more reliable cable terminations.

The tool has two sets of blades designed for precise scoring of the outer and inner jackets of the cables mentioned above. The scoring blades are protected by a spring-loaded cap that rotates automatically. For safety, the cap rotates back to its original position automatically after the cutting operation is performed.

The tool also includes a unique core scoring feature that prevents damage to the conductors. The tool has a robust metallic body, ergonomic contour and replaceable blades.

PRODUCT SPECIFICATIONS

Body	Symmetric and Ergonomic Aluminum A380 Metallic Body with TPE soft sleeve.
Jacket scoring blades	A pair of jacket scoring stainless steel blades with depth ranges of 0.04–0.06 inch and 0.01–0.03 inch.
Blade cover	Spring loaded Zinc alloy cap that covers both the blades when the tool is not in use.
Core scoring feature	Core scoring blade which will prevent damage to the conductors. The blade height should be 0.01–0.04 inch.
Replaceable blades	All blades can be replaced with a screwdriver. Replaceable blades are provided with the tool.
Coating	Metallic body coated with electrostatic epoxy powder 0.002–0.005 inch thick.

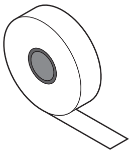
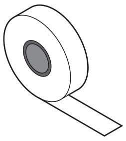
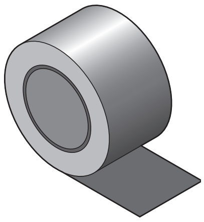
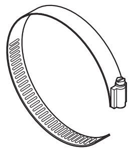
Ordering Details	Catalog Number	Part Number
Stripping tool	STRIPPING-TOOL-SR-CABLE	P000001126
Replacement jacket scoring blade	Techni Edge®#10 Hobby blade TE01-103	Should be ordered directly from Techni Edge.
Replacement jacket slitting blade	Techni Edge 3/8 inch 13 point blade TE01-333	Should be ordered directly from Techni Edge.

APPROVALS

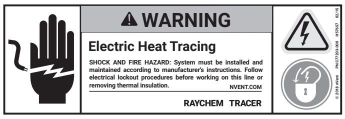
EAC (Russia, Kazakhstan, Belarus)
For other countries contact your local nVent representative.

ACCESSORIES

ATTACHMENT PRODUCTS

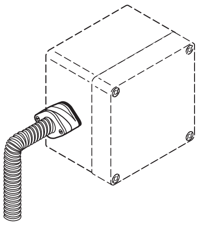
Catalog number	Part number	Description
GT-66 	C77220-000	66 ft (20 m) roll of glass tape for attaching heating cable to pipe. Not for stainless steel pipes or for installation temperatures below 40°F (5°C).
GS-54 	C77221-000	54 ft (16.5 m) roll of glass tape for attaching heating cable to pipe. For stainless steel pipes or for any installation below 40°F (5°C).
AT-180 	158139-000	180 ft (55 m) roll of aluminum tape for attaching heating cables and thermostat sensors to pipes and tanks. Minimum installation temperature: 32°F (0°C). Dimensions: 2.5 in wide, 5 mils thick.
Pipe straps 	PS-01 C77211-000	For conduit ≤ 1 in
	PS-03 C77212-000	For connection kits on pipes with dimensions ≤ 2 in
	PS-10 C77213-000	For connection kits on pipes with dimensions 2 in – 10 in
	PS-20 C77216-000	For connection kits on pipes with dimensions 10 in – 19.5 in
	Used to secure connection kits and brackets to pipes. Order by pipe diameter, as shown above.	

LABELS

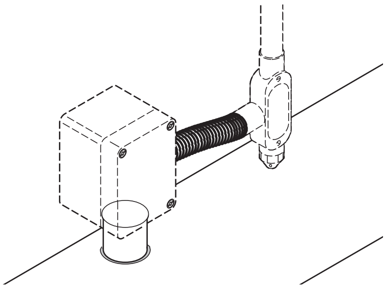
Catalog number	Part number	Description
ETL  ⚠ WARNING Electric Heat Tracing SHOCK AND FIRE HAZARD: System must be installed and maintained according to manufacturer's instructions. Follow electrical lockout procedures before working on this line or removing thermal insulation. NVENT.COM RAYCHEM TRACER © 2018 nVent PN C77203-000 H57657 02/15	C77203-000	“Electric Traced” label for identifying traced pipes and tanks.

10 YEAR Product warranty

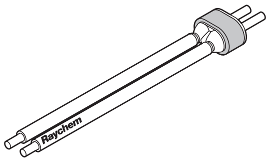
GLAND ENTRY KIT

			Kit Contents	
Catalog number	**Part number**	**Description**	**Qty**	**Description**
C75-100-A 	000539-000	A NEMA 4X-rated gland kit used to transition heating cables into a junction box when making connections off of a pipe or tank. It may be used for power, splice, or tee connections. For use with nVent RAYCHEM brand BTV, QTVR, XTV, KTV(1), VPL, and LBTV2-CT(2) heating cables. The kit does not include the junction box, flexible tubing, or tape that are required to make a complete connection. (1) For KTV only, order PMK-GP-10 grommet (P/N 700823) (2) For LBTV2-CT only, order HCS-100-A heat-shrink core sealer (P/N 257649) and PMK-GK-10 grommet (P/N 222724)	1	Red grommet
			1	Gland with threaded inserts
			1	Gland with screws
			1	Gland gasket
			1	Locknut
			1	Green / yellow tube
			1	CS-100 core sealer
			1	Terminal block

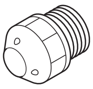
SINGLE-ENTRY TRANSITION KIT

			Kit Contents	
Catalog number	**Part number**	**Description**	**Kit Contents**	**Description**
JS-100-A 	166639-000	Junction box stand for use with nVent RAYCHEM brand BTV, QTVR, XTV, KTV, and VPL heating cables. A separate customer-supplied NEMA 4X junction box is required.	1	Stand assembly
			1	Lubricant
			1	Adapter for small pipes
			1	Cable tie
			1	Green / yellow tube
			1	CS-100 cold-applied core sealer
			1	JS-100 transition
			1	1-inch locknut

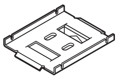
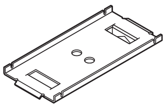
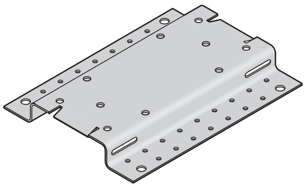
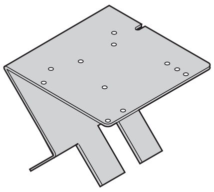
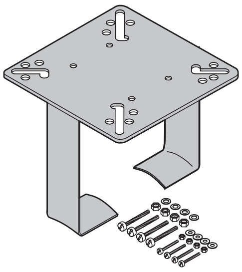
COLD-APPLIED CORE SEALER

Catalog number	**Part number**	**Description**
CS-100-A 	232949-000	Replacement cold-applied core sealer for nVent RAYCHEM brand BTV, QTVR, XTV, KTV, and VPL heating cables

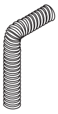
CONDUIT DRAIN

Catalog number	**Part number**	**Description**
JB-DRAIN-PLUG-3/4IN 	278621-000	nVent recommends the use of this 3/4-in conduit drain with each JBS-100 and JBM-100, and other enclosures with associated conduits, to prevent condensate from collecting in the box.

BRACKETS, ADAPTERS

Catalog number	Part number	Description
JBS-SPA 	E90515-000	Adapter for mounting E-100, JBS-100, and JS-100 to small pipe (≤ 1 inch nominal diameter).
JBM-SPA 	D55673-000	Adapter for mounting JBM-100 and T-100 to small pipe (≤ 1 inch nominal diameter).
SB-100-T 	279613-000	Adapter for mounting E-100, E-100-L, and JBS-100 connection kits on a tank surface.
UMB 	263757-000	Universal mounting bracket for mounting thermostats and other equipment on a pipe.
JB-SB-25 	471139-000	Stainless-steel mounting bracket for RAYSTAT-EX-03-A thermostat.

HELICAL FLEXIBLE PLASTIC TUBING

Catalog number	Part number	Description
HCTE-1000 	3679754004	Helical flexible plastic tubing for C75-100-A and HAK-C-100 connection kits.

SC, SC/H, AND SC/F

CONNECTION KITS AND ACCESSORIES

PRODUCT OVERVIEW

nVent offers a full range of power connections, splices, and end terminations for use with SC, SC/H and SC/F heating cables. These connection kits must be used to ensure proper functioning of the product and compliance with warranty, code, and approvals requirements.

SC connection kits include specially sized grommets, solder and splices and therefore must be ordered according to the correct SC cable in use. All above-insulation connection kits use a NEMA 4X-rated re-enterable enclosures. All below-insulation connection kits use a high temperature potting compound and are rated NEMA 4.

10 YEAR Product warranty

Approvals

Hazardous Locations

2SC & 3SC Connection Kits

-W,
-WS

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III
For T-Rating, see design documentation

Ex e II T* (see schedule) Ex tD A21 IP66
IECEx BAS 06.0049X[1]
Ex e IIC T* Gb - IEx 09.0008X(1)

[1] For Above-Insulation Kits only

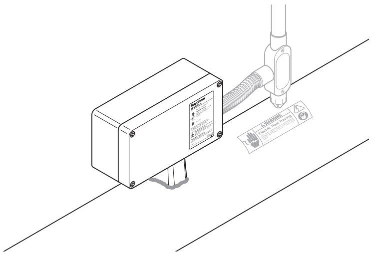
1SC, 2SC & 3SC Connection Kits

Ex e II T[2] [3]

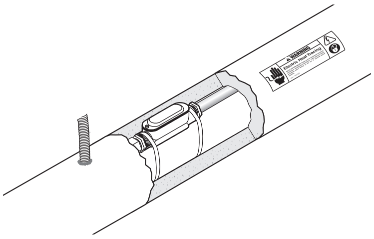
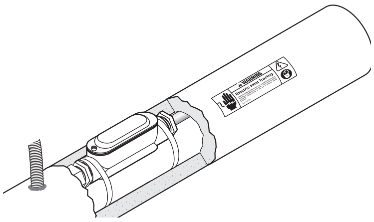
-W,
-WS

[2] For T-Rating, see design documentation

POWER CONNECTION KITS

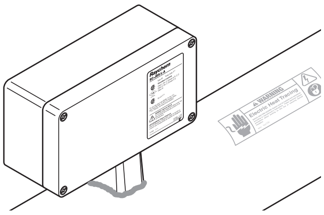
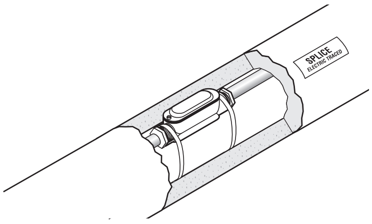
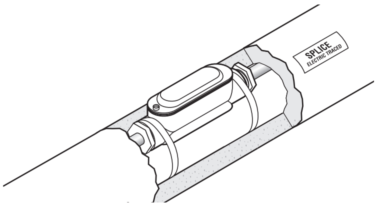
Product name	Description	Catalog number	Heating cable compatibility (SC,SC/H and SC/F) (1)
Above-Insulation 	Polymeric enclosure and stand with captive sealing grommet. The box has one 1" NPT entry hole. Includes 5-ft cold-lead wires.	SC-JBP-S-A	2SC30, 3SC30 2SC40, 3SC40 2SC50, 3SC50
	Box dimensions: 8.6" x 4.7" x 3.6" (220 mm x 120 mm x 90 mm) Stand height: 4.7" (120 mm)	SC-JBP-L-A	2SC60, 3SC60 2SC70, 3SC70 2SC80, 3SC80

POWER CONNECTION KITS

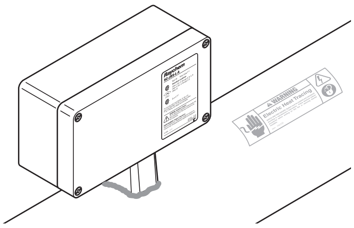
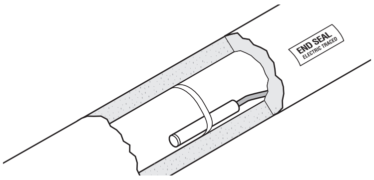
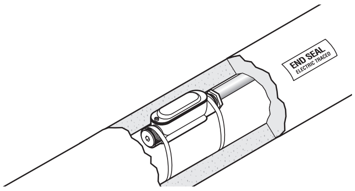
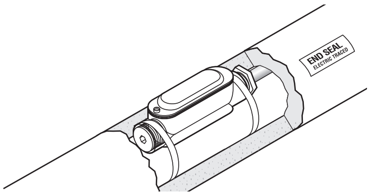
Product name	Description	Catalog number	Heating cable compatibility (SC,SC/H and SC/F) (1)
Small Below-Insulation 	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1/2" entries and a large top opening with cover for easy potting. Includes 5-ft cold-lead wires and a 3-ft flexible stainless steel armor. Condulet dimensions: 1/2" body – 5.5" x 1.5" x 1.5" (140 mm x 38 mm x 38 mm)	1SC-12PT 2SC-12PT 3SC-12PT	1SC30 1SC40 1SC50 2SC30 2SC40 2SC50 3SC30 3SC40 3SC50
Large Below-Insulation 	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1" NPT entries and large top opening with cover for easy potting. Includes 5 ft cold-lead wires and a 3-ft flexible stainless steel armor. Condulet dimensions: 1" body – 7" x 2" x 2" (178 mm x 51 mm x 51 mm)	1SC-8PT 1SC-6PT 1SC-4PT	1SC60 1SC70 1SC80
		2SC-8PT 2SC-6PT 2SC-4PT	2SC60 2SC70 2SC80
		3SC-8PT 3SC-6PT 3SC-4PT	3SC60 3SC70 3SC80

(1) SC/F cables are not available in 1 conductor construction.

SPLICE CONNECTION KITS

Product name	Description	Catalog number	Heating cable ompatibility (SC, SC/H and SC/F) (1)
Above-Insulation 	Polymeric enclosure and stand with captive sealing grommet. Box dimensions: 8.6" x 4.7" x 3.6" (220 mm x 120 mm x 90 mm) Stand height: 4.7" (120 mm)	SC-JBS-S-A SC-JBS-L-A	2SC30, 3SC30 2SC40, 3SC40 2SC50, 3SC50 2SC60, 3SC60 2SC70, 3SC70 2SC80, 3SC80
Small Below-Insulation 	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1/2" NPT entries and a large top opening with cover for easy potting. Condulet dimensions: 1/2" body – 5.5" x 1.5" x 1.5" (140 mm x 38 mm x 38 mm)	1SC-SSC	1SC30, 1SC60 1SC40, 1SC70 1SC50, 1SC80
		2SC-SSC	2SC30, 2SC40 2SC50
		3SC-SSC	3SC30, 3SC40 3SC50
Large Below-Insulation 	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1" NPT entries and a large top opening with cover for easy potting. Condulet dimensions: 1" body – 7" x 2" x 2" (178 mm x 51 mm x 51 mm)	2SC-LSC	2SC60 2SC70 2SC80
		3SC-LSC	3SC60 3SC70 3SC80

END TERMINATION KITS

Product name	Description	Catalog number	Heating cable compatibility (SC, SC/H and SC/F) (1)
Above-Insulation  	Polymeric enclosure and stand with captive sealing grommet. Box dimensions: 8.6" x 4.7" x 3.6" (220 mm x 120 mm x 90 mm) Stand height: 4.7" (120 mm)	SC-JBE-S-A SC-JBE-L-A	2SC30, 3SC30 2SC40, 3SC40 2SC50, 3SC50 2SC60, 3SC60 2SC70, 3SC70 2SC80, 3SC80
Small Below-Insulation (for 2SC)  	Stainless steel 1/2" plug with grommet and potting compound. Plug dimensions: 0.5" (12.7 mm) diameter, 2.4" (61 m) long	2SC-STC	2SC30 2SC40 2SC50
Small Below-Insulation (for 3SC)  	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1/2" NPT entries and a large top opening with cover for easy potting. Includes threaded NPT close-up plug. Condulet dimensions: 1/2" body – 5.5" x 1.5" x 1.5" (140 mm x 38 mm x 38 mm)	3SC-STC	3SC30 3SC40 3SC50
Large Below-Insulation  	Copper-free aluminum conduit body with epoxy finish. The conduit body has two 1" NPT entries and large top opening with cover for easy potting. Includes threaded NPT close-up plug. Condulet dimensions: 1" body – 7" x 2" x 2" (178 mm x 51 mm x 51 mm)	2SC-LTC 3SC-LTC	2SC60 2SC70 2SC80 3SC60 3SC70 3SC80

[1] SC/F cables are not available in 1 conductor construction.

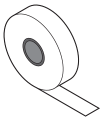
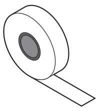
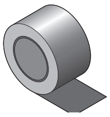
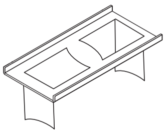
IDENTIFICATION TAG

Product name	Description	Catalog number	Heating cable compatibility (SC, SC/H and SC/F)
Circuit Tag  	SC cable circuit identification tag. A metal tag for attachment to the power connection of each circuit. Tag information includes cable catalog number, watts, volts, amps, circuit length, maximum sheath temperature, hazardous location information and circuit number.	SC-NPLATE-CIRCUIT-ID-TAG	All

LABELS

Product name	Description	Catalog number	Heating cable compatibility (SC, SC/H and SC/F)
ETL Tag 	"Electric Traced" label for identifying traced pipes and tanks.	ETL-ENGLISH	All

ATTACHMENT PRODUCTS

Product name	Description	Catalog number	Heating cable compatibility (SC, SC/H and SC/F)
GT-66 	1/2" x 66" (12.5 mm x 20 m) roll of glass tape for attaching heating cable to pipe. Not for stainless steel pipes or for installation temperatures above 40°F (4°C).	GT-66	All
GS-54 	1/2" x 54" (62.5 mm x 16.5 m) roll of glass tape for attaching heating cable to pipe. For stainless steel pipes or for any installation temperatures below 40°F (4°C).	GS-54	All
AT-180 	2 1/2" x 180" (62.5 mm x 55 m) of aluminum tape for attaching cable to pipe. Minimum installation temperature is 32°F (0°C).	AT-180	All
Pipe Adapter 	Pipe adapter for SC-JB Kits to increase the stand height by 1.5".	SC-JB-PIPE ADAPTER	All

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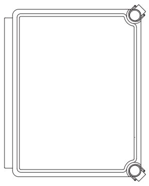
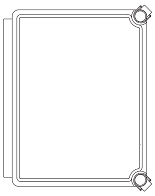
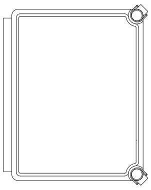
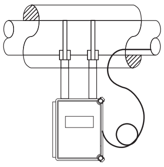
COMPONENTS AND ACCESSORIES

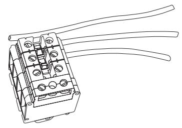
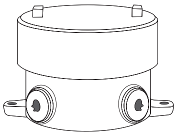
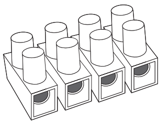
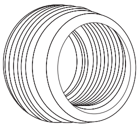
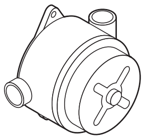
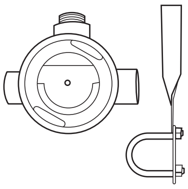
SYSTEM COMPONENTS

Junction Boxes - Power and Splice Connection Kits

Product	Order reference	Description
Fibreglass CID2 enclosure 	MIJB-864-A	Junction box with pre-drilled earth plate for use with MI heating units. Typical uses - Power, splice and end box for 3 phase systems Hazardous locations: CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X. Entries: Up to 8 x ½” and 3 x ¾”. Power cable gland and hubs not included. Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation. Enclosure dimensions: 8” x 6” x 4” (200 x 150 x 100mm)
Fibreglass CID2 enclosure 	MIJB-1086-A	Junction box with pre-drilled earth plate for use with MI heating units. Accommodates up to 3 power cables. Typical uses - Power, splice and end box for 3 phase systems Hazardous locations - CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X. Entries: Up to 11 x ½” and 8 x ¾”. Power cable gland and hubs not included. Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation. Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG (35A). Enclosure dimensions: 10” x 8” x 6” (250 x 200 x 150mm)
Fibreglass CID2 enclosure 	MIJB-1086-B	Junction box with pre-drilled earth plate for use with MI heating units. Accommodates up to 7 outgoing heating cables and one incoming power cable. It can also be used as a marshalling box – one incoming power cable and 5 outgoing power cables. Typical uses - Power or marshalling, splice and end box for 3 phase systems. Hazardous locations: CID2 Groups B, C and D. Maximum operating voltage 600Vac. Maximum 35A per terminal, rated 18AWG to 6AWG, NEMA 4X. Entries: Up to 11 x ½” and 8 x ¾”. Power cable gland and hubs not included. Two mounting brackets (MBRP-B) and two pipe straps must be ordered separately for installation. Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG (35A). Enclosure dimensions: 10” x 8” x 6” (250 x 200 x 150mm)
Enclosure mounting bracket 	MBRP-B	Enclosure mounting bracket for MIJB series fiberglass enclosures. Mounting bracket enables enclosure installation and connection prior to application of insulation and cladding. Stainless steel pipe support bracket for MIJB-864-A, MIJB-1086-A and MIJB-1086-B fiberglass enclosures. Two brackets are required to support each enclosure. Each bracket requires one pipe strap.

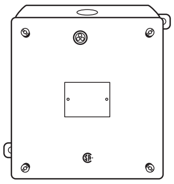
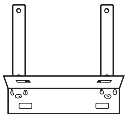
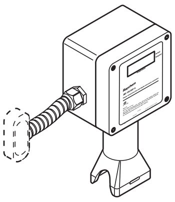
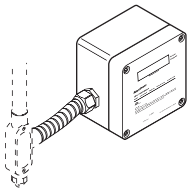
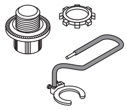
10 YEAR Product warranty

SYSTEM COMPONENTS

Junction Boxes - Power and Splice Connection Kits		
Product	**Order reference**	**Description**
Terminal kit for MIJB-1086 model 	MIJB-LPWR-KIT	Terminal kit to facilitate downsizing of large power cables. Large power wire kit to downsize #2 or #4 power cable to #6AWG (max 35amps for enclosure terminal blocks). Use with MIJB-1086-A and MIJB-1086-B enclosures as required.
Cast CID1 enclosure 	XMI-JB	Aluminum enclosure for CID1 areas. Typical uses: MI heating units power or splice connection box, RTD connection box Hazardous locations - CID1 Groups B, C and D, Maximum operating voltage 600Vac, Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG), NEMA 4X. Entries : 5 x 3/4" and includes 3 x 3/4" plugs, two reducer bushings (3/4" x 1/2") and two mounting feet with space to tap hole for bonding wire. Power cable gland should be purchased separately. Additional terminal strips or reducer bushings may also be purchased separately for additional RTD connection. (4POLETSTRIP and PTRDBH3412) Enclosure dimensions: 4 ½" x 3 ½" (114 x 89mm).
Terminal strip 	4POLETSTRIP	Terminal strip for enclosure, 4 pole terminal strip (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG) for use with XMI-JB enclosure. May be used for additional RTD connections.
Reducer bushing 	PTRDBH3412	Reducer bushing for enclosure, Zinc plated steel reducer bushing for use with XMI-JB enclosure. Reduces ¾" NPT tapered hole to ½" NPT. Body length 23/32" (18mm), Class I, Div. 1 &2, Groups A, B, C, D. Class I, Zone 1, Groups IIC, IIB, IIA. Class II, Div. 1 & 2, Groups E, F, G.
CID1 enclosure with mounting feet 	RMI-JB3	Copper-free aluminum alloy box with three entries for use with MI heating cables. Typical use : power or splice connection box Includes terminal block (500 Vac, 50 A, 2 x 6 AWG) and three 3/4" x 1/2" reducers and two 3/4" NPT plugs. FM and CSA approved for: Class I, Div. 1 & 2, Groups B, C, D; Class II, Div. 1 & 2, Groups E, F, G; and Class III. Enclosure dimensions: 6.1" x 5.2" x 3.9" (156 mm x 133 mm x 98 mm).
CID1 enclosure with bracket 	PT-JB	A smaller ferro-alloy junction box with three entries for use with MI heating cables. Typical use : power or splice connection box Three 3/4" NPT entries. Provided with one plug and two 3/4" x 1/2" reducers. Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG / UL-300 Vac, 65 A, 18–6 AWG) and stainless steel support bracket (U-clamp). UL and CSA approved for: Class I, Div. 1 & 2, Groups A, B, C, D; Class II, Div. 1 & 2, Groups E, F, G. Enclosure dimensions: 5.5" x 4.75" x 3" (140 mm x 121 mm x 76 mm).

SYSTEM COMPONENTS

Junction Boxes - Power and Splice Connection Kits

Product	Order reference	Description
Cast CID2 enclosure  D1297TERM4	D1297TERM4	A large cast aluminum junction box (NEMA 3R) for installation in nonhazardous and CID2 areas. Typical use : power or splice connection box Three 1/2" NPT entries on bottom, provided with plugs. Includes 4 pole terminal block (CSA-600 Vac, 65 A, 18–6 AWG / UL-300 Vac, 65 A, 18–6 AWG). External mounting feet. CSA approved for Class I, Div 2, Groups A, B, C, and D. Enclosure dimensions: 6" x 6" x 4" (152 mm x 152 mm x 101 mm).
Support bracket for D1297TERM4 	D1297BRACK	Optional stainless steel mounting bracket for junction box type D1297TERM4. To be strapped on metal cladding of pipe insulation using metal banding or pipe straps (based on outer dimension of insulation).
Nonhazardous enclosure and digital electronic controller 	JBS-100-ECP-A	Electronic temperature controllers that provide accurate control of a heating circuit using a RTD sensor. Adjustable set points between 32°F to 425°F (0°C to 218°C), power input of 120 Vac to 277 Vac, and current switching up to 30 A. c-CSA-us (certified to U.S. and Canadian Standards) for use in nonhazardous locations. Requires MI grounding kit. The JBS-100-ECP-A is pipe mounted and serves as a power connection kit for both self-regulating and mineral insulated heating cables.
	JBS-100-ECW-A	The JBS-100-ECW-A is wall mounted and may be used with all types of heating cables. It can also be used as a power connection kit with MI cables.
MI cable grounding kit 	MI-GROUND-KIT	Required grounding kit for use with JBS-100-ECP-A and JBS-100-ECW-A. Allows for a direct connection to a MI heating cable, eliminating the need for a separate junction box.

ACCESSORIES

Attachment Materials

Product	Order reference	Description
Pipe straps for MI heating cable 	PB (see Table 1)	Stainless-steel straps for holding MI heating cables onto pipe. Pliers are the only tool required to pull the pipe strap tight. Allow one pipe strap per foot of pipe (3.3 pipe straps per meter of pipe).

Table 1 Available Pipe Straps

Order Reference	Pipe diameter	Package quantity
PB 125	To 1-1/4"	50 pc
PB 300	1-1/2" to 3"	35 pc
PB 600	3-1/2" to 6"	25 pc
PB 1000	6" to 10"	1 pc
PB 1200	To 12"	1 pc
PB 2400	To 24"	1 pc
PB 3600	To 36"	1 pc

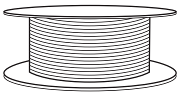
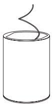
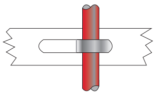
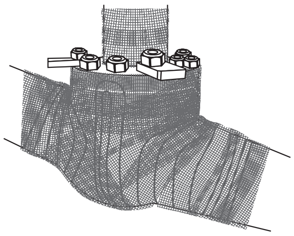
Product	Order reference	Description
Tie wire 	051CUPRON	16 AWG tie wire for fastening Alloy 825 MI heating cables on pipes. Do not use with copper-sheathed MI heating cables; use PB pipe straps. Particularly good for irregular shaped objects like valves and pumps. Order quantity as required (in ft) as per Table 2.
RMI-TW 	559600-000	Tie wire for fastening steel heating cables on pipes. Especially suitable for irregular shaped objects such as pumps, valves, flanges. Supplied in 50m reels.

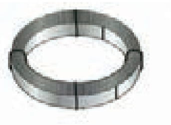
Table 2 Allowance for Banding / Tie Wire on Pipes

Pipe size (inches)	1	1.5	2	4	6	8	10	12	14	16	18	20	24	30	36	48
Required length (ft) per ft of pipe	0.8	1.1	1.2	1.6	2.1	2.8	3.5	4.2	4.6	5.2	5.9	6.5	7.9	9.8	11.8	15.7
Required length (m) per m of pipe	0.8	1.1	1.2	1.6	2.1	2.8	3.5	4.2	4.6	5.2	5.9	6.5	7.9	9.8	11.8	15.7

Stainless-steel pre-punched strapping band 	107826-000	HARD-SPACER-SS-25MM-25M stainless steel prepunched strapping to hold MI heating cable in place. Supplied in 82 ft (25.0 m) rolls. Use on large pipes to simplify installation of multiple heating cables. For quantities, see Table 2 (installation every 1 ft = 0.328 m).
HWA-METAL-MESH-SS-50MM-10M 	1244-005772	Stainless steel mesh to hold heating cables on valves, pumps or other odd shaped surfaces. This mesh provides optimum contact and heat transfer between heating cables and heated equipment and can be used for exposure temperatures up to 400°C (752°F). 10 m per roll. 50 mm width. Weight: 0.36 kg.

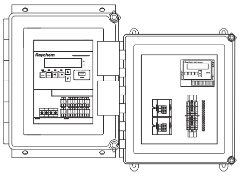
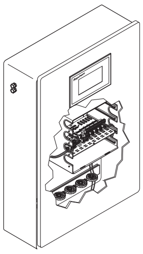
ACCESSORIES

Attachment Materials

Product	Order reference	Description
Banding 	BAND100FT	Stainless steel banding used to strap MI cables to pipes Ideal for large OD pipes 100ft roll x ½" wide x 0.020" thick (30m x 12.5mm wide x 0.5mm thick) Use with BANDCLIP100 banding clips ordered separately
Clips 	BANDCLIP100	Stainless steel clips used with stainless steel banding 100 clips per package Use with BAND100FT ordered separately
Tensioner 	T34P	Ratchet-type tensioning tool tightens stainless-steel banding used to support MI Cables.
Crimper 	S12P	Crimping tool used to crimp clip onto stainless-steel banding.

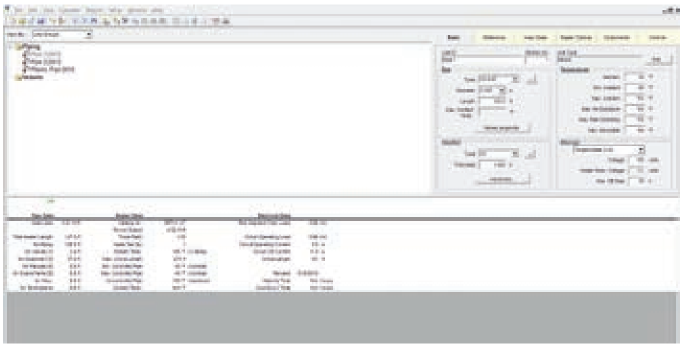
ADDITIONAL ACCESSORIES AND COMPONENTS

Attachment Materials

Product	Order reference	Description
Electric traced label 	ETL - English ETL - French	Attach the label to the outside of the thermal insulation weather barrier to indicate presence of electrical heat tracing. Use one label for every 10 feet (3 m) of pipe, alternating on either side of the pipe. Also install at equipment requiring periodic maintenance (control valves, pumps, instruments, etc.).
Temperature controls  		For a complete selection of control and monitoring products, including line-sensing thermostats, see Control and Monitoring.

TRACECALC PRO

AUTOMATED HEAT-TRACING DESIGN SOFTWARE FOR PIPES AND VESSELS



Download TraceCalc Pro from nVent.com/RAYCHEM

PRODUCT OVERVIEW

With nVent RAYCHEM TraceCalc Pro software, nVent provides you with an unprecedented design tool that lets you select heat-tracing products from a world-class brand giving you an optimal heat-tracing solution.

TraceCalc Pro design software brings you the latest advances in automated heat-tracing design capabilities. It sets new standards in the features you need for simple or sophisticated designs. With its intuitive user-friendly interface, you can create a heat-tracing design quickly and accurately.

TraceCalc Pro includes a wide variety of heating cable technologies and provides:

- Design calculations, such as pipe and vessel heat loss, number of circuits, electrical loads and maximum temperatures
- Automated heating cable and connection kit selection
- Recommendations for control and monitoring systems
- Easy-to-use standard reports
- Pictorial representations of heat-tracing connection kits

The software is designed for all levels of users. The novice user can quickly obtain a design through default settings and auto-select features. Advanced users can customize default settings for full design capability, while the expert user will enjoy the ability to set project defaults, and export saved projects to remote users.

TraceCalc Pro provides a common platform for users in different countries to share data in the language of their preference: English, French and German with worldwide codes and design practices supported.

SPECIFICATIONS

System requirements

To install and run the software, you will need:

- Microsoft Windows 7 or 8
- Web browser such as Windows Internet Explorer, Google Chrome or Mozilla Firefox
- Adobe Acrobat Reader 11 or later
- Internet access
- At least 50 MB of free hard disk space
- Recommended: 500 MHZ, 2 GB RAM
- A mouse or other pointing device
- SVGA display with 800 x 600 resolution minimum

Registration

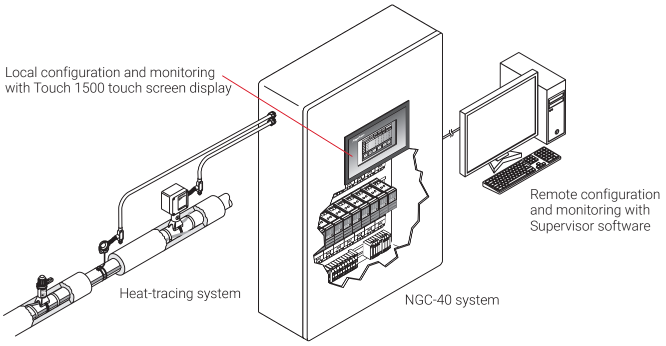
TraceCalc Pro will allow for complete pipe tracing designs for a period of 30-days from installation. After this period, or for vessel design capability, you must register the software. For more information on how to register, visit our web site at nVent.com.

Features

- Intuitive, easy-to-navigate, user-friendly interface
- Allows for design of both pipe and vessel tracing systems
- Supports designs for pipes and/or vessels using self-regulating, power-limiting, and series cables
- Also supports 3-phase series cable designs
- Graphical representation of heat-tracing connection kits
- Create complex piping circuits with drag-and-drop piping segments
- Accommodates multiple pipe sections each with different design parameters on a single circuit
- Up to three different valve and support types on a single line
- Nonstandard, oversized insulation design capability
- Supports worldwide codes and design practices
- Unlimited number of lines per project
- Enhanced reporting capability
- Designs comply with area classification requirements
- User-specified T-rating and autoignition temperatures
- Supports all control and monitoring capabilities: uncontrolled, ambient-sensing, PASC (proportional ambient sensing control), and line sensing
- Agency-approved maximum sheath temperature calculation, including control-limited designs
- User-selectable stabilized design capability
- Automatically and continuously displays calculated design results
- Users can register online to be notified of new releases and special updates
- Export functions simplify the exchange of data to other applications
- English, French and German user interface and help text

NGC-40

ADVANCED HEAT-TRACING CONTROL SYSTEM



PRODUCT OVERVIEW

The nVent RAYCHEM NGC-40 is a multipoint electronic control, monitoring and power distribution system with a unique single-point controller architecture for heat-tracing used in process temperature maintenance and freeze protection applications. By taking advantage of innovative modular packaging techniques, the NGC-40 system provides configuration and component flexibility so that it may be optimized for a customer's specific needs.

The NGC-40 uses a single controller module per heat-tracing circuit for maximum reliability. The NGC-40 control system can be powered between 100 to 240 Vac, while mechanical contactors (EMRs) or solid-state relays (SSRs) allow circuit switching up to 60 A at 600 Vac with single- or three-phase power. The NGC-40 control modules include ground-fault detection and protection and eliminate the need for external GF circuit breakers, thus reducing the overall cost of the Heat Management System. The control modules also guarantee precise single-phase and three-phase line current measurements.

Up to eight (8) Resistance Temperature Detectors (RTDs) can be used for each heat-tracing circuit allowing a variety of temperature control, monitoring, and alarming configurations. The NGC-40 System accommodates RTD inputs from a variety of sources. In addition to hardwiring an RTD directly into a Heat Trace Control module, RTDs can be wired to Input/Output modules (IO Module) within the panel or Remote Monitoring Modules (RMM2) in the field and assigned to heat tracing circuits through software. This means that a NGC-40 system can be optimized for the specific needs of an application or customer.

Each IO module accepts up to four additional RTD inputs. Each RMM2 module installed in the field can accept up to 8 RTDs. 16 RMM2 Modules can be daisy chained together via RS-485 for a total of 128 (8x16) RTDs. Since multiple RMM2's can be networked over a single cable to the NGC-40, the cost of RTD field wiring will be significantly reduced.

The NGC-40 system supports multiple communications ports, allowing serial interfaces (RS-485 and RS-232) and network connections (Ethernet) to be used with external devices. All communications with the NGC-40 panel are accomplished through the NGC-40-BRIDGE module which acts as the central router for the system, connecting the panel's control modules, IO modules, nVent RAYCHEM Touch 1500 touch screen and Remote Monitoring Modules (RMM2), as well as upstream devices such as nVent RAYCHEM Supervisor and Distributed Control System (DCS). Communications to devices external to the NGC-40 panel are done using the Modbus® protocol over Ethernet, RS-485 or RS-232.

The NGC-40 system provides both alarm outputs and digital inputs. The alarm output can be used to control an external annunciator. The digital input is programmable and may be used for various functions such as forcing outputs on and off or generating alarms, making the system more flexible to match each customer's specific needs.

Systems can be configured for nonhazardous and hazardous locations. The ability to monitor and configure the controller is available both locally and remotely with Touch 1500 touch screen and the Supervisor software.

Touch 1500 local control and monitoring

The NGC-40 system is configured with a user interface, Touch 1500, that is a state-of-the-art 15-inch (381 mm) color display with touch screen technology. The Touch 1500 touch screen allows convenient user access on site to all heat-tracing circuits and provides an easy user interface for programming without using keyboards. The Touch 1500 can be installed either locally on the panel door (hazardous or nonhazardous location) or in a remote location and communicates to the NGC-40 heat-tracing controllers via Ethernet or serial interface. In case of outdoor location, a window cover and a heater/cooler may be required.

The Touch 1500 can be used for configuration and monitoring of all heat-tracing circuits. The software is multilingual, offers 4 levels of integrated security and records alarms and events for maintenance purposes.

Supervisor software central control and monitoring

The Supervisor software package provides a remote, graphic interface for the NGC-40. The software allows the user to configure and monitor various NGC systems from a central location. It also provides an audible alarm tone, acknowledge and clear alarms; and contains advanced features such as data logging, trending, implement changes in batches, and other useful functions. Users can access all information from anywhere in the world, making Supervisor a powerful management tool for the entire Heat Management System.

Control

The NGC-40 measures temperatures with 3-wire, 100-ohm platinum RTDs, 2 or 3-wire, 100-ohm nickel iron RTDs, or 2-wire, 100-ohm nickel RTDs. The temperature information may come from a single, direct RTD hard-wired to the NGC-40 control panel, from a local NGC-40 IO module, or from a remote source such as an RMM2 module.

With EMRs the NGC-40 can be configured for the following control modes:

- On/Off EMR
- PASC EMR
- Always On
- Always Off

PASC= Proportional Ambient Sensing Control

With SSRs, the panel can be configured for the following control modes:

- Proportional
- On/Off SSR
- PASC SSR
- Always On
- Always Off

The NGC-40 also supports load-shedding. This mode overrides temperature control and forces the output of the control module off. The load-shedding command can be issued by Distributed Control System (DCS) or Supervisor.

Monitoring

The NGC-40 system measures a variety of parameters including ground-fault, temperature and load current(s) to ensure system integrity. In the case of three-phase heaters, the current of each phase can be separately measured and monitored. The system can be set to periodically check the heating cable for faults, alerting maintenance personnel of a pending heat-tracing problem.

All alarms can be individually enabled or disabled depending on customer preference. They can be also separately defined as latching or non-latching by the customer to meet their needs. The latching alarms need to be reset before they disappear from the alarm list.

A dry contact relay is available for alarm annunciation back to a Distributed Control System (DCS). Alternatively, the NGC- 40 system can report alarm and monitoring data directly to the DCS via Modbus.

Ground-fault protection

National electrical codes require ground-fault equipment protection on all heat tracing circuits. Heat-tracing circuits equipped with NGC-40 control modules do not require additional ground-fault detection equipment, thus simplifying installation and reducing costs.

Installation and communications

The NGC-40 system can be networked to a host PC running Windows®-based Supervisor client-server software and/or to a User Interface touch screen display (Touch 1500) for central programming, status review, and alarm annunciation.

Information access for external devices is through the NGC-40-BRIDGE communications module, which supports the Modbus protocol and is available with RS-232/RS-485 and 10/100Base-T Ethernet communication interfaces.

Packaging

NGC-40 is designed for easy installation and requires minimal wiring on site. All NGC-40 units are packaged in DIN rail mount housings, suitable for installation onto symmetric 35 mm DIN rails.

Complete system

The NGC-40 is supplied as a complete system, ready for field connections to power wiring and temperature sensor input. Optional Power Distribution provides further enhancement reducing field wiring and installation labor.

GENERAL

Area of use	NGC-40 EMR for nonhazardous locations NGC-40 EMR with Z purge for hazardous locations NGC-40 SSR for hazardous locations Class I, Division 2, Groups A-D Class I, Zone 2, Group IIC –13°F to 140°F (–25°C to 60°C) Temperature Rating: T4
Approvals	Nonhazardous Locations: ETL LISTED CONFORMS TO ANSI/UL STD. 508 UL STD. 508A; CERTIFIED TO CAN/CSA C22.2 NO. 14 Hazardous Locations (EMR purged version): ETL LISTED CONFORMS TO ANSI/UL STD. 508 UL STD. 508A; CERTIFIED TO CAN/CSA C22.2 NO. 14; ETL LISTED CONFORMS TO NFPA STD 496 Hazardous Locations (SSR version): ETL LISTED CONFORMS TO UL STD 508A ANSI/ISA STD 12.12.01; CERTIFIED TO CSA STD C22.2 NO. 213 CSA STD C22.2 NO. 14
Heater cable power	120–600 Vac, 50/60 Hz, 60 A
Supply voltage	100–240 Vac, +5% / –10%, 50/60 Hz
Internal Power Consumption	< 2.4 W per NGC-40-HTC/HTC3 module

ENCLOSURE

Protection/materials	Enclosure	Type area classification	Usage
	Type 12	Nonhazardous (Unclassified)	Locations indoors
	Type 4X/3R	Nonhazardous (Unclassified) Locations	Outdoors, stainless/painted steel
	Type 4X/3R with Z purge option	Hazardous Locations • Class I, Division 2, Groups A, B, C, D • Class I, Zone 2, Group IIC	Outdoors, stainless/painted steel with mechanical relays
	Type 4X/3R	Hazardous Locations • Class I, Division 2, Groups A, B, C, D • Class I, Zone 2, Group IIC	Outdoors, stainless/painted steel with solid-state relays

ENVIRONMENTAL

Operating temperature	
Without distribution	–40°F to 140°F (–40°C to 60°C) Space heater and thermostat must be used if below –13°F (–25°C)
With distribution	14°F to 140°F (–10°C to 60°C) Space heater and thermostat must be used if below 14°F (–10°C)
With Installed Touch 1500 / Touch 1500-HAZ	32°F to 122°F (0°C to 50°C) Window cover, space heater and thermostat must be used if below 32°F 0°C)

Storage temperature	
Without distribution	–40°F to 140°F (–40°C to 60°C)
With distribution	–13°F to 167°F (–25°C to 75°C)
With Installed Touch 1500 / Touch 1500-HAZ	–4°F to 140°F (–20°C to 60°C)

CONTROL HARDWARE

Relay types	• Electromechanical, (EMR versions): Poles: 3-pole Amperage: 30 A, 60 A • Solid-state relays (SSR versions): Poles: 1-, 2-, or 3-pole Amperage: 30 A, 60 A

PROGRAMMING AND SETTING

Method	The ability to program the controller is available both locally and remotely with Touch 1500 touch screen and the Supervisor software via Modbus communications.
Units	°F or °C
Memory	Nonvolatile, restored after power loss
Reset switch	Recessed hardware reset pushbutton on front of module. (HTC, HTC3, I/O and bridge modules)
Stored parameters (measured)	Minimum and maximum temperatures, contactor cycle count, heater time in use
Temperature set point range	–112°F to 1292°F (–80°C to 700°C)
Deadband	1°F to 90°F (1°C to 50°C) in On/Off control
Alarm conditions	• Low/high temperature • High temperature limit cutout • Low/high current • Over current trip • Ground-fault alarm and trip • Contactor cycle count • Switch limiting • Total time heater energized • Controller reset • RTD failure • Communications failure • Relay failure (covers both SSR/EMR) • Current transformer failure • External input source failure • Load shed source failure • User configuration data lost • Factory configuration data lost
Monitoring modes	• Temperature • Current • Ground Fault
Control modes	User selectable for each circuit:

EMR	**SSR**
On/Off EMR	Proportional
PASC EMR	On/Off SSR
Always On	PASC SSR
Always Off	Always On
	Always Off

PASC= Proportional Ambient Sensing Control

ANALOG AND DIGITAL SIGNAL INPUTS

Ambient or pipe sensors	• One RTD per control point directly connected to each NGC-40-HTC/HTC3 for up to 80 directly connected RTD inputs via NGC-40-HTC/HTC3 • Up to 7 additional RTDs can be assigned to one HTC/HTC3 via the optional NGC-40-IO, or another HTC/HTC3, or RMM2 modules
Additional temperature sensor inputs (optional)	• Each NGC-40-IO module installed in the panel can accept up to 4 RTDs • Each RMM2 module installed in the field can accept up to 8 RTD's. 16 RMM2 modules can be daisy chained together via RS-485 for the total of 128 (8x16) RTDs
Temperatures sensor types	• 100 Ω platinum RTD, 3-wire, α = 0.00385 ohms/ohm/°C Can be extended with a 3-conductor shielded cable of 20 Ω maximum per conductor • 100 Ω nickel iron RTD, 2 or 3-wire, α = 0.00518 ohms/ohm/°C Can be extended with a 2-conductor shielded cable of 20 Ω maximum per conductor • 100 Ω nickel RTD, 2-wire, α = 0.00518 ohms/ohm/°C Can be extended with a 2-conductor shielded cable of 20 Ω maximum per conductor (**Note:** Power wire and RTD wire should not be housed in the same conduit.)
Digital input	Each HTC, HTC3, and I/O module provides one multi-purpose digital input for connection to external dry (voltage-free) contact or DC voltage. Digital Input is programmable. It can be configured to be active open or active closed.
Alarm output	Each HTC, HTC3 and I/O module has a dry contact alarm output relay. Relay contact rated 250 Vac / 3 A 50/60 Hz (CE) and 277 Vac / 3 A 50/60 Hz (cCSAus). Alarm relay is programmable. NO and NC contacts available.
Relay output	One Form C relay rated at 12 A @ 250 Vac. Relay is used as a common system alarm. Relay may be assigned for alarm output.

CONNECTION TERMINALS

Heating cable output	Screw terminals, 20–6 AWG (30 A and 60 A versions)
Internal ground	14–4 AWG ground bar
Wiring terminals (RTD)	Spring clamp, 28–12 AWG
Wiring terminals (Relay/alarm/communications)	Spring clamp, 28–10 AWG
Module networking and module power	(2) RJ-45s, one each IN and OUT Provides CAN bus signals and +24 Vdc power

MONITORING RANGES

Temperature	Low alarm range High alarm range	–112°F to +1292°F (–80°C to +700°C) or OFF –112°F to +1292°F (–80°C to +700°C) or OFF
Ground fault	Alarm range Trip range	10 mA to 250 mA 10 mA to 250 mA or OFF
Current	Low alarm range High alarm range	0.3 A to 60.0 A 0.3 A to 60.0 A
Autocycle	Each circuit can be programmed from 1 to 750 hours or OFF	

MOUNTING

Panel mounting on 35 mm DIN rails	FE connection from module housing to DIN rail

INTERNAL NETWORKING PORT

Type	2-wire isolated CAN-based peer-peer network. Isolated to 300 Vac
Connection	(2) 8-pin RJ-45 connectors (both may be used for Input or Output connections)
Protocol	Proprietary NGC-40
Topology	Daisychain
Length	10 m max.
Quantity	A maximum of 80 CAN nodes per network segment
Address	Unique, Factory assigned

DISTRIBUTION (FOR RAYCHEM NGC-40-EMR ONLY)

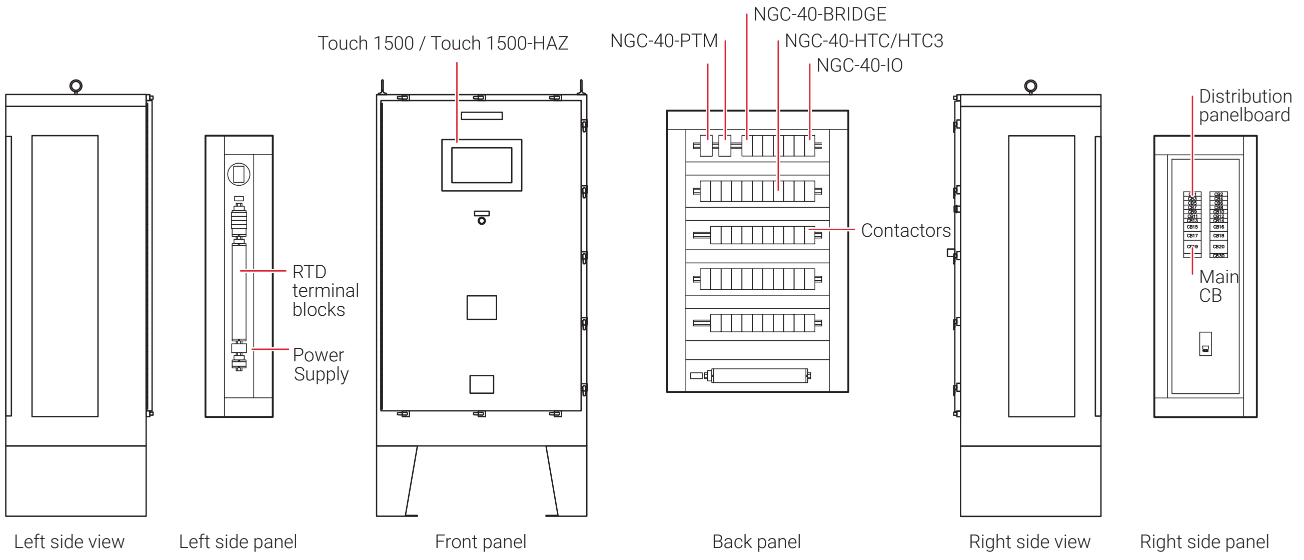
Load power	120 / 208 / 240 / 277 / 347 / 480 / 600 Vac	
Field wire size	14–8 AWG (15–30 Amp C.B.), 8–4 AWG (40–50 Amp C.B.)	
Circuit breaker amperage rating	120 Vac	20 A, 30 A, 40 A, 50 A
	208, 240, 277, 347, 480, 600 Vac	20 A, 30 A, 40 A, 50 A, 60 A
Main contactor	3-pole	

TOUCH 1500 – USER INTERFACE TOUCH SCREEN

Touch 1500 15-inch color touch screen display kit – touchscreen and Relay Output Module, panel mounting	Area Classification: Usage:	Nonhazardous (Unclassified) locations Type 4 (IP 65), Indoors or outdoors (with optional space heaters and window shield)
Touch 1500R 15-inch color touch screen display kit – touch screen and Relay Output Module, remote, stand-alone mounting	Area Classification: Usage:	Nonhazardous (Unclassified) locations Type 4 (IP 65), Indoors
Touch 1500-HAZ 15-inch color touch screen display kit – touchscreen and Relay Output Module, panel mounting	Area Classification: Usage:	Hazardous locations Type 4 (IP 65), Indoors or outdoors (with optional space heaters and window shield)

NGC-40

A typical NGC-40 consists of at least one Power and Termination module (NGC-40-PTM), one Bridge module (NGC-40-BRIDGE), one or more Heat Trace Controllers (NGC-40-HTC or HTC3) and one or more IO modules (NGC-40-IO). RMM2 modules and/or Touch 1500 touch screen unit may also be optionally used.



NGC-40 PANEL SIZES

EMR Panels		
Number of control points	**Panelboard size**	**NGC-40 panel size**
5	None	36" H x 36" W x 16" D
5	12 space	48" H x 36" W x 16" D
5	18 space	48" H x 36" W x 16" D
10	None	48" H x 36" W x 16" D
10	18 space	48" H x 36" W x 16" D
10	20 space	48" H x 36" W x 16" D
10	24 space	48" H x 36" W x 16" D
10	30 space	60" H x 36" W x 16" D
10	42 space	72" H x 36" W X 24" D
20	None	72" H x 36" W x 24" D
20	30 space	78" H x 36" W x 24" D
20	42 space	78" H x 36" W x 24" D
30	None	84" H x 36" W x 24" D
30	42 space	84" H x 36" W x 24" D
40	None	88" H x 36" W x 24" D
40	42 space	88" H x 36" W x 24" D

SSR Panels	
Number of control points	**NGC-40 panel size**
5	36" H x 30" W x 16" D
10	48" H x 36" W x 16" D
20	72" H x 36" W x 24" D
30	84" H x 36" W x 24" D
40	88" H x 36" W x 24" D

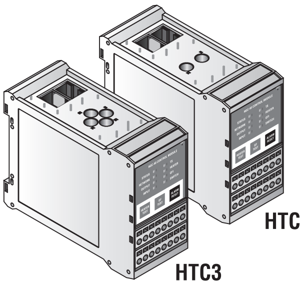
REPLACEMENT COMPONENTS

Description	Catalog number	Part number
NGC-40 Module		
Heat Tracing Control and Monitoring Module (Single-phase Heater)	NGC-40-HTC	10730-003
Heat Tracing Control and Monitoring Module (Three-phase Heater)	NGC-40-HTC3	10730-004
Input and Output Module	NGC-40-IO	10730-001
Communications Bridge Module	NGC-40-BRIDGE	10730-002
Power Termination Module	NGC-40-PTM	10730-005

Touch 1500 Touch Screen		
Touch 1500: 15-inch color touch screen display kit – touch screen and Relay Output Module, panel mounting, IP 65 (Type 4), nonhazardous (unclassified) locations, indoors or outdoors (with optional space heaters and window shield)	Touch 1500	10332-009
Touch 1500R: 15-inch color touch screen display kit – remote touch screen and Relay Output Module, stand-alone mounting, IP 65 (Type 4), nonhazardous (Unclassified) locations, indoors	Touch 1500R	10332-020
Touch 1500-TS: 15-inch color touch screen display – touch screen only, panel mounting, IP 65 (Type 4), nonhazardous (unclassified) locations, indoors or outdoors (with optional space heaters and window shield)	Touch 1500-TS	10332-014
Touch 1500-HAZ-TS: 15-inch color touch screen display – touch screen display only, panel mounting, IP 65 (Type 4), hazardous locations, indoors or outdoors (with optional space heaters and window shield)	Touch 1500-HAZ-TS	10332-011
Touch 1500-HAZ-CPU: CPU for Touch 1500-HAZ-TS approved for use in hazardous locations	Touch 1500-HAZ-CPU	10332-010
Relay Output: Relay Output Module with Modbus for Touch 1500	Relay Output – Touch	10332-024
Remote Monitoring Module, no enclosure	RMM2	051778
Remote Monitoring Module, with Type 4X enclosure	RMM2-4X	523420

SYSTEM COMPONENTS

Control Modules (NGC-40-HTC, NGC-40-HTC3)



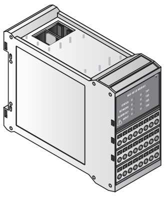
Two versions of this module are available: The NGC-40 Control module for single-phase heaters, NGC-40-HTC; the NGC-40 Control module for three-phase heaters, NGC-40-HTC3. Both versions use temperature data to control one single heat-tracing circuit by switching of Electromechanical relays (EMR) or Solid-State Relays (SSR). The NGC-40-HTC/HTC3 also provides ground-fault (leakage) current and line current sensing, monitoring and alarming.

One RTD can be directly connected to each HTC/HTC3 module for up to 80 directly connected RTD inputs. Up to 7 additional RTDs can be assigned to one HTC/HTC3 circuit via the optional NGC-40-IO or RMM2 modules.

A maximum of 81 NGC-40 modules (combination of Bridge, HTC, HTC3 and I/O modules) may be assembled in a single panel.

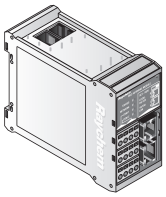
The NGC-40-HTC/HTC3 has one alarm relay output that can be connected to an external annunciator and one digital input that is programmable and may be used for various functions such as forcing the contactor or SSR on or off.

Input/Output Module (NGC-40-IO)



Each Input Output Module, NGC-40-IO, installed in the panel provides up to four (4) additional RTD inputs. These additional RTD inputs can be assigned to any NGC-40-HTC/HTC3 module. The NGC-40-IO module also provides one alarm relay that can be connected to an external annunciator and one digital input that is programmable and may be assigned to any NGC-40-HTC/HTC3 module for various functions such as forcing the contactor or SSR on or off.

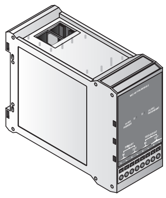
Communications Bridge Module (NGC-40-BRIDGE)



The NGC-40-BRIDGE module provides the interface between a panel's internal CAN-based network and upstream devices. Multiple communication ports are supported, allowing serial and Ethernet connections to be used with external devices: Each Bridge Module has two RS-485 ports, one RS-232 port and one 10/100Base-T Ethernet network with programmable communication parameters.

A maximum of 80 NGC-40 modules, a combination of HTC, HTC3 or I/O modules, can be connected to one NGC-40-BRIDGE module.

Power Termination Module (NGC-40-PTM)

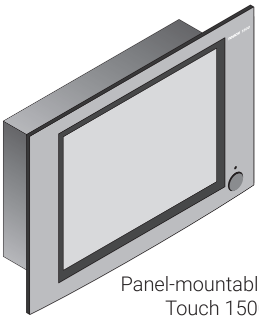


The NGC-40-PTM accepts a primary and redundant +24 Vdc power supply input add a space power to the NGC-40 module.

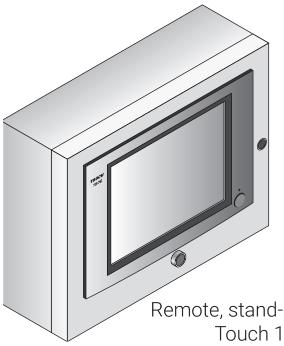
Each NGC-40-PTM can provide power to a maximum of 10 NGC-40 modules.

ADDITIONAL SYSTEM COMPONENTS (ORDERED SEPARATELY)

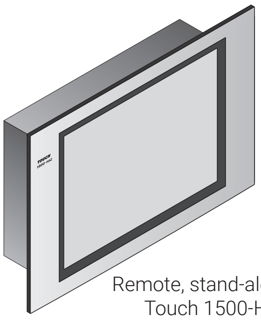
Touch 1500 - User Interface Touch Screen



Panel-mountable
Touch 1500



Remote, stand-alone
Touch 1500R



Remote, stand-alone
Touch 1500-HAZ

The Touch 1500 user interface touch screens are easy-to-navigate displays, with intuitive screens for use with the NGC-40 control panel. The intent of the Touch 1500 is to be installed in the field where the physical heat-tracing hardware is located to assist with system commissioning, setup, troubleshooting and on-site monitoring and control. Each Touch 1500 has a 15-inch LCD color display with touch-screen technology, and provides an easy user interface for programming without using keyboards. It has RS-485, RS-232, and 10/100Base-T Ethernet communications ports that allow communication with the Bridge Module (NGC-40-BRIDGE). A USB interface is included for easy configuration and software upgrades.

The Touch 1500 User Interface Touch Screens are available in three options:

1) Touch 1500 – Panel Mountable User Interface Touch Screen

Designed for use in nonhazardous location installations, indoors or outdoors (with optional space heaters and window shield), this Touch 1500 is rated for Type 4 environments and installed on the external NGC-40 panel door.

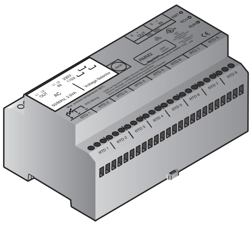
2) Touch 1500R – Remote Stand Alone User Interface Touch Screen

Designed for use in indoor, nonhazardous location installations, this remote Touch 1500R is a stand-alone display with Type 4 enclosure for use with the NGC-40 panel.

3) Touch 1500-HAZ – Panel Mountable User Interface Touch Screen

Designed for use in hazardous location installations, indoors or outdoors (with optional space heaters and window shield), this Touch 1500-HAZ is rated for Type 4 environments and installed on the external NGC-40 panel door.

Remote Monitoring Module (RMM2)

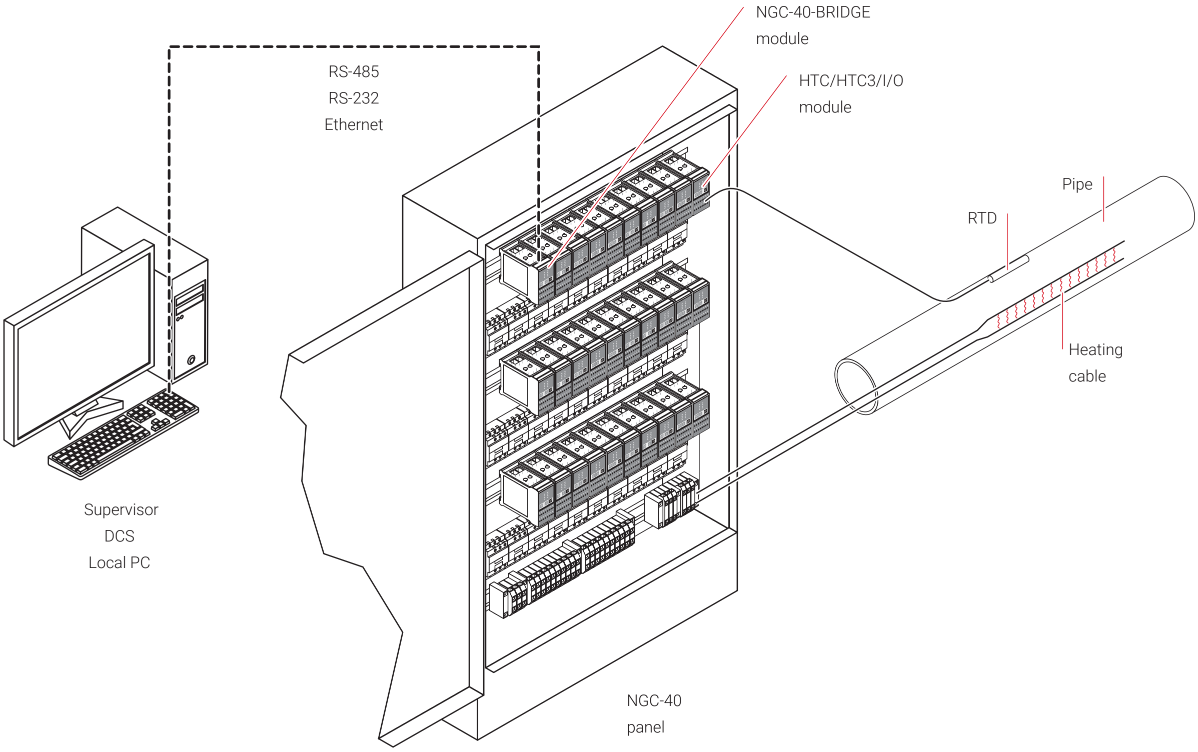


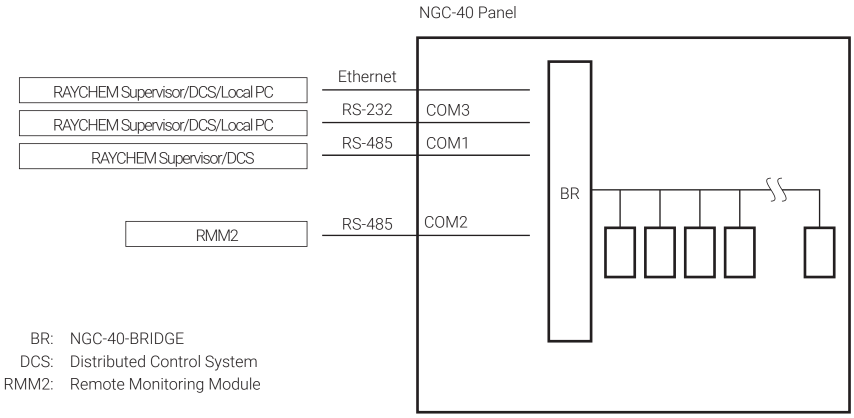
A Remote Monitoring Module (RMM2) is used to collect temperatures for control and monitoring of the heat-tracing system by the NGC-40 control panel. The RMM2 accepts up to 8 RTDs that measure pipe, vessel, or ambient temperatures. A single twisted-pair RS-485 cable connects up to 16 RMM2's for a total monitoring capability of 128 temperatures. The RMM2's are placed near desired measurement locations in nonhazardous or hazardous locations.

NGC-40 CONNECTION DIAGRAMS

One NGC-40 Panel Using Supervisor Software

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heating cable current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-40) and alarms upon low or high temperature condition



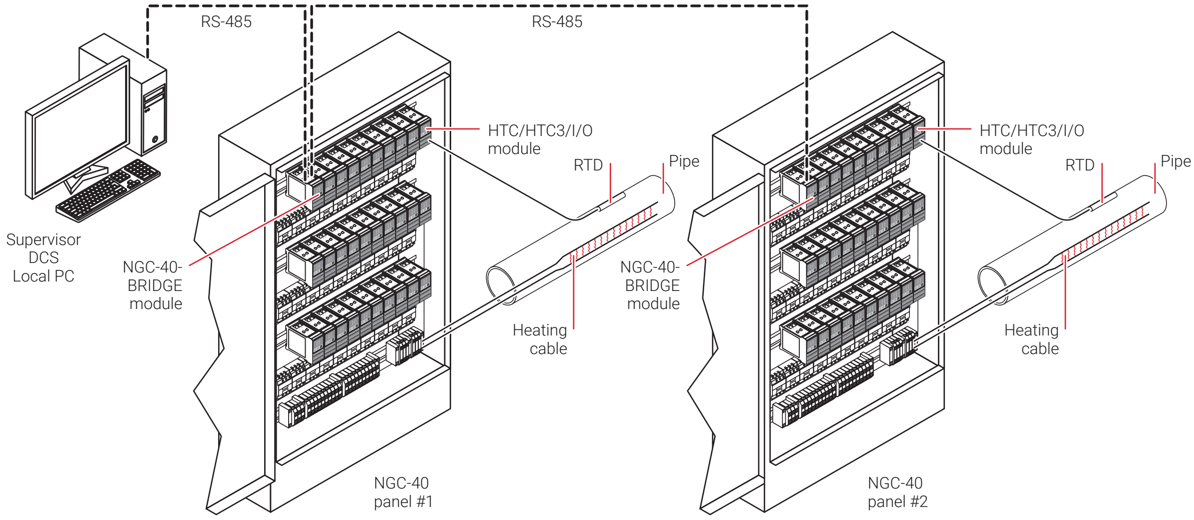


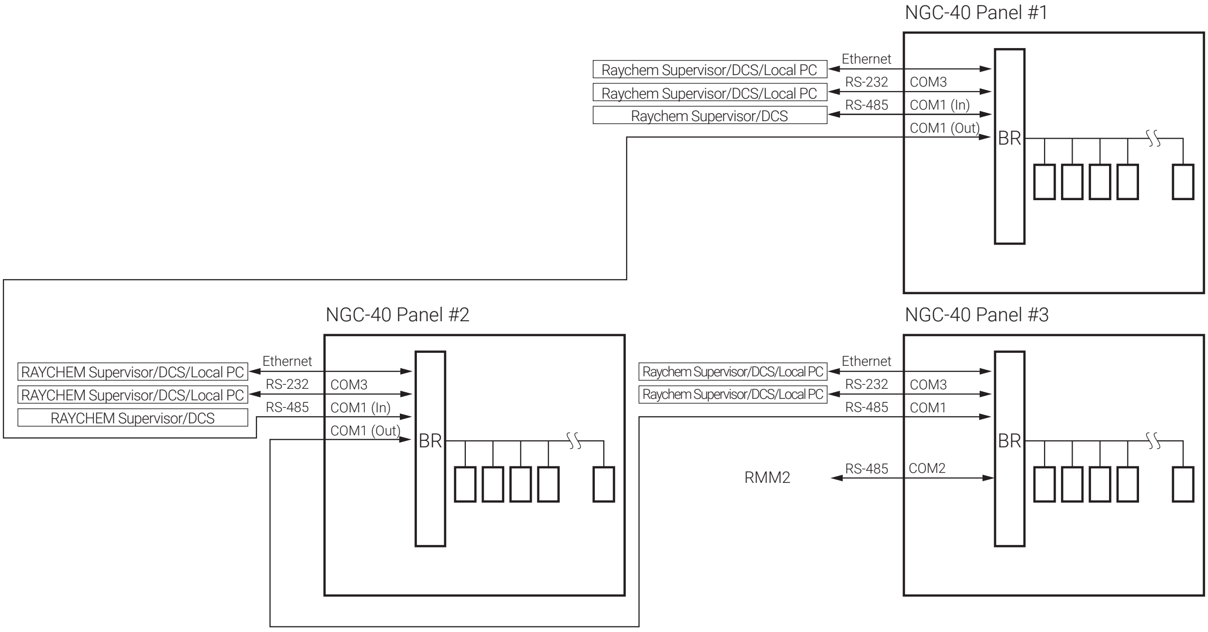
BR: NGC-40-BRIDGE
DCS: Distributed Control System
RMM2: Remote Monitoring Module

NGC-40 CONNECTION DIAGRAMS

Multiple NGC-40 Panels Using Supervisor Software

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heating cable current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-40) and alarms upon low or high temperature conditions



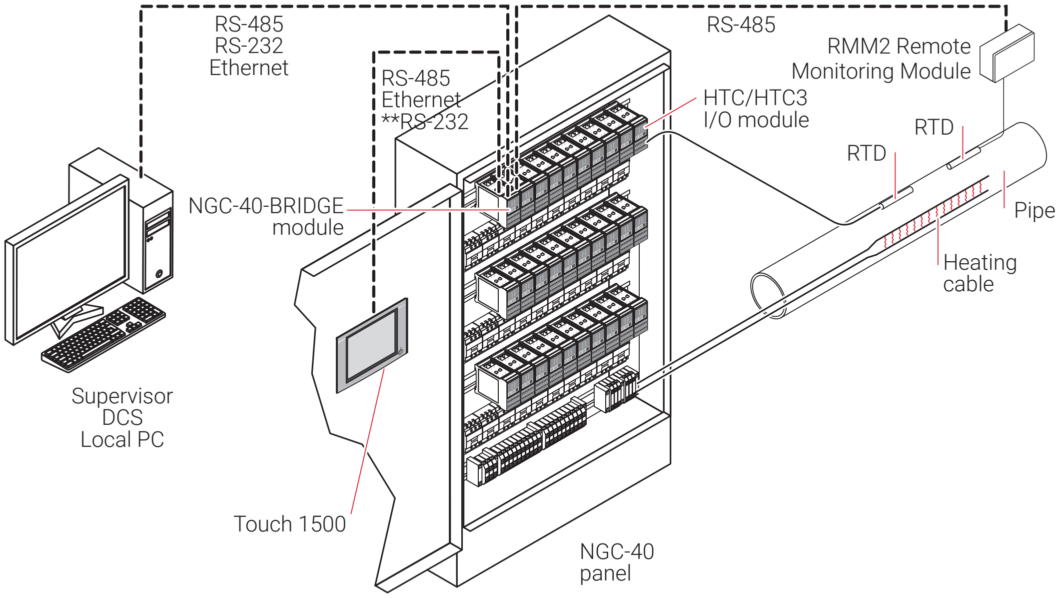


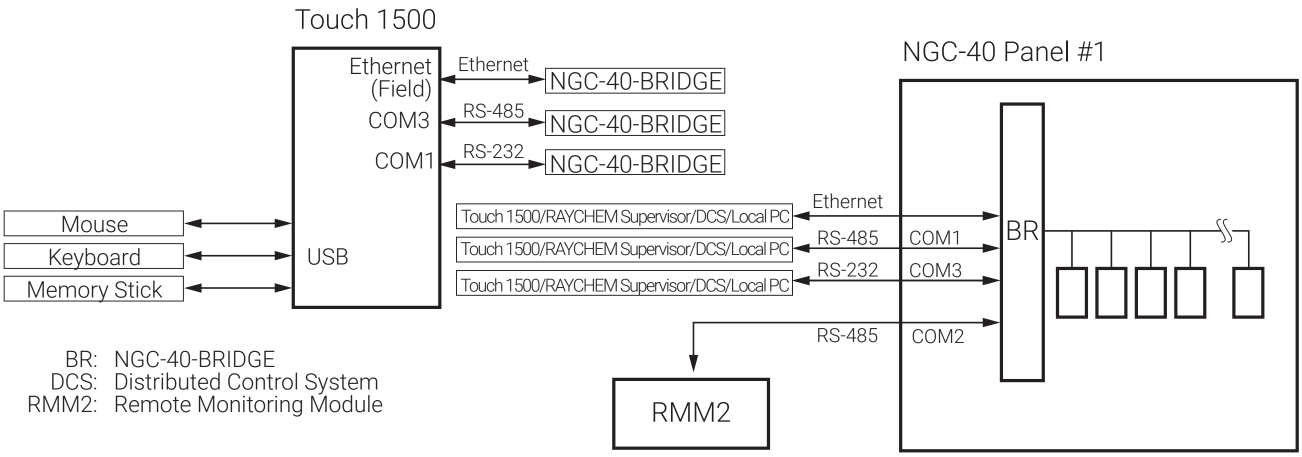
BR: NGC-40-BRIDGE
DCS: Distributed Control System
RMM2: Remote Monitoring Module

NGC-40 CONNECTION DIAGRAMS

One NGC-40 Panel Using One Touch 1500 Touch Screen and Optional RMM2 Module

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heating cable current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-40) and alarms upon low or high current conditions
- Using optional RMM2 (remote monitoring modules) mounted in the field, up to 128 additional RTD inputs can be added to the NGC-40 system
- The RMMs allow the RTD cables to be terminated locally and only a single RS-485 twisted wire pair brought back to the panel. This results in a significant reduction in field wiring.



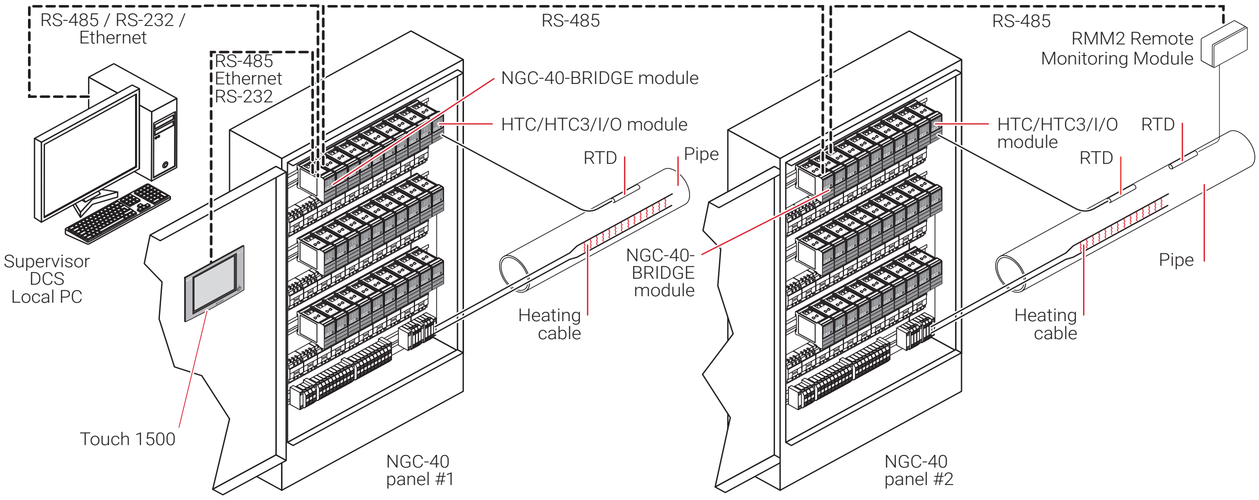


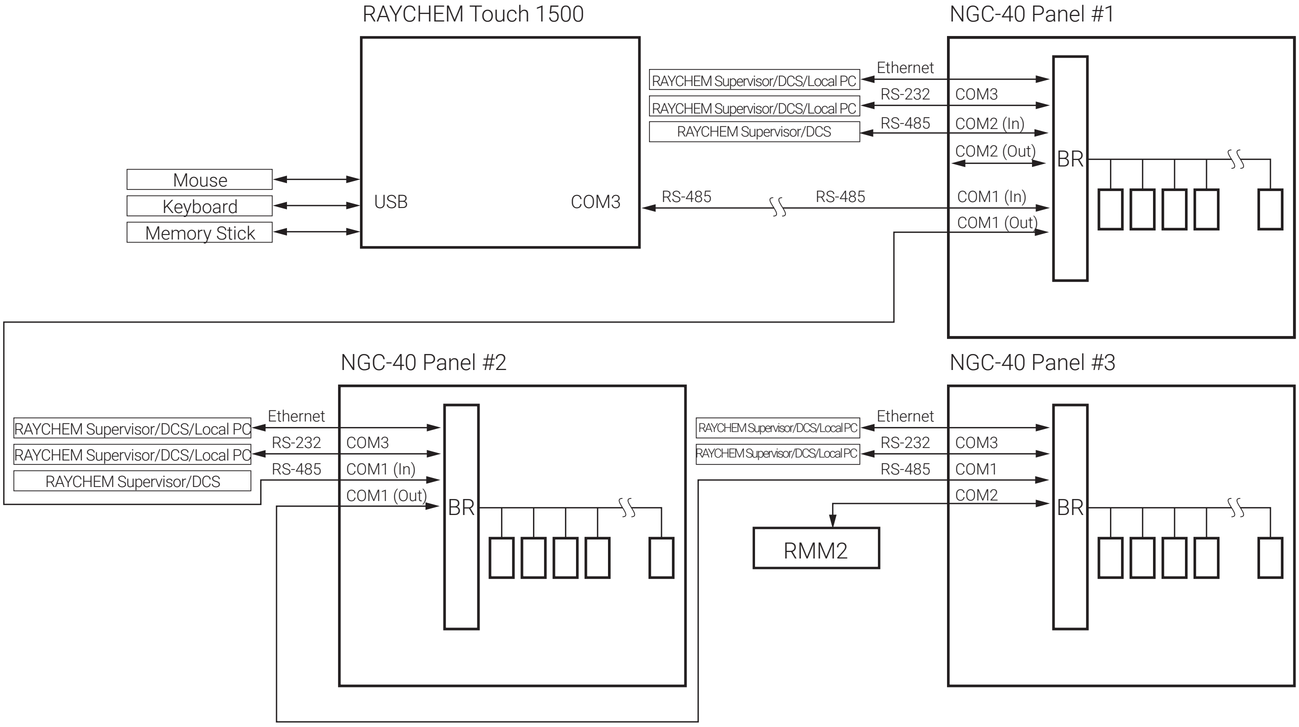
BR: NGC-40-BRIDGE
DCS: Distributed Control System
RMM2: Remote Monitoring Module

NGC-40 CONNECTION DIAGRAMS

Multiple NGC-40 Panels Using Common Touch 1500 Touch Screen and Optional RMM2 Module

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heating cable current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-40) and alarms upon low or high current conditions
- Using optional RMM2 (remote monitoring modules) mounted in the field, up to 128 additional RTD inputs can be added to the NGC-40 system
- The RMMs allow the RTD cables to be terminated locally and only a single RS-485 twisted wire pair brought back to the panel. This results in a significant reduction in field wiring.





BR:NGC-40-BRIDGE
DCS:Distributed Control System
RMM2:Remote Monitoring Module

ORDERING DETAILS

NGC-40 – Output – No. of Control Points – No. of I/O Modules – Enclosure – Voltage – Panelboard Size – Breaker or SSR or EMR – MCB – Options

NGC-40 – XXX – XX(XXHTC, XXHTC3) – XX(IO) – XX – XXX/XXX – XX – XX/XX (XX) – XXX – XX

Output
EMR= Electro-mechanical relay
SSR = Solid-state relay

No. of control points
1 - 40

No. of modules
(max 40 HTC/HTC3 modules)
XX (HTC) No. of single phase control modules
XX (HTC3) No. of three phase control modules
Note: The total quantity of HTC and HTC3 modules must be equal to the number of control points

No. of optional I/O modules
XX (IO)

Enclosure
12 = Type 12 (indoors; painted steel)
4 = Type 4/3R (outdoors; painted steel)
4X = Type 4X/3RX (outdoors; stainless steel)

Voltage
120 / 208 Vac
120 / 240 Vac[1]
277 / 480 Vac
347 / 600 Vac

Panelboard
0 = none required

# of control points	Panelboard size 120/208 Vac	120/240 Vac	277/480 Vac	347/600 Vac
1–5	12	12	18	18
6–10	24	20/30	18/30	18/24
11–20	30/42	30/42	30/42	30/42
21–30	42	42	42	42
31–40	42	42	42	42

Example: NGC40-EMR without Panelboard for USA with one User Interface Unit (UIT)
NGC40-EMR-22(17HTC, 5HTC3), 5(IO)-12-277/480-0-17(30A), 5(60A)-0-US,U1

Example: NGC40-EMR with Panelboard and Z Purge for Canada
NGC40-EMR-22(17HTC, 5HTC3), 3(IO)-12-277/480-42-15/1P(30A), 2/2P(40A), 5/3P(60A)-125-CA, Z

Example: NGC40-SSR without Panelboard for South America
NGC40-SSR-22(17HTC, 5HTC3), 2(IO)-12-277/480-0-15/1P(30A), 2/2P(60A), 5/3P(60A)-0-US

Options
Country Installed
US = U.S. / South America [default]
CA = Canada
E = Environmental purge
H1 = Electric heater option for min. ambient from –20°C to 0°C (–4°F to 32°F)
H2 = Electric heater option for min. ambient below –20°C (–4°F)
R = Redundant power supply
TU0 = No Touch 1500 (Raychem Supervisor or remote Touch 1500R is required, Touch 1500R can be ordered separately)
TU1 = 1 Touch 1500 (nonhazardous)
TU2 = 1 Touch 1500-HAZ (hazardous)
X = Panel spare parts
Z = Z purge
SP = Special requirement[2]

Main circuit breaker
0 = none required (choose if no panelboard required)

Panelboard size	120/208 Vac	120/240 Vac	277/480 Vac	347/600 Vac
12	50, 100	50, 80, 100	–	–
18	–	–	30, 50 , 70, 125	20, 40, 60, 90
20	–	50, 80, 100	–	–
24	50, 100	–	–	20, 40, 60, 90
30	50, 100, 150, 225	50, 80, 175, 225	50, 70, 125, 175, 225	40, 60, 90, 150, 200
42	50, 100, 150, 225	50, 80, 175, 225	50, 70, 125, 175, 225	40, 60, 90, 150, 200

Breaker or SSR or EMR
Breaker
No. of Circuit Breakers / No. of Poles (ampere rating)

		Max Number of Circuit Breakers (Number of Poles)									
No. of control points	Panel size	120 Vac (1P)	208 Vac (2P)	208 Vac (3P)	240 Vac (2P)	277 Vac (1P)	480 Vac (2P)	480 Vac (3P)	347 Vac (1P)	600 Vac (2P)	600 Vac (3P)
1–5	12	5	5	–	5	–	–	–	–	–	–
	18	5[3]	5[3]	5[3]	5[3]	5	5	5	5	5	5
6–10	18	–	–	–	–	10	8	5	10	8	5
	20	10	–	–	9	–	–	–	–	–	–
	24	10	10	7	–	–	–	–	10	10	7
	30	10	10	9	10	10	10	9	10	10	9
	42	10	10	10	10	10	10	10	10	10	10
	30	10	–	–	10	10	10	9	–	–	–
11–20	30	20	14	9	14	20	14	9	20	14	9
	42	20	20	13	20	20	20	13	20	20	13
21–30	42	30	20	13	20	30	20	13	30	20	13
31–40	42	40	20	13	20	40	20	13	40	20	13

Note: The quantity of breakers must be equal to the number of control points.
Note: The total number of C.B.; EMR or SSR selected must be equal to selected control module capacity. (Consult factory for 2P SSR above 20 or 3P SSR above 13)

SSR without panelboard
Number of output devices (SSRs) / Number of poles (amperage)
Output devices: 1 – 40
Poles: 1P or 2P or 3P
Amperage: 30 A, 60 A

EMR without panelboard
Number of output devices (EMRs) (amperage)
Output devices: 1 – 40
Amperage: 30 A, 60 A

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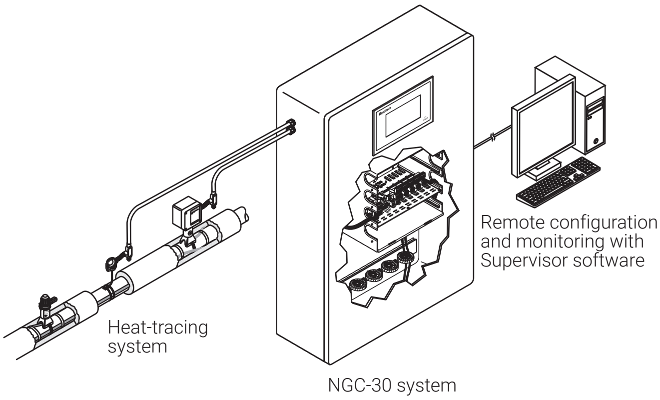
[1] Single phase
[2] Special - Describe special requirement in detail
[3] Applies to Canada only

NGC-30

ADVANCED HEAT-TRACING CONTROL SYSTEM



PRODUCT OVERVIEW

The nVent RAYCHEM NGC-30 is a multi-circuit electronic control, monitoring and power distribution system for heat-tracing used in process-temperature maintenance and freeze-protection applications. The NGC-30 system can control up to 260 circuits and monitor up to 1040 temperature inputs with multiple networked panels. The NGC-30 Controller can accommodate temperature inputs from a variety of sources: hard-wired, from Remote Monitoring Modules (RMM2) or from Power Line Carrier Interface (PLI) transmitters (SES/SPC/700-TT). Each panel can typically control up to 40 individual heat-tracing circuits and is available with power distribution as an option. The NGC-30 is available with two output types: an electromechanical relay (EMR) or a solid-state relay (SSR). Both types allow circuit switching up to 60 A at 600 Vac with single or three-phase power. Up to four Resistance Temperature Detector (RTD) inputs for each heat-tracing circuit allow for a variety of combinations of temperature control, monitoring, and alarming. Systems can be configured for nonhazardous and hazardous locations. The ability to monitor and configure the controller is available both locally and remotely with the User Interface Unit (UIT2) and the nVent RAYCHEM Supervisor software.

CONTROL

The NGC-30 measures temperatures with 3-wire, 100-ohm platinum RTDs. The temperature information can be transferred to the NGC-30 control panel through an RTD directly connected to the NGC-30 panel, through an optional Remote Monitoring Module (RMM2) or through an optional PLI Module with special transmitters: nVent RAYCHEM SES (Smart-End-Seal), nVent RAYCHEM SPC (Smart Power Connection) or nVent RAYCHEM 700-TT transmitters. Each RMM2 accepts up to eight RTDs. The RMM2s are typically located near the desired measurement location (RTDs). Multiple RMM2s are networked over a single cable to the NGC-30, significantly reducing the cost of RTD field wiring. With EMRs and SSRs, the NGC-30 can be configured for On/Off, ambient sensing, and proportional ambient sensing modes. Additionally, with SSRs, the panel can be configured for proportional, power limiting, and soft start modes.

POWER LINE CARRIER INTERFACE TECHNOLOGY

The nVent RAYCHEM Power Line carrier Interface Module (PLI) is an optional part of the NGC-30 heat-tracing control and monitoring system. When using Power Line Interface Technology, the RTD temperature information and the continuity confirmation are sent back through special transmitters, SES/SPC/700-TT, to the PLI Module and the NGC-30 controller along the heat-tracing bus wires and the AC power line, meaning the heating cable is also the data cable. Since no additional wiring is required to bring RTD temperature and continuity data back to a central location, installation and maintenance costs of the heat-tracing system are significantly reduced.

The PLI technology is only available in EMR output panels, which allow the signal to be passed through the heating cable and AC power line to the PLI module; this option is not available with SSR output panels.

MONITORING

The NGC-30 can measure up to 12 control parameters including ground-fault, temperature, and current variables to ensure system integrity. Configurable alarm settings provide options for local or remote alarms. The system can be set to periodically check for heating cable faults, alerting maintenance personnel of a pending heat-tracing problem. This helps avoid costly downtime. Dry contact relays are provided for alarm annunciation back to a Distributed Control System (DCS).

The PLI Module can receive temperature inputs from up to 127 SES, SPC, or 255 700-TT transmitters. Up to four PLI modules can communicate with a NGC-30 central controller using a single RS-485 bus (a shielded, twisted pair).

GROUND-FAULT PROTECTION

National electrical codes require ground-fault equipment protection on all heat-tracing circuits. Heat-tracing circuits equipped with NGC-30 controllers do not require additional ground-fault detection equipment, simplifying installation and reducing costs.

LOCAL MONITORING AND CONTROL

The NGC-30 system is configured with a User Interface Terminal (UIT2) that has an LCD color display with touch screen technology. This UIT2 provides an easy user interface for programming without using keyboards. The UIT2-EX is rated for ordinary and hazardous, indoor or outdoor locations and can be mounted on the panel door. An option is also available to have the User Interface Terminal not mounted on the panel door but located remotely from the panel. The remote stand-alone User Interface Terminal, NGC-UIT2-ORD-R, with a NEMA 4 enclosure is available for mounting remotely in a nonhazardous, indoor or outdoor location.

COMMUNICATIONS

The NGC-30 units can be networked to a host PC running Windows®-based Supervisor client-server software for central programming, status review, and alarm annunciation. NGC-30 units support the Modbus® protocol and are available with an RS-232/RS-485 or 10/100Base-T Ethernet communication interface.

GENERAL

Area of use	NGC-30-EMR for nonhazardous locations NGC-30-EMR with Z purge for hazardous locations NGC-30-SSR for hazardous locations
Approvals	

Nonhazardous Locations	Hazardous Locations (EMR purged version)	Hazardous Locations (SSR version)
ETL LISTED CONFORMS TO ANSI/UL STD. 508 UL STD. 508A CERTIFIED TO CAN/CSA C22.2 NO. 14	ETL LISTED CONFORMS TO ANSI/UL STD. 508 UL STD. 508A CERTIFIED TO CAN/CSA C22.2 NO. 14 ETL LISTED CONFORMS TO NFPA STD 496	ETL LISTED CONFORMS TO UL STD 508A ANSI/ISA STD 12.12.01 CERTIFIED TO CSA STD C22.2 NO. 213 CSA STD C22.2 NO. 14

Supply voltage	100 – 240 Vac, +5% / –10%, 50/60 Hz common supply for controller and heat-tracing circuit Up to 600 Vac for heat-tracing circuit when controller is powered from a separate circuit

ENCLOSURE

Protection/materials	NEMA 12 (indoors painted steel) NEMA 4/3R (outdoors, painted steel) NEMA 4X/3RX (outdoors, stainless steel)
Operating temperature NGC-UIT2-ORD installed	Without distribution: –13°F to 140°F (–25°C to 60°C) Below –13°F (–25°C), space heater and thermostat must be used With distribution: 14°F to 140°F (–10°C to 60°C) Below 14°F (–10°C), space heater and thermostat must be used
NGC-UIT2-HAZ installed	With or without distribution: 32°F to 140°F (0°C to 60°C) Below 32°F (0°C), space heater and thermostat must be used
Storage temperature NGC-UIT2-ORD installed NGC-UIT2-HAZ installed	–13°F to 167°F (–25°C to 75°C) –40°F to 149°F (–40°C to 65°C)
Relative humidity	0% to 90%, noncondensing

CONTROL

Heat-tracing circuits	One NGC-UIT2 can configure and monitor up to 260 heat-tracing circuits
Relay types	3-pole, electromechanical (EMR versions) 1-, 2-, or 3-pole solid-state relays (SSR versions)
Voltage, maximum	240 Vac nominal, 50/60 Hz (standard), 600 Vac nominal (optional)
Current, maximum per circuit* *Depending on panelboard amperage rating, the maximum current may not be used on all circuits.	EMR: 30 A @ 104°F (40°C) or 60 A @ 104°F (40°C) SSR: 30 A @ 104°F (40°C) or 60 A @ 104°F (40°C)
Control algorithms	EMR: On/Off, Ambient on/off, PASC (proportional ambient sensing control) SSR: On/Off, Ambient on/off, PASC (proportional ambient sensing control), Proportional (includes soft start for all SSR control modes)
Control range	–99°F to 900°F (–73°C to 482°C)
Dead band	1°F to 50°F (1°C to 50°C) (On/Off control only)

MONITORING

Temperature	Low alarm range	–99°F to 900°F (–73°C to 482°C) or OFF
	High alarm range	–99°F to 900°F (–73°C to 482°C) or OFF
Ground fault	Alarm range	10 mA to 200 mA
	Trip range	10 mA to 200 mA or OFF
Current	Low alarm range	0 A to 100 A (where 0 equals OFF)
	High alarm range	0 A to 100 A (where 0 equals OFF)
Voltage	100 – 277 Vac supply voltage to heat-tracing (**Note:** Requires the loss of one circuit)	
Autocycle	Each circuit can be programmed from 1 to 1000 hours or OFF	

TEMPERATURE SENSOR INPUTS

Monitoring	NGC-30 system can monitor up to 1040 (260 x 4) temperatures
Quantity per circuit	Up to four temperature inputs can be assigned to one circuit
Temperature sources	Hard-wired, optional RMM2 Module, optional PLI module
Temperature inputs per control point	Standard: One input standard per control point Optional: Up to three additional RTDs per control point connected via RMM2 and/or PLI Module
Temperature inputs per NGC-UIT2	Hard-wired: Up to 260 hard-wired temperature inputs, one per circuit RMM2 (optional): Up to 128 RTD inputs via RMM2 Modules. Up to 8 RTDs per RMM2 Module and up to 16 RMM2 Modules per NGC-30 controller PLI module (optional; NGC-30 EMR Panel only): Up to 127 RTDs via SES Transmitter (per PLI Module) Up to 127 RTDs via SPC Transmitter (per PLI Module) Up to 255 RTDs via 700-TT Transmitter (per PLI Module) Four PLI Modules per circuit, maximums 1040 RTDs
Types	100 Ω platinum RTD, 3-wire, α = 0.00385 ohms/ohm/°C Can be extended with a 3-conductor shielded cable of 20 Ω maximum per conductor (**Note:** power wire and RTD wire should not be housed in the same conduit).

ALARM OUTPUTS

Relay Outputs	3 SPDT Form C. Rating: 3 A 100 – 277 Vac Each relay may be assigned to alarm outputs

PROGRAMMING AND SETTING

Method	Via NGC-UIT2 (User Interface Terminal)
Units	°F or °C
Digital display	
NGC-UIT2-ORD	8.4 inch LCD color touch screen (17.5 cm X 13.3 cm)
NGC-UIT2-HAZ	10.4 inch LCD color touch screen with interval LED backlight
Memory	Nonvolatile, restored after power loss
Stored parameters (measured)	Minimum and maximum temperatures, contactor cycle count, heater time in use
Alarm conditions	Low/high temperature, low/high current, ground-fault alarm and trip, RTD failure, communications failure, relay failure, relay count, total time heater energized, contactor failure

USER INTERFACE TERMINALS (UITS)

NGC-UIT2-ORD	Area Classification:	Nonhazardous (Unclassified) Locations
	Usage:	NEMA 4 (indoors or outdoors)
NGC-UIT2-HAZ	Area Classification:	Nonhazardous (Unclassified) or Hazardous Locations
	Usage:	NEMA 4 (indoors or outdoors)
NGC-UIT2-ORD-R	Area Classification:	Nonhazardous (Unclassified) Locations • The NGC-UIT2-ORD-R must be installed in a nonhazardous, indoor or outdoor location. • The NGC-UIT2-ORD-R connects to NGC-30 panels using RS-485 communications wiring.
	Usage:	NEMA 4 (indoors or outdoors)

LANGUAGE SUPPORT

English, Spanish, French, German, Russian, Chinese, Italian, Czech

CONNECTION TERMINALS

Heating cable output	Screw terminals, 20–6 AWG (30 A versions), 14–2 AWG (60 A versions)
Ground	14–4 AWG ground bar
RTD / alarm / communications	28–12 AWG spring clamp terminals

DISTRIBUTION (FOR NGC-30-EMR ONLY)

Load power	120 / 208 / 240 / 277 / 347 / 480 / 600 Vac	
Circuit breaker amperage rating	120 Vac	20 A, 30 A, 40 A, 50 A
	208, 240, 277, 347, 480, 600 Vac	20 A, 30 A, 40 A, 50 A, 60 A

TYPICAL NGC-30 LAYOUT

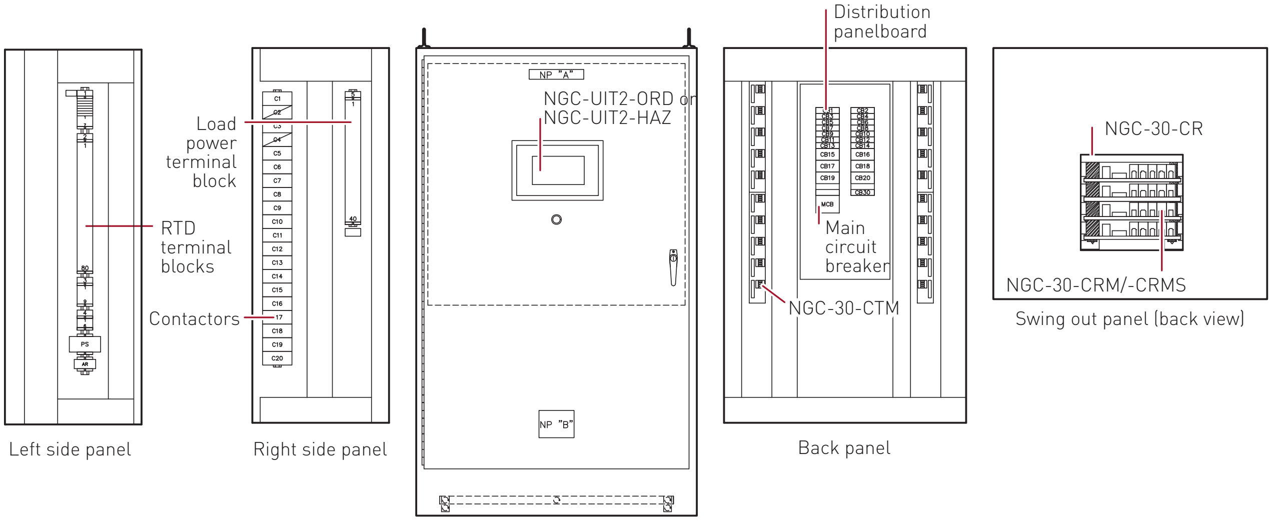
Multipoint temperature control with ground-fault/current/temperature monitoring and optional distribution.

The NGC-30 is a multipoint electronic control, monitoring, and power distribution system for heat-tracing used in process temperature maintenance and freeze protection applications. The system contains nVent RAYCHEM controllers, multiple individual Electromechanical Relays (EMRs), or Solid-State Relays (SSRs) and an optional assembled circuit breaker panelboard with a main breaker.

The NGC-30 provides the following alarming features per control point.

- High/low temperature
- Ground fault
- High/low current fault
- RTD failure

The NGC-30 provides ground-fault monitoring and trip protection for every heat-tracing circuit and fulfills the requirements of national electrical codes.



Left side panel

Right side panel

Front panel

Back panel

Swing out panel (back view)

EMR PANELS

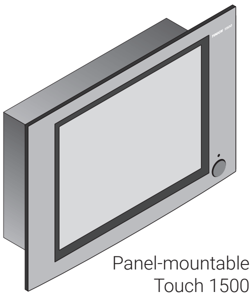
Number of control points	Panelboard size	EMR panel size with or without panelboard (nominal)	
5	12 space	42"H X 36"W x 12"D	(wall mount)
5	18 space	48"H X 36"W x 12"D	(wall mount)
10	18, 20, 24 space	48"H X 36"W x 16"D	(wall mount)
10	30 space	72"H X 36"W x 16"D	(includes 12" floor stands)
15, 20, 25	30 space	72"H X 36"W x 25"D	(includes 12" floor stands)
15, 20, 25	42 space	84"H X 36"W x 25"D	(includes 12" floor stands)
25, 30	42 space	84"H X 36"W x 25"D	(includes 6" floor stands)
35, 40	42 space	90"H X 36"W x 25"D	(includes 6" floor stands)

SSR PANELS

Number of control points	SSR panel size without panelboard (nominal)	
5	36"H X 30"W x 12"D	(wall mount)
10	48"H X 36"W x 16"D	(wall mount)
15, 20	72"H X 36"W x 24"D	(includes 6" floor stands)
25, 30	84"H X 36"W x 24"D	(includes 6" floor stands)
35, 40	90"H X 36"W x 24"D	(includes 6" floor stands)

SYSTEM COMPONENTS

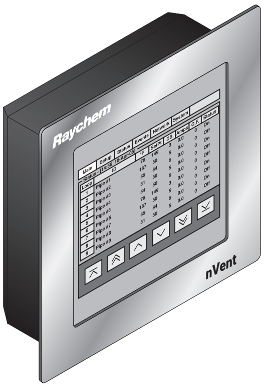
User Interface Terminal (NGC-UIT2-ORD)



The NGC-30 User Interface Terminals (NGC-UIT2) are panel-mounted displays for use with the NGC-30 panel. Available in different models, each NGC-UIT2-ORD has a 7 inch x 5 ¼ inch (17.5 cm X 13.3 cm) LCD color display with touch-screen technology, and provides an easy user interface for programming without using keyboards. It has RS-485, RS-232, or 10/100Base-T Ethernet communications ports that allow communication with the Supervisor software and external Distributed Control Systems. A USB interface is included for easy configuration and firmware upgrades.

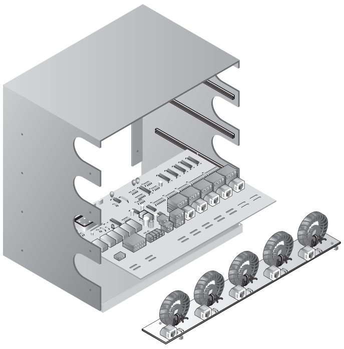
The NGC-UIT2-ORD is designed for use in nonhazardous, indoor or outdoor location installations and is rated for NEMA 4 environments. The NGC-UIT2-ORD is installed locally on the panel door.

User Interface Terminal (NGC-UIT2-HAZ)



Same features as the NGC-UIT2-ORD except it has a 10.4 inch color display and designed for use in nonhazardous and hazardous locations (Class I, Division 2; Groups A, B, C, D).

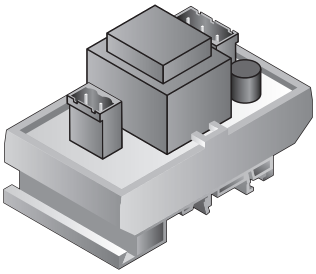
Card Rack Modules (NGC-30-CRM/-CRMS), Current Transformer Module (NGC-30-CTM) and Card Rack (NGC-30-CR)



The Card Rack (NGC-30-CR) is mounted in a panel and it houses up to four Card Rack modules (NGC-30-CRM/S). The Card Rack Modules (NGC-30-CRM/S) with the associated Current Transformer Module (NGC-30-CTM) provide ground fault and line current information. The Card Rack modules also provide RTD input, alarming and switching of the Electrical Mechanical (NGC-30-CRM) and Solid State Relays (NGC-30-CRMS) for five heat tracing circuits.

A typical panel consists of 8 Card Rack Modules wired together via a twisted pair (RS-485) cable for a total of 40 heating cable circuits. Additional panels can be connected to a single User Interface Terminal to create a heat-tracing system of up to 260 circuits.

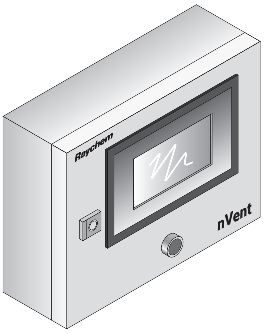
Voltage Monitoring Module (NGC-30-CVM) (optional)



The Voltage Monitoring Module monitors the actual voltage being used by the NGC-30-CRM/-CRMS. The NGC-30-CVM module uses one channel on one CRM/-CRMS board in a panel.

ADDITIONAL SYSTEM COMPONENTS (ORDERED SEPARATELY)

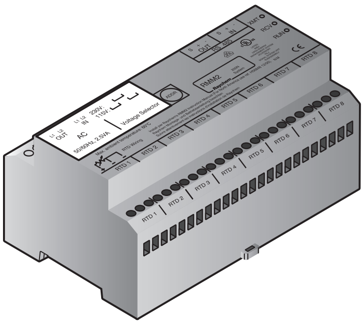
Remote User Interface Terminal (NGC-UIT2-ORD-R)



The Remote User Interface Terminal (NGC-UIT2-ORD-R) is a stand-alone display for use with the NGC-30 panel. The NGC-UIT2-ORD-R is mounted remotely (in a nonhazardous location) when the NGC-30 panel is placed in a hazardous or difficult to access location. Like the NGC-UIT2-ORD, it has a 7 inch x 5 ¼ inch (17.5 cm X 13.3 cm) LCD color display with touch-screen technology, and provides an easy user interface for programming without using keyboards. It is rated NEMA 4 (IP 65), and must be mounted in a nonhazardous indoor or outdoor location.

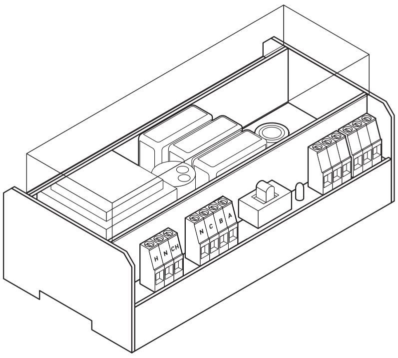
It has RS-485, RS-232, or 10/100Base-T Ethernet communications ports that allow communication with the Supervisor software and external Distributed Control Systems. A USB interface is included for easy configuration and firmware upgrades.

Remote Monitoring Module (RMM2)



A Remote Monitoring Module (RMM2) is used to collect temperatures for control and monitoring of the heat-tracing system by the NGC-30 control panel. The RMM2 accepts up to eight RTDs that measure pipe, vessel, or ambient temperatures. Multiple RMM2s communicate with a single NGC-UIT to provide centralized monitoring of temperatures. A single twisted-pair RS-485 cable connects up to 16 RMM2s for a total monitoring capability of 128 temperatures. The RMM2s are placed near desired measurement locations in nonhazardous or hazardous locations.

Power Line Carrier Interface Module (PLI)



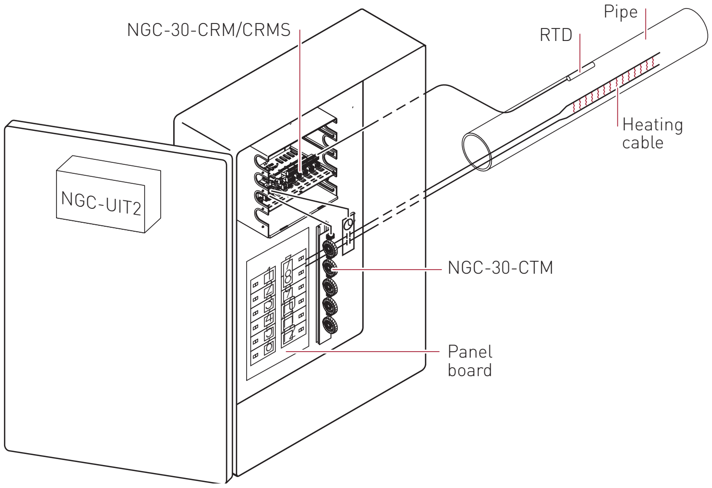
PLI modules (Power Line Carrier Interface) together with special temperature transmitters provide remote temperature-monitoring capability for heat-tracing control and monitoring systems by communicating the temperature data to the control system over the heat-tracing bus wires and the AC power line, eliminating the need for RTD wiring. Typical savings on the installation costs of a heat-tracing system can be as much as 30% with PLI technology, depending on the specifics of each application.

The PLI module typically resides in the NGC-30 EMR panel and receives input from special transmitters connected to the heat-tracing. The transmitters provide pipe temperatures from RTDs and continuity confirmation; they are typically located at the front and/or end of the heat-tracing circuit. The PLI special transmitters are: SES (Smart End Seal), SPC (Smart Power Connection) and 700-TT.

The NGC-30 system can accept up to 127 temperature inputs from SES/SPC transmitters or 255 temperature inputs from 700-TT transmitters, per PLI module. Up to four PLI modules can be connected to one NGC-30 UIT.

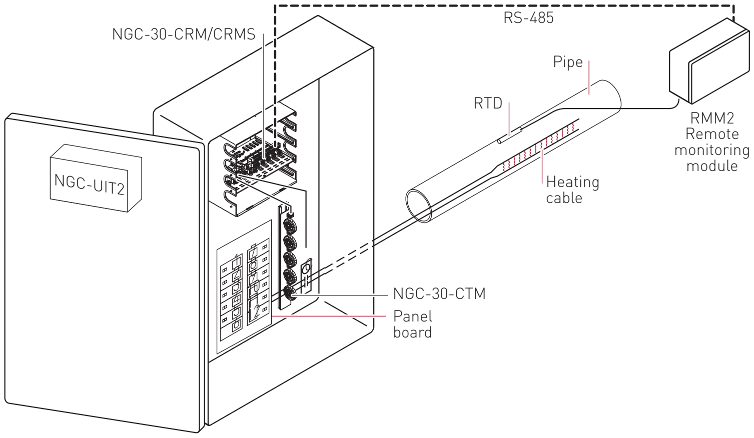
TYPICAL CONFIGURATIONS FOR THE NGC-30

Individual Controls with Ground-fault Trip/Current/Temperature Monitoring



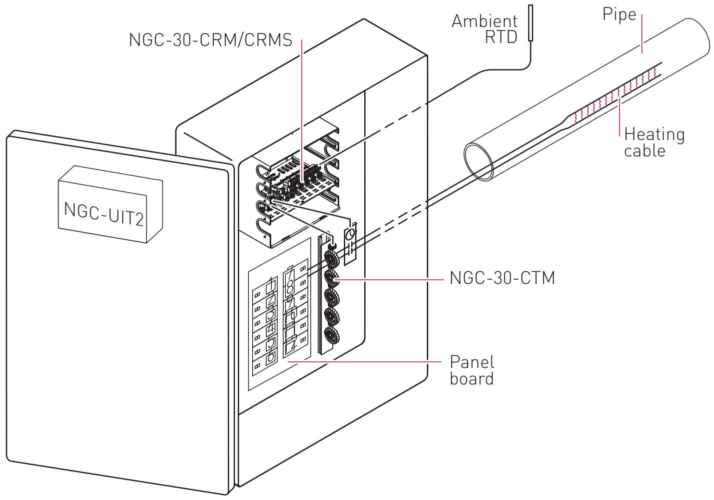
- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-30) and alarms upon low or high current condition

Individual Controls with RMM2 for Ground-fault Trip/Current/Temperature Monitoring with Networked RTDs



- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current and alarms upon low or high current conditions
- Monitors pipe temperature (via RTD inputs wired back to the NGC-30) and alarms upon low or high current conditions
- Using optional RMM2 (remote monitoring modules) mounted in the field, up to 128 RTD inputs can be added to the NGC-30 system.
- The RMMs allow the RTD cables to be terminated locally and only a single RS-485 twisted wire pair brought back to the panel. This results in a significant reduction in field wiring.

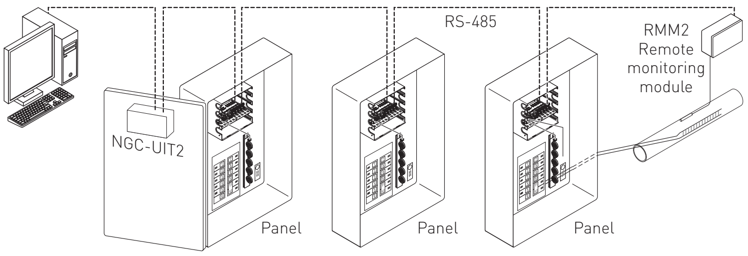
Individual Ambient or PASC Control with Ground-fault Trip/Current/Temperature Monitoring



- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current and alarms upon low or high current conditions

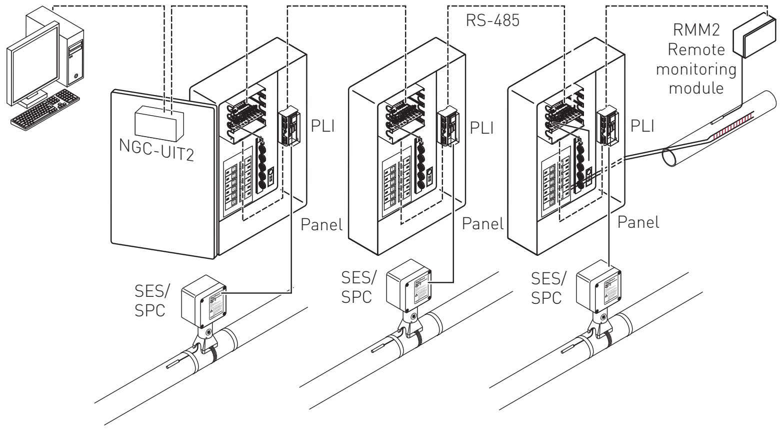
TYPICAL CONFIGURATIONS FOR THE NGC-30

Multi-panel Configuration with RMM2 Module



- Multiple panels can be ganged together for control using a single User Interface Terminal.
- Communications is accomplished using RS-485 wiring.
- Up to 260 heat trace circuits can be supported using this architecture.
- Supervisor Software interfaces with the User Interface Terminal via RS-485 or 10/100BaseT Ethernet.

Multi-panel Configuration with PLI and RMM2 Modules



- Multiple panels can be ganged together for control using a single User Interface Terminal.
- Communications is accomplished using RS-485 wiring.
- Up to 260 heat trace circuits can be supported using this architecture.
- Up to 1040 temperature inputs can be monitored with one NGC-UIT2.
- Up to 127 SES/SPC transmitters or 255 700-TT transmitters per PLI and up to 4 PLI modules per NGC-30 controllers for control or monitoring.
- 700-TT and SES/SPC Transmitters can be used in any combination in the same multi-panel configuration system using one NGC-UIT2.
- The 700-TT and SES/SPC Transmitters cannot be used on the same PLI module. At least two PLI modules are required if a combination of 700-TT and SES/SPC transmitters are used.

REPLACEMENT COMPONENTS

Description	Catalog number	Part number
User Interface Terminal		
User Interface Terminal Nonhazardous (Unclassified) Locations; indoors or outdoors, panel mounting	NGC-UIT2-ORD	10332-013
User Interface Terminal Nonhazardous (Unclassified) and Hazardous Locations; indoors or outdoors, panel mounting	NGC-UIT2-HAZ	10332-022
User Interface Terminal with NEMA 4 Enclosure Nonhazardous (Unclassified) Locations; indoors or outdoor, remote stand-alone mounting	NGC-UIT2-ORD-R	10332-016
NGC-30 Modules		
Card Rack Module (for EMRs)	NGC-30-CRM	10720-001
Card Rack Module (for SSRs)	NGC-30-CRMS	10720-004
Current Transformer Module	NGC-30-CTM	10720-002
Voltage Monitoring Module	NGC-30-CVM	10720-005
NGC-30 Auxiliary		
DB9F-DB9F Null Modem Cable 5 ft	NGC-UIT2-RS232	20577020
Remote Monitoring Module	RMM2	051778
Remote Monitoring Module with NEMA 4X Enclosure	RMM2-4X	523420

REPLACEMENT COMPONENTS

Description	Catalog number	Part number
Power Line Carrier Interface: Smart End Seal Transmitter		
120 V temperature/continuity transmitter with pipe-mount power connection enclosure	SPC-P-1	P000001049
208–277 V temperature/continuity transmitter with pipe-mount power connection enclosure	SPC-P-2	P000001050
120 V temperature/continuity transmitter with wall-mount power connection enclosure	SPC-W-1	P000001051
208–277 V temperature/continuity transmitter with wall-mount power connection enclosure	SPC-W-2	P000001052
120 V temperature/continuity transmitter	SES-RTD-1	265212-000
208–277 V temperature/continuity transmitter	SES-RTD-2	677596-000
120 V continuity transmitter	SES-CONT-1	293536-000
208–277 V continuity transmitter	SES-CONT-2	398720-000
120 V Smart End Seal replacement transmitter board	SES-TT-1	815918-000
208–277 V Smart End Seal replacement transmitter board	SES-TT-2	771274-000
Smart End Seal Replacement RTD and stand assembly	SES-RTD-Replace	693618-000
Power Line Carrier Interface: Auxiliary Equipment		
Front End Filter – 480 V	MONI-700-FEF-480 V	922847-000
Front End Filter – 600 V	MONI-700-FEF-600 V	P000000312
PLI Module	PLI	488323-000
RTD lead wire, per 1000 ft reel	MONI-RTD-WIRE	962661-000
RS-485 comm. wire, per 1000 ft reel	MONI-RS485-WIRE	549097-000

ORDERING DETAILS

NGC-30 – Output – No. of Control Points – Enclosure – Voltage – Panelboard – Breaker or SSR or EMR – MCB – Options

NGC-30 – XXX – XX – XXX – XXX/XXX – XX – XX/XX (XX) – XXX – X

Output

EMR = Electro-mechanical relay
SSR = Solid-state relay

No. of control points

5, 10, 15, 20, 25, 30, 35, 40

Enclosure

12 = NEMA 12 (indoors; painted steel)
4 = NEMA 4/3R (outdoors; painted steel)
4X = NEMA 4X/3RX (outdoors; stainless steel)

Voltage

120 / 208 Vac
120 / 240 Vac[1]
277 / 480 Vac
347 / 600 Vac

Panelboard

0 = none required

	Panelboard size			
# of control points	120/208 Vac	120/240 Vac	277/480 Vac	347/600 Vac
5	12	12	18	18
10	24	20/30	18/30	18/24
15, 20	30/42	30/42	30/42	30/42
25, 30	30/42	30/42	30/42	30/42
35, 40	42	42	42	42

[1] Single phase
[2] Require remote NGC-UIT-ORD-12
[3] Special - Describe special requirement in detail.
[4] Applies to Canada only

Options

Country Installed
US = U.S. and Americas (except Canada) [default]
CA = Canada
E = Environmental purge
H = Electric heater
N = No UIT installed[2] (a remote NGC-UIT2-ORD-R can be ordered separately)
PL = PLI Module with 3-pole standard breaker (EMR option panel only)
U = If EMR, or SSR with panelboard, then NGC-UIT2-ORD installed (ordinary area)
If SSR without panel, or Z purged, then NGC-UIT2-HAZ installed (hazardous area)
V = Voltage monitoring (subtracts one control point)
X = Spare parts
Z = Z purge (EMR only; Class 1, Division 2 Hazardous Area)
SP = Special[3]

Main circuit breaker

0 = none required (choose if no panelboard required)

Panelboard size	120/208 Vac	120/240 Vac	277/480 Vac	347/600 Vac
12	50, 100	50, 80, 100	–	–
18	–	–	30, 50 , 70, 125	20, 40, 60, 90
20	–	50, 80, 100	–	–
24	50, 100	–	–	20, 40, 60, 90
30	50, 100, 150, 225	50, 80, 175, 225	50, 70, 125, 175, 225	40, 60, 90, 150, 200
42	50, 100, 150, 225	50, 80, 175, 225	50, 70, 125, 175, 225	40, 60, 90, 150, 200

Breaker or SSR or EMR

Breaker

No. of C.B./No. of poles (ampere rating)

No. of control points	Panelboard size	120 Vac (1P)	208 Vac (2P)	240 Vac (2P)	277 Vac (1P)	480 Vac (2P)	347 Vac (1P)	600 Vac (2P)
5	12	5	5	5				
5	18	5[4]	5[4]	5[4]	5	5	5	5
10	18	–	–	–	10	6	10	6
10	20	10	–	9	–	–	–	–
10	24	10	10	–	–	–	10	10
10	30	–	–	10	–	–	–	–
15	30	15	14	14	15	13	15	13
15	42	–	15	15	–	15	–	15
20	30	20	9	9	20	8	20	8
20	42	–	20	20	–	20	–	20
25	30	25	4	4	25	4	25	4
25	42	25	16	16	25	15	25	15
30	30	30	–	–	30	–	30	–
30	42	–	10	10	–	10	–	10
35	42	35	6	6	35	5	35	5
40	42	40	–	–	40	–	40	–

Note: The quantity of breakers must be equal to the number of control points.

SSR without panelboard

Select no. of output devices (SSRs)/ no. of poles/amperage

Output devices:	5 – 40
Poles:	1P or 2P
Amperage:	30, 60

EMR without panelboard

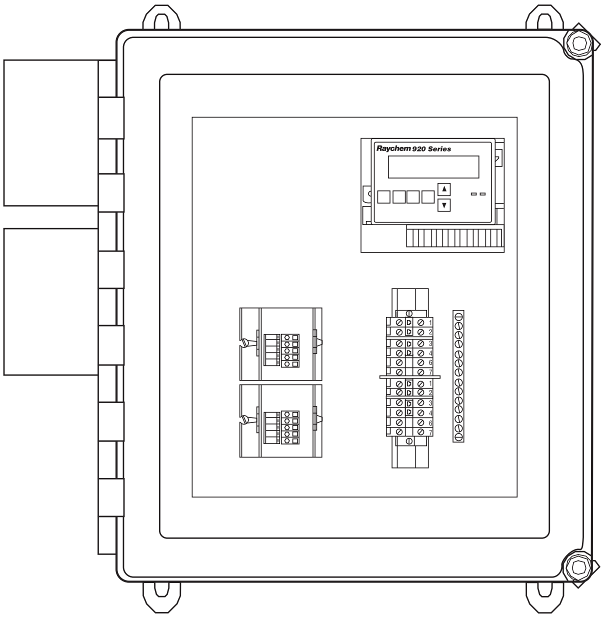
Select no. of output devices (EMRs)/ amperage

Output devices:	5 – 40
Amperage:	30, 60

920 SERIES

nVent RAYCHEM

DUAL-POINT HEAT-TRACING CONTROL SYSTEM



920*E4FWL*SIS302*SS3102 shown

PRODUCT OVERVIEW

The nVent RAYCHEM 920 is a compact, full-featured, microprocessor-based, dual-point heat-tracing control system. The 920 provides control and monitoring of two independent electrical heat-tracing circuits for both freeze protection and temperature maintenance, and can be set to monitor and alarm for high and low temperature, high and low current, ground-fault level, and voltage on each of its control points. The 920 controller is available with two output types: an electromechanical relay (EMR) for use in nonhazardous locations and a solid-state relay (SSR) for use in nonhazardous and Class I Div. 2/Zone 2 hazardous locations. Communications modules are available for remote control and configuration, complete with nVent RAYCHEM Supervisor software capability.

Control

The 920 measures temperatures with 3-wire 100-ohm platinum RTDs connected directly to the unit. Up to two RTDs are supported for each of the two control points. The controller may be used in line-sensing, ambient-sensing, proportional ambient-sensing, and power-limiting modes.

Monitoring

A variety of parameters are measured, including ground fault, temperature, and current to ensure system integrity. The system can be set to periodically check the heating cable for faults, alerting maintenance personnel of a heat-tracing problem.

A dry contact relay is provided for alarm annunciation back to a distributed control system (DCS).

Ground-fault protection

National electrical codes require ground-fault equipment protection on all heat-tracing circuits. The 920 controllers incorporate the ground-fault sensing, alarm, and trip functionality internally. Heat-tracing circuits equipped with 920 controllers do not require additional ground-fault detection equipment, simplifying installation and reducing costs.

Installation

The standard 920 unit comes ready to install right from the box, eliminating the need for custom panel design or field assembly. Custom configurations are also available from the factory to allow the user to tailor the solution to the application.

The TYPE 4X-rated FRP or optional stainless steel enclosures are approved for use in indoor and outdoor locations. Wiring is as simple as connecting the incoming and outgoing power wiring (up to 600 Vac) and an RTD.

The 920 operator console includes LED displays and function keys that make it easy to use and program. No additional handheld programming devices are needed. Alarm conditions and programming settings are easy to interpret on the full-text front panel. Settings are stored in nonvolatile memory in the event of power failure.

Communications

920 units may be networked to a host PC running Windows®-based Supervisor software for central programming, status review, and alarm annunciation. 920 units support the Modbus® protocol and may be ordered with an RS-485 communications interface.

GENERAL

Area of use	Nonhazardous locations (EMR versions) Nonhazardous and Division 2 hazardous locations (SSR versions)	
Approvals	**Nonhazardous locations** (SSR and EMR versions)	**Hazardous locations** (SSR versions only) Class I, Div. 2, Groups A, B, C, D Ex nA IIC T-code: T4 (T3A with optional alarm light)
Supply voltage	100 Vac to 277 Vac, +5% / –10%, 50/60 Hz Ctommon supply for controller and heat-tracing circuit Up to 600 Vac for heat-tracing circuit when controller is powered from a separate circuit or when transformer option is included	

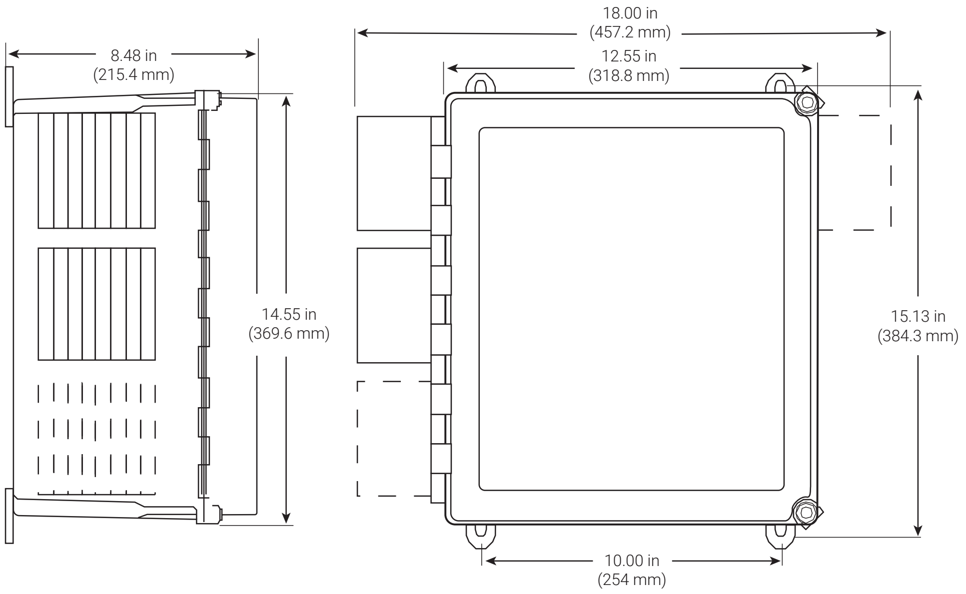
ENCLOSURE

Protection	TYPE 4X
Materials	FRP or optional stainless steel
Ambient operating temperature range	–40°F to 140°F (–40°C to 60°C)
Ambient storage temperature range	–40°F to 185°F (–40°C to 85°C)
Relative humidity	0% to 90%, noncondensing

CONTROL

Relay types	3-pole, mechanical (EMR versions) 1-, 2-, or 3-pole solid-state, normally open (SSR versions)
Voltage, maximum	277 Vac nominal, 50/60 Hz (standard), 600 Vac nominal (optional)
Current, maximum	30 A @ 104°F (40°C) (standard) For ratings at higher ambient temperatures, contact the factory. 60 A @ 104°F (40°C) (optional)
Control algorithms	EMR: Line sensing on/off, proportional ambient SSR: Line sensing on/off, proportional, proportional ambient, power limiting, soft start
Control range	–76°F to 1058°F (–60°C to 570°C)

TYPICAL ENCLOSURE DIMENSIONS



**920*E4FWL*SIS302*SS3102 (1 pole model) shown
920*E4FWL*SIS302*SS3202 (2 pole model)**

MONITORING (EACH CONTROL POINT)

Temperature	Low alarm range High alarm range	–76°F to 1058°F (–60°C to 570°C) or OFF –76°F to 1058°F (–60°C to 570°C) or OFF
Ground fault	Alarm range Trip range	20 mA to 250 mA or OFF 20 mA to 250 mA or OFF
Current	Low alarm range High alarm range Power limit	0.3 A to 100 A or OFF 0.3 A to 100 A or OFF 3 W to 33 kW
Voltage	Low alarm range High alarm range	10 V to 330 V or OFF 10 V to 330 V or OFF
Resistance	Low resistance range High resistance range	1% to 100% of deviation from nominal 1% to 250% of deviation from nominal
Autocycle	Diagnostic test interval adjustable from 1 to 240 minutes or 1 to 240 hours	

TEMPERATURE SENSOR INPUTS (EACH CONTROL POINT)

Quantity	Two inputs standard
Types	100 Ω platinum RTD, 3-wire, α = 0.00385 ohms/ohm/°C Can be extended with a 3-conductor shielded cable of 20 Ω maximum per conductor 100 Ω Ni-Fe RTD, 2-wire

ALARM OUTPUTS

Dry contact relay	Pilot duty only, 48 Vac/dc, 500 mA maximum, 10 VA maximum resistive switching

Note: Output is configurable as “open on alarm” or “close on alarm”

PROGRAMMING AND SETTING

Method	Programmable keypad or communications
Units	°F or °C
Digital display (using optional operator console)	Actual temperature, control temperature, heater current, voltage, resistance, ground fault, programming parameter values, alarm values
LEDs	Power on, heater(s) on, alarm conditions, receive/transmit data (standard) Current mode, heater(s) on, alarm conditions, receive/transmit data (using optional operator console)
Memory	Nonvolatile, restored after power loss, checksum data checking
Stored parameters (measured)	Minimum and maximum process temperature, maximum ground-fault current, maximum heater current, power accumulator, contactor cycle count, time in use
Alarm conditions	Low/high temperature, low/high current, low/high voltage, low/high resistance Ground-fault alarm, trip RTD failure, loss of programmed values, or EMR or SSR failure
Other	Multi-language support Password protection

CONNECTION TERMINALS

Power supply input	Screw terminals, 22–8 AWG (30 A versions), 14–6 AWG (60 A versions)
Heating cable output	Screw terminals, 22–8 AWG (30 A versions), 14–6 AWG (60 A versions)
Ground	14–4 AWG ground bar
RTD/alarm/communications	28–12 AWG spring clamp terminals

MOUNTING

2 point FRP enclosure	Surface mounting with four fixing holes on 15.1 in x 10 in (384 mm x 254 mm) centers Hole diameter: 0.31 in (8 mm)
4 point FRP enclosure	Surface mounting with four fixing holes on 17.1 in x 12 in (435 mm x 305 mm) centers Hole diameter: 0.31 in (8 mm)
8 point FRP enclosure	Surface mounting with four fixing holes on 31.3 in x 21.9 in (795 mm x 556 mm) centers Hole diameter: 0.40 in (10 mm)
20 point FRP enclosure	Surface mounting with four fixing holes on 41.2 in x 30.2 in (1047 mm x 767 mm) centers Hole diameter: 0.40 in (10 mm)

COMMUNICATIONS (OPTIONAL)

Protocol	Modbus RTU or ASCI I / HTCBus
Topology	Multidrop, daisy chain
Cable	Single shielded twisted pair, 26 AWG or larger
Length	1.7 miles (2.7 km) maximum @ 9600 baud
Quantity	Up to 32 devices without repeater
Address	Programmable

ORDERING DETAILS

920 Series Dual-point Heat-Tracing Control System

Description	Catalog number	Part number	Weight/lbs
920 controller–2 Pt in a 14" x 12" x 8" **FRP** enclosure with window and quick-release latches, control module, and operator console. 1P 30 A 277 V SSR/pt. Controls two circuits, each with a 1-pole solid-state relay. (Approved for Class I, Div. 2 locations)	920*E4FWL*SIS302*SS3102*HTC*CON	10160-010	27
920 controller–2 Pt in a 14" x 12" x 8" **FRP** enclosure with window and quick-release latches, control module, and operator console. Includes an isolated 2-wire RS-485 communication option. 1P 30 A 277 V SSR/pt. Controls two circuits, each with a 1-pole solid-state relay. (Approved for Class I, Div. 2 locations)	920*E4FWL*SIS302*SS3102*HTC485*CON	10160-011	27
920 controller–2 Pt in a 14" x 12" x 8" **FRP** enclosure with window and quick-release latches, control module, and operator console. 2P 30 A 277 V SSR/pt. Controls two circuits, each with a 2-pole solid-state relay. (Approved for Class I, Div. 2 locations)	920*E4FWL*SIS302*SS3202*HTC*CON	10160-012	32
920 controller–2 Pt in a 14" x 12" x 8" **FRP** enclosure with window and quick-release latches, control module, and operator console. Includes an isolated 2-wire RS-485 communication option. 2P 30 A 277 V SSR/pt. Controls two circuits, each with a 2-pole solid-state relay. (Approved for Class I, Div. 2, locations)	920*E4FWL*SIS302*SS3202*HTC485*CON	10160-013	32
RAYCHEM-Supervisor Software	Available for download at nVent.com/RAYCHEM		

ORDERING DETAILS

920 Series Dual-point Heat-Tracing Control System

Description	Catalog number	Part number	Weight/lbs
Control Modules—Requires one for every two control points			
920 controller–Control module only (No communications options installed)	920HTC	10260-001	1
920 controller–Control module with an isolated 2-wire RS-485 communication option installed	920HTC*485	10260-004	1
OPERATOR CONSOLE—Requires at least one per panel			
920 controller–Operator console	920CON	10260-005	1
RTD Sensors			
100-ohm platinum RTD with 10 foot stainless-steel corrugated sheath	RTD10CS	RTD10CS	1.0
RTD, ambient, cable style	RTD-200	254741	0.1
C1D1 RTD, –100°F to 900°F, pipe mounted	RTD7AL	RTD7AL	2.0
RTD, –100°F to 900°F, pipe mounted	RTD4AL	RTD4AL	1.2

ORDERING DETAILS

920 Series Dual-point Heat-Tracing Control System

Description	Catalog number	Part number	Weight/lbs

920 * Enclosure * Sensing Components * Output Devices * Options * Controller Parts * Console

920 * E10FWQ1 * SIS308 * SS3208 * PR1 * HTC * CON

Enclosure

Enclosure Dimension
Dependent on configuration

Enclosure Material
FW = Fiberglass / Window
SW = Stainless Steel / Window
AW = Aluminum / Window

Type of Latches
Q = Quarter (1/4) turn latch
L = Quick release latch

Sensing Components

Type of Interface
SIS = SSR
SIC = Contactor

Amperage
3 = 30 A
6 = 60 A

Number of Circuits
1 - 20
- greater than 20, special

Console
CON

Controller Parts
HTC
HTC*MDM (with modem)
HTC*485 (with RS-485)

Options
PR1 = 120 V alarm light with red lens
ALM = 120 V ~ 277 V SSR alarm relay
HRM = 120/240 V hermetically sealed 2FormC alarm relay
LAM = Lamacoid label on enclosure door (Provide details)
AMBRTD1 = Ambient RTD installed in 1/2/4/8 cct enclosure
TWR = Temp bus circuit prewired to terminal board
OWR = Override (Wiring)

Output Devices

Number of Circuits
1 - 20
- greater than 20, special

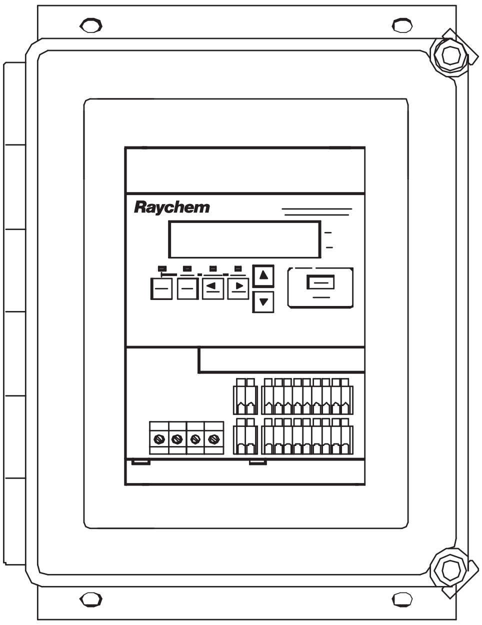
Number of Poles
(1, 2, or 3)

Amperage
3 = 30 A
6 = 60 A
* must correspond with sensing component amperage

Type of Interface
SS = Solid State Relay
C = Contactor
* must correspond with sensing component interface
SIS = SS/SSH
SIC = C

910 Series

SINGLE-POINT HEAT-TRACING CONTROL SYSTEM



910*E1FWL*SSR2

PRODUCT OVERVIEW

The nVent RAYCHEM 910 is a compact, full-featured, microprocessor-based, single-point heat-tracing control system. The 910 provides control and monitoring of electrical heat-tracing circuits for both freeze protection and temperature maintenance, and can be set to monitor and alarm for high and low temperature, high and low current, ground- fault level, and voltage.

The 910 controller is available with two output types: an electromechanical relay (EMR) for use in nonhazardous locations, and a solid-state relay (SSR) for use in nonhazardous and Class I Div. 2 / Zone 2 hazardous locations. Communications modules are available for remote control and configuration, complete with RAYCHEM Supervisor software capability.

Control
The 910 measures temperature with one or two 3-wire 100-ohm platinum RTD(s) connected directly to the unit. The controller may be used in line-sensing, ambient-sensing, proportional ambient-sensing, and power-limiting modes.

Monitoring
A variety of parameters are measured, including ground fault, temperature, and current to ensure system integrity. The system can be set to periodically check the heating cable for faults, alerting maintenance personnel of a heat-tracing problem.

Both an isolated solid-state triac relay and a dry contact relay are provided for alarm annunciation back to a distributed control system (DCS).

Ground-fault protection
National electrical codes require ground-fault equipment protection on all heat-tracing circuits. The 910 controllers incorporate the ground-fault sensing, alarm, and trip functionality internally. Heat-tracing circuits equipped with 910 controllers do not require additional ground-fault detection equipment, simplifying installation and reducing costs.

Installation

The 910 unit comes ready to install right from the box, eliminating the need for custom panel design or field assembly. The TYPE 4X-rated FRP or stainless steel enclosure is approved for use in indoor and outdoor locations. Wiring is as simple as connecting the incoming and outgoing power wiring (up to 277 Vac) and an RTD.

The 910 operator interface includes LED displays and function keys that make it easy to use and program. No additional handheld programming devices are needed. Alarm conditions and programming settings are easy to interpret on the full-text front panel. Settings are stored in nonvolatile memory in the event of power failure.

Communications

910 units may be networked to a host PC running Windows®-based nVent RAYCHEM Supervisor software for central programming, status review, and alarm annunciation. 910 units support the Modbus® protocol and may be ordered with an RS-485 communications interface.

GENERAL

Area of use	Nonhazardous locations (EMR versions) Nonhazardous and Division 2 hazardous locations (SSR versions)	
Approvals	**Nonhazardous locations** (SSR and EMR versions) C US	**Hazardous locations** (SSR versions only) C US Class I, Div. 2, Groups A, B, C, D Ex nA IIC T-code: T4
Supply voltage	100 Vac to 277 Vac, +5 / –10%, 50/60 Hz Common supply for controller and heat-tracing circuit	

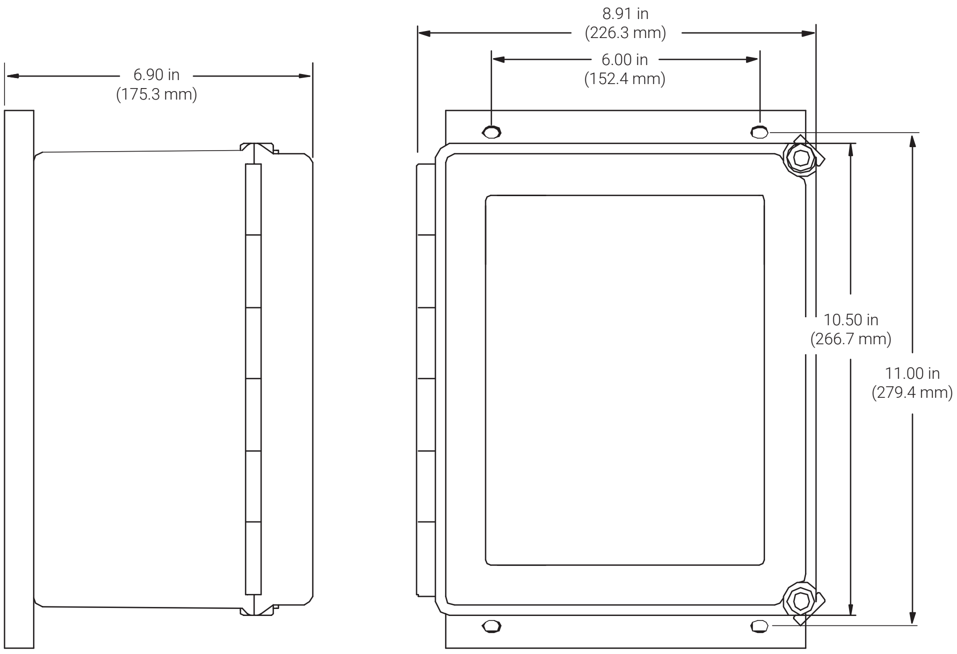
ENCLOSURE

Protection	TYPE 4X
Materials	FRP or stainless steel
Ambient operating temperature range	–40°F to 140°F (–40°C to 60°C)
Ambient storage temperature range	–40°F to 185°F (–40°C to 85°C)
Relative humidity	0% to 90%, noncondensing

CONTROL

Relay type	Double-pole, mechanical (EMR versions) Double-pole, solid-state, normally open (SSR versions)
Voltage, maximum	277 Vac nominal, 50/60 Hz
Current, maximum	30 A @ 104°F (40°C) derated to 20 A @ 140°F (60°C) (EMR) 30 A @ 104°F (40°C) derated to 15 A @ 140°F (60°C) (SSR)
Control algorithms	EMR: Line sensing on/off, proportional ambient SSR: Line sensing on/off, proportional, proportional ambient, power limiting, soft start
Control range	–76°F to 1058°F (–60°C to 570°C)

TYPICAL ENCLOSURE DIMENSIONS



910*E1FWL*SSR2 shown

MONITORING

Temperature	Low alarm range	–76°F to 1058°F (–60°C to 570°C) or OFF
	High alarm range	–76°F to 1058°F (–60°C to 570°C) or OFF
Ground fault	Alarm range	20 mA to 250 mA or OFF
	Trip range	20 mA to 250 mA or OFF
Current	Low alarm range	0.3 Amps to 100 Amps or OFF
	High alarm range	0.3 Amps to 100 Amps or OFF
	Power limit	3 W to 33 kW
Voltage	Low alarm range	10 V to 330 V or OFF
	High alarm range	10 V to 330 V or OFF
Resistance	Low resistance range	1% to 100% of deviation from nominal
	High resistance range	1% to 250% of deviation from nominal
Autocycle	Diagnostic test interval adjustable from 1 to 240 minutes or 1 to 240 hours	

TEMPERATURE SENSOR INPUTS

Quantity	Two inputs standard
Types	100 Ω platinum RTD, 3-wire, α = 0.00385 ohms/ohm/°C Can be extended with a 3-conductor shielded cable of 20 Ω maximum per conductor 100 Ω Ni-Fe RTD, 2-wire

ALARM OUTPUTS

AC relay	Isolated solid-state triac, SPST, 0.75 A maximum, 100 Vac to 277 Vac nominal
Dry contact relay	Pilot duty only, 48 Vac/dc, 500 mA maximum, 10 VA maximum resistive switching

Note: Outputs are configurable as “open on alarm” or “close on alarm”

PROGRAMMING AND SETTING

Method	Programmable keypad
Units	°F or °C
Digital display	Actual temperature, control temperature, heater current, voltage, resistance, ground fault, programming parameter values, alarm values
LEDs	Current mode, heater on, alarm condition, receive / transmit data
Memory	Nonvolatile, restored after power loss, checksum data checking
Stored parameters (measured)	Minimum and maximum process temperature, maximum ground-fault current, maximum heater current, power accumulator, contactor cycle count, time in use
Alarm conditions	Low / high temperature, low / high current, low / high voltage, low / high resistance Ground-fault alarm, trip RTD failure, loss of programmed values, or EMR or SSR failure
Other	Multi-language support Password protection

CONNECTION TERMINALS

Power supply input	Screw terminals, 22–8 AWG
Heating cable output	Screw terminals, 22–8 AWG
Ground	Two box lugs, 14–6 AWG
RTD/alarm/communications	28–12 AWG spring clamp terminals

MOUNTING

FRP enclosure	Surface mounting with four fixing holes on 6.0 in x 11.0 in (152 mm x 279 mm) centers. Hole diameter: 0.31 in (8 mm)
SS enclosure	Surface mounting with four fixing holes on 5.31 in x 11.4 in (135 mm x 290 mm) centers. Hole diameter: 0.25 in (6.4 mm)

COMMUNICATIONS (OPTIONAL)

Protocol	Modbus RTU or ASCI I / HTCBus
Topology	Multidrop, daisy chain
Cable	Single shielded twisted pair, 26 AWG or larger
Length	1.7 miles (2.7 km) maximum @ 9600 baud
Quantity	Up to 32 devices without repeater
Address	Programmable

ORDERING DETAILS

910 Single-point Heat-Tracing Control System

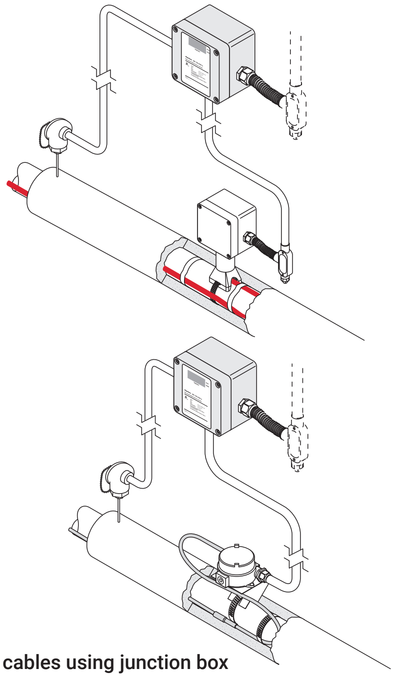
Description	Catalog number	Part number	Weight/lbs
910 controller in an 8 in x 10 in **FRP** enclosure with window. 2-pole 30 A EMR. Controls a single circuit with a 2-pole electromechanical relay. (Approved for nonhazardous locations only)	910*E1FWL*EMR2	10170-001	15
910 controller in an 8 in x 10 in **FRP** enclosure with window. 2-pole 30 A EMR. Controls a single circuit with a 2-pole electromechanical relay. Includes an isolated 2-wire RS-485 communication option. (Approved for nonhazardous locations only)	910*E1FWL*EMR2*485	10170-015	15
910 controller in an 8 in x 10 in **FRP** enclosure with window. 2-pole 30 A 277 V SSR. Controls a single circuit with a 2-pole solid-state relay. (Approved for Class I, Div. 2 locations)	910*E1FWL*SSR2	10170-002	20
910 controller in an 8 in x 10 in **FRP** enclosure with window. 2-pole 30 A 277 V SSR. Controls a single circuit with a 2-pole solid-state relay. Includes an isolated 2-wire RS-485 communication option. (Approved for Class I, Div. 2 locations)	910*E1FWL*SSR2*485	10170-016	20
910 controller in an 8 in x 10 in **stainless steel** enclosure with window. 2-pole 30 A EMR. Controls a single circuit with a 2-pole electromechanical relay. (Approved for nonhazardous locations only)	910*E1SW*EMR2	10170-003	20
910 controller in an 8 in x 10 in **stainless steel** enclosure with window. 2-pole 30 A EMR. Controls a single circuit with a 2-pole electromechanical relay. Includes an isolated 2-wire RS-485 communication option. (Approved for nonhazardous locations only)	910*E1SW*EMR2*485	10170-017	20
910 controller in an 8 in x 10 in **stainless steel** enclosure with window. 2-pole 30 A 277 V SSR. Controls a single circuit with a 2-pole solid-state relay. (Approved for Class I, Div. 2 locations)	910*E1SW*SSR2	10170-004	25
910 controller in an 8 in x 10 in **stainless steel** enclosure with window. 2-pole 30 A 277 V SSR. Controls a single circuit with a 2-pole solid-state relay. Includes an isolated 2-wire RS-485 communication option. (Approved for Class I, Div. 2 locations)	910*E1SW*SSR2*485	10170-018	25
RAYCHEM – Supervisor Software	Available for download at nVent.com		

RTD SENSORS

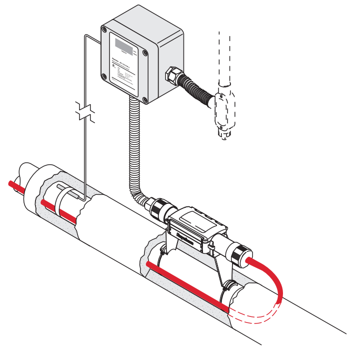
100-ohm platinum RTD with 10 foot stainless steel corrugated sheath	RTD10CS	RTD10CS	1.0
RTD, ambient, cable style	RTD-200	254741	0.1
C1D1 RTD, –100°F to 900°F, pipe mounted	RTD7AL	RTD7AL	2.0
RTD, –100°F to 900°F, pipe mounted	RTD4AL	RTD4AL	1.2

JBS-100-ECW-A

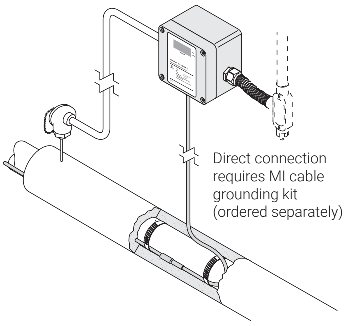
WALL-MOUNTED DIGITAL ELECTRONIC CONTROLLER FOR NONHAZARDOUS LOCATIONS



Heating cables using junction box



Heating cables using RayClic connection kit



Direct connection requires MI cable grounding kit (ordered separately)

MI heating cable using direct connection

PRODUCT OVERVIEW

The nVent RAYCHEM JBS-100-ECW-A is an electronic temperature controller that provides accurate control for all heating cables.

Housed in a TYPE 4X enclosure and designed to be wall mounted, the unit includes a window and a digital display that shows the monitored actual/set point temperatures and alarm conditions (RTD failure, high or low temperature) if detected. Alarm conditions can be remotely indicated via a form C dry contact. Status LEDs indicate whether the digital display is showing the set point or actual temperature.

Programming the set point temperature, deadband, and high and low alarm thresholds on the JBS-100-ECW-A is accomplished using the built-in digital display and push buttons.

The JBS-100-ECW-A is programmable to maintain temperatures of 425°F (218°C), can be used with voltages from 100 to 277 Vac, and is capable of switching current up to 30 Amps.

Temperature data is provided by a customer supplied 100-ohm platinum RTD, which can provide feedback for either temperature maintenance or ambient sensing for freeze protection.

The kit contains all the necessary materials for a complete installation. For a direct connection to a nVent RAYCHEM MI cable, eliminating the need for a field power connection device, a grounding kit is required (ordered separately).

GENERAL

Approvals	**Nonhazardous locations**
Supply voltage	100–277 Vac ±10% 50–60Hz Common supply for controller and heat tracing circuit

ENCLOSURE

Protection	TYPE 4X
Material	Fiberglass reinforced polyester plastic
Entries	2 x 3/4 in (19 mm) conduit entries for power and heater 1 x 1/2 in (13 mm) conduit entry for RTD sensor
Relative humidity	0% to 90%, noncondensing
Ambient installation and usage temperature	–40°F to 140°F (–40°C to 60°C)

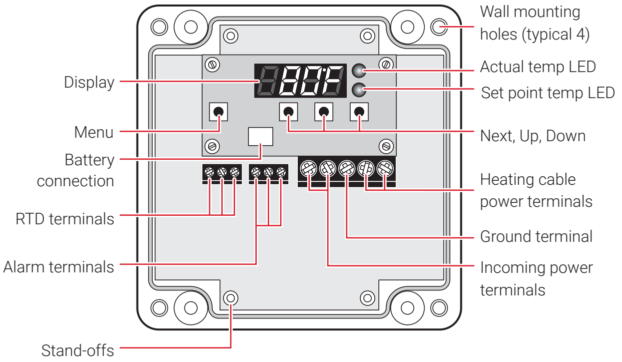
CONTROL

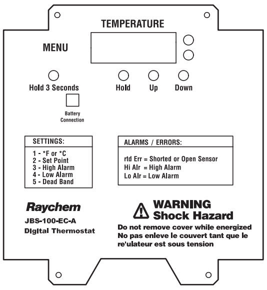
Relay type	Double-pole, mechanical
Control range	32°F to 425°F (0°C to 218°C)
Deadband	Adjustable 2°F to 10°F (2°C to 10°C)
Accuracy	±3°F (1.7°C) of set point

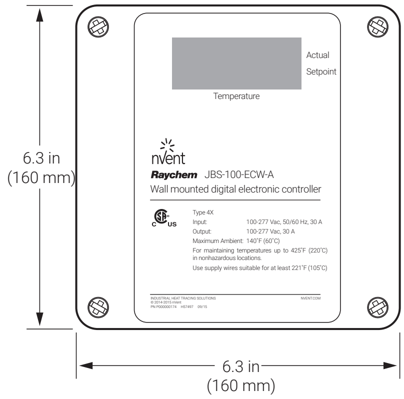
INPUT POWER

Voltage	277 Vac nominal, 50/60 Hz maximum
Current	30 A maximum
Circuit breaker rating	40 A maximum

ENCLOSURE


JBS-100-ECW-A without wire cover


Wire cover


Lid

MONITORING AND ALARM OUTPUT

Temperature	Low alarm range: 20°F–420°F (–6°C–216°C) from set point, or OFF High alarm range: 38°F–482°F (3°C–250°C) from set point, or OFF
RTD failure	Shorted or open RTD sensor
Alarm relay	Form C: 2 A at 277 Vac, 2 A at 48 Vdc Normally energized; changes state upon an alarm
Voltage	Alarm relay changes state upon loss of voltage to the controller

TEMPERATURE SENSOR (NOT INCLUDED)

Input type	100 Ω platinum RTD, 3 wire α = 0.00385 Ω/Ω/°C

PROGRAMMING AND SETTING

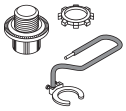
Method	Programmable at controller – Set/Up/Down push buttons on front panel
Units	°F or °C
Digital display	Four numeric display digits for parameter and error/alarm indication
LEDs	Indicate actual and set point from display
Memory	Nonvolatile, restored after power loss
Stored parameters	Parameters can be programmed without power supply (external battery) and parameters are stored in nonvolatile memory.
Alarm conditions	Low/high temperature and RTD failure (open or shorted)

CONNECTION TERMINALS

Power supply input	Screw rising cage clamp, 18–6 AWG
Heating cable output	Screw rising cage clamp, 18–6 AWG
Ground	Screw rising cage clamp, 18–6 AWG
RTD	Screw rising cage clamp, 22–14 AWG
Alarm	Screw rising cage clamp, 22–14 AWG

ORDERING DETAILS

JBS-100-ECW-A

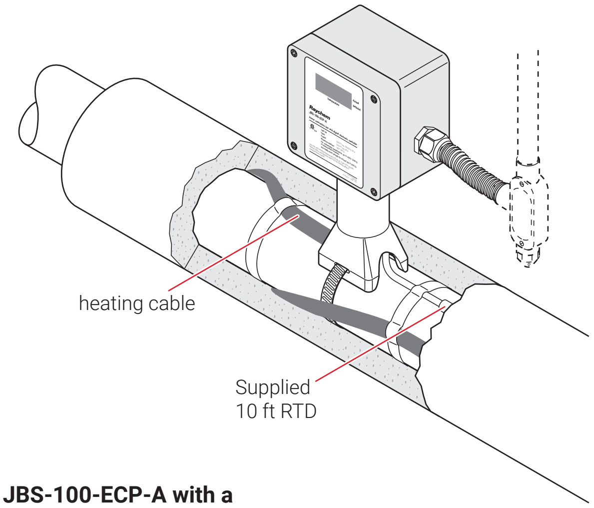
Description	Catalog number	Part number	Weight/lbs
Wall mounted digital electronic controller	JBS-100-ECW-A	P000000181	4.0
Spare Parts and Accessories			
MI cable grounding kit (required if installing MI heating cable) 	MI-GROUND-KIT	P000000279	0.2
Replacement controller unit	JBS-100-EC	P000000217	1.0

JBS-100-ECP-A

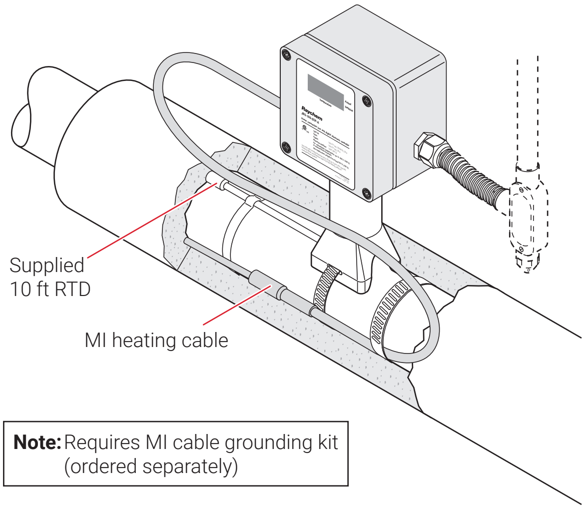
nVent
RAYCHEM

COMBINATION POWER CONNECTION BOX AND DIGITAL ELECTRONIC CONTROLLER FOR NONHAZARDOUS LOCATIONS

JBS-100-ECP-A with a heating cable



JBS-100-ECP-A with a MI heating cable



Note: Requires MI cable grounding kit (ordered separately)

PRODUCT OVERVIEW

The nVent RAYCHEM JBS-100-ECP-A is a power connection/ electronic controller combination for nVent RAYCHEM polymeric and MI cables. Utilizing the features of the JBS-100-A single-entry power connection with junction box, along with an indicating electronic controller, this assembly allows for local control of a heating circuit.

The assembly includes a window and a digital display that shows the monitored actual/set point temperatures and alarm conditions (RTD failure, high or low temperature) if detected. Alarm conditions can be remotely indicated via a form C dry contact. Status LEDs indicate whether the digital display is showing the set point or actual temperature.

Programming the set point temperature, deadband, and high and low alarm thresholds on the JBS-100-ECP-A is accomplished using the built-in digital display and push buttons.

The JBS-100-ECP-A is programmable to maintain temperatures of 425°F (218°C), can be used with voltages from 100 to 277 Vac, and is capable of switching current up to 30 Amps.

A 100-ohm platinum RTD provides feedback for either pipe maintenance or ambient sensing for freeze protection

The power connection/electronic controller combination significantly reduces installation cost. Eliminating wiring and devices to connect separate power connections and thermostats/controllers not only reduces material cost, but also leads to significant labor savings when combined with the cold-applied core sealer and spring clamp terminals characteristic of the JBS-100 line of power connection kits.

The kit contains all the necessary materials for a complete installation except one pipe strap, which must be ordered separately. For connection to a nVent RAYCHEM MI cable, a grounding kit is required (ordered separately).

GENERAL

Heating cable compatibility	nVent RAYCHEM BTV-CR, XL-Trace, BTV-CT, QTVR-CT, XTV-CT, KTV and VPL-CT Design A & D MI cables (requires MI cable grounding kit – ordered separately)
Approvals	**Nonhazardous locations** c US
Supply voltage	100–277 Vac ±10% 50–60 Hz Common supply for controller and heat-tracing circuit

ENCLOSURE

Protection	TYPE 4X
Material	Fiberglass reinforced polyester plastic
Entries	1 x 3/4 in (19 mm) conduit entries for power 1 x 1/2 in (13 mm) conduit entry (with plug) for MI cable entry or alarm wiring
Relative humidity	0% to 90%, noncondensing
Ambient installation and usage temperature	–40°F to 140°F (–40°C to 60°C)
Maximum pipe temperature	Intermittent 482°F (250°C), continuous 425°F (218°C)

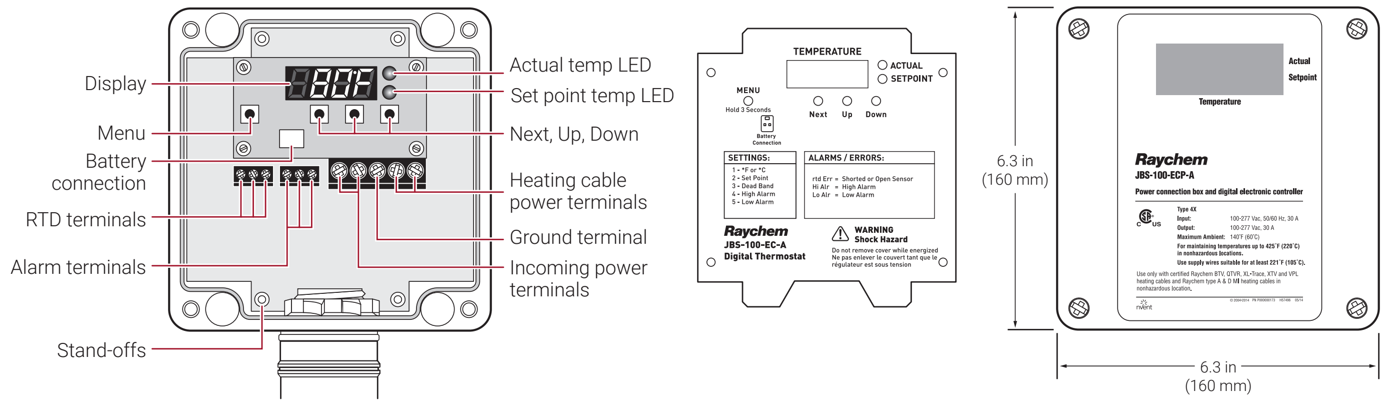
CONTROL

Relay type	Double-pole, mechanical
Control range	32°F to 425°F (0°C to 218°C)
Deadband	Adjustable 2°F to 10°F (2°C to 10°C)
Accuracy	±3°F (1.7°C) of set point

INPUT POWER

Voltage	277 Vac nominal, 50/60 Hz maximum
Current	30 A maximum
Circuit breaker rating	40 A maximum

ENCLOSURE



JBS-100-ECP-A without wire cover

Wire cover

Lid

MONITORING AND ALARM OUTPUT

Temperature	Low alarm range: 20°F–420°F (–6°C–216°C) from set point, or OFF High alarm range: 38°F–482°F (3°C–250°C) from set point, or OFF
RTD failure	Shorted or open RTD sensor
Alarm relay	Form C: 2 A at 277 Vac, 2 A at 48 Vdc Normally energized; changes state upon an alarm
Voltage	Alarm relay changes state upon loss of voltage to the controller

RTD TEMPERATURE SENSOR

Sensor sheath	316 stainless-steel housing, 4 in (100 mm) length, 0.25 in (6 mm) outer diameter
Material	Platinum 100 ohms at 0°C α = 0.00385 ohms/ohm/°C
Leads	24 AWG stranded, Teflon PFA insulated

RTD TEMPERATURE SENSOR

Lead length	10 ft (3 m)
Exposure temperature	Minimum: −40°F (−40°C) Maximum: Intermittent 482°F (250°C), continuous 425°F (218°C)
Accuracy	±1°F (0.5°C) at 32°F (0°C)

PROGRAMMING AND SETTING

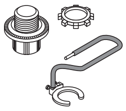
Method	Programmable at controller – Set/Up/Down push buttons on front panel
Units	°F or °C
Digital display	Four numeric display digits for parameter and error/alarm indication
LEDs	Indicate actual and set point from display
Memory	Nonvolatile, restored after power loss
Stored parameters	Parameters can be programmed without power supply (external battery) and parameters are stored in nonvolatile memory.
Alarm conditions	Low/high temperature and RTD failure (open or shorted)

CONNECTION TERMINALS

Power supply input	Screw rising cage clamp, 18–6 AWG
Heating cable output	Screw rising cage clamp, 18–6 AWG
Ground	Screw rising cage clamp, 18–6 AWG
RTD	Screw rising cage clamp, 22–14 AWG
Alarm	Screw rising cage clamp, 22–14 AWG

ORDERING DETAILS

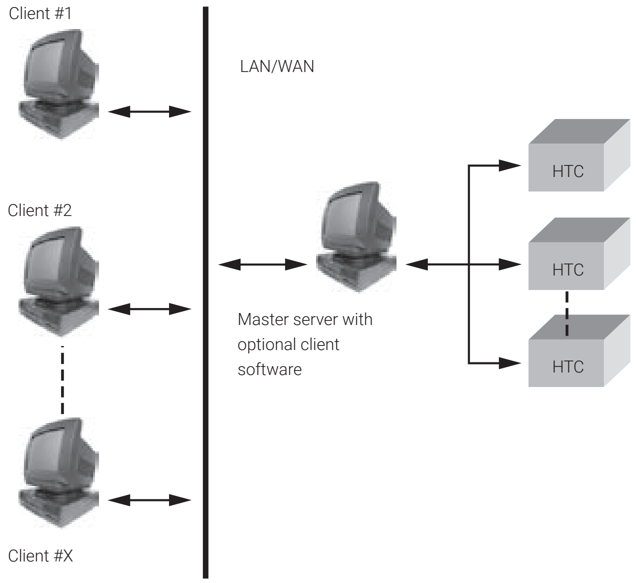
JBS-100-ECP-A

Description	Catalog number	Part number	Weight/lbs
Power connection kit with junction box and digital electronic controller	JBS-100-ECP-A	P000000180	5.0
Spare Parts and Accessories			
MI cable grounding kit (required if installing MI heating cable)	MI-GROUND-KIT	P000000279	0.2
			
Replacement controller unit	JBS-100-EC	P000000217	1.0
Replacement RTD and stand assembly	JBS-RTD-Replace	P000000341	0.8

SUPERVISOR

STANDARD EDITION
HEAT-TRACING CONTROLLER CONFIGURATION AND MONITORING SOFTWARE

Typical single master, multiple-client system



PRODUCT OVERVIEW

The nVent RAYCHEM Supervisor heat-tracing controller configuration and monitoring software provides a graphical user interface for communications and controller products. The software supports one or more NGC series controllers, 780 Series/GCC-9000 Group Communications Controllers, nVent RAYCHEM T2000 AC 2000+ alarm/communications interface cards, and most nVent RAYCHEM controllers supporting the Modbus® protocol.

Supervisor allows central configuration and monitoring of any controller installed in the field that includes the appropriate communications interface.

Full featured alarm monitoring with the ability to acknowledge and clear alarms is provided. Advanced features such as data logging and trending, batch and recipe processing, scheduled events, etc., are also incorporated into the software.

This version of the software includes networking and full multi-user capabilities for up to four users. Electric Heat-Tracing (EHT) system information can now be accessed and managed from almost anywhere in the world, using the latest connectivity technologies. This flexibility can reduce the cost of installing communications to controllers within your facility. Devices are no longer limited to simple hard-wired serial communications, but can now take advantage of existing network infrastructures including Ethernet LANs (Local Area Networks) and Internet-based WANs (Wide Area Networks).

Supervisor — a powerful, integrated management tool for your electric heat-tracing system.

SPECIFICATIONS

System requirements

To install and run the software, you will need:

- Master Server Computer:
  - Pentium® 4 – 2.4 GHz or faster (Recommended), Pentium III– 500 MHz (Minimum) PC
  - A hard disk with at least 500 megabytes of free space (Recommended), 150 megabytes (Minimum)
  - 1 gigabyte of RAM (Recommended), 256 megabytes of RAM (Minimum)
- Client Computer(s):
  - Pentium III – 500 MHz or faster (Recommended), Pentium II– 300 MHz (Minimum) PC
  - A hard disk with at least 50 megabytes of free space
  - 256 megabytes of RAM (Recommended), 128 megabytes of RAM (Minimum)
- CD-ROM drive
- 1 or more available serial ports (for computers that connect to field devices)
- A mouse or other compatible pointing device
- SVGA display with 800 x 600 resolution
- Microsoft Windows® XP Pro SP3 or newer
- Microsoft .NET Framework version 4.0
- Microsoft Windows 7/Vista compatible (32 or 64 bit)
- Network connectivity

Registration

RAYCHEM Supervisor will run for 14 days until you register and activate the software. For more information about how to register, see the RAYCHEM Supervisor Operations Manual (H57576).

Controller compatibility

This software is compatible with any of the following controllers that have the appropriate communications interface installed:

- NGC-40 Bridge, HTC, HTC3 and I/O modules
- NGC-20 Controllers
- NGC-UIT/UIT2 with NGC-30-CRM and -CRMS Controllers
- 910/915/920 Series HTCs
- T2000 systems using AC2000+ communication interfaces
- Legacy systems using GCC-9000/780 Series group communications controllers:
  - 720/HTC-9000/HTC-9000 CAS HTCs
  - 790/HTC-9100 Series HTCs
  - T2000 systems using AC2000 communication interfaces

SPECIFICATIONS

Feature comparison table

• • = Full or enhanced support
• = Limited support

		Supervisor Standard Edition	Supervisor Enterprise Edition
Product Support	NGC-40 Bridge, HTC, HTC3 and I/O Modules	• •	• •
	NGC-20 Controllers	• •	• •
	NGC-UIT/UIT2, NGC-30 Controllers	• •	• •
	910/915/920 Series Controllers	• •	• •
	T2000 Controllers	• •	• •
	Legacy Devices (780/GCC, 720/790/-9000/-CAS/-9100 HTCs)	• •	• •
HTC Connectivity	Serial (RS-232, RS-485)	• •	• •
	Ethernet	• •	• •
	Support for Extended Addressing	• •	• •
	Unique Communications Settings per Device	• •	• •
System Features	Multi-Level Security	• •	• •
	System Mangagement by Plant Group	• •	• •
	Product Configuration	• •	• •
	Real-time Monitoring	• •	• •
	Alarm Scanning/Logging	• •	• •
	Individual User-defined Preferences	• •	• •
	Multi-Level Device Alarm Priorities	• •	• •
Data Management	Enhanced Documentation	• •	• •
	Drawing Viewer	• •	• •
	Data Logging & Trending	• •	• •
	Data Import/Export	• •	• •
	Visual and Printed Reports	• •	• •
	Database Utilities	• •	• •
	History Logging	• •	• •
	System-wide Data Synchronization	• •	• •
	Internal User Messaging	• •	• •
Automation	Batches	• •	• •
	Recipes	• •	• •
	Event Scheduler	• •	• •
	Email on Alarm	• •	• •
	Offline Modes	• •	• •
	Automated Steam-Out Feature	• •	• •
Networking	Multi-User Connections	•[1]	• •
	Muti-server Architectures		• •
	Remote Connectivity (LAN/WAN+VPN)	• •	• •
	Administration Tools	• •	• •

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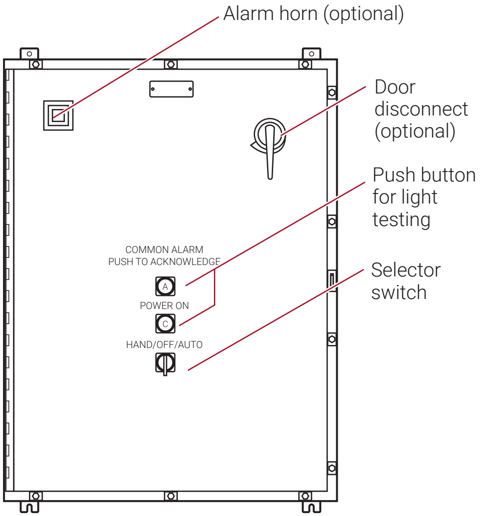
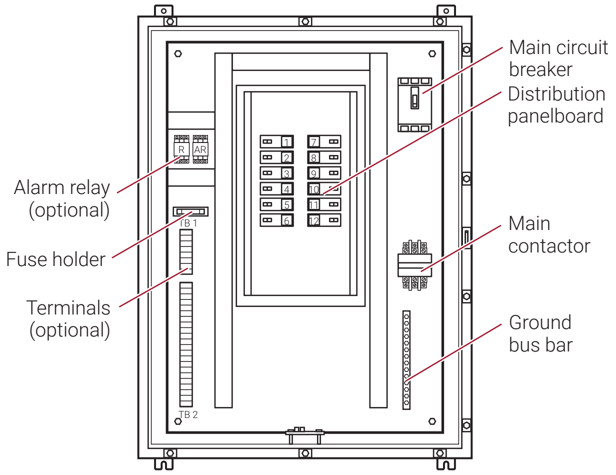
[1] Limited to 4 users (clients)

HTPG

HEAT-TRACING POWER DISTRIBUTION PANEL FOR GROUP CONTROL GROUND-FAULT PROTECTION, MONITORING, AND OPTIONAL ALARM PANEL



Alarm option shown above



PRODUCT OVERVIEW

The nVent RAYCHEM HTPG is a dedicated power distribution, control, ground-fault protection, monitoring, and alarm panel for freeze protection and broad temperature maintenance heat-tracing applications. This wall-mounted enclosure contains an assembled circuit-breaker panelboard.

Panels are equipped with circuit breakers with or without alarm contacts.

The group control package allows the system to operate automatically in conjunction with an external controller/thermostat.

LOAD POWER

120 / 208 / 240 / 277 Vac

AMBIENT OPERATING TEMPERATURE

32°F (0°C) to 122°F (50°C) (without space heater option)

FIELD WIRE SIZE

14–8 AWG (15–30 A), 8–4 AWG (40–50 A)

CIRCUIT BREAKER TYPES

	To comply with NEC Article 427-55(a), circuit breakers are equipped with the means for lockout in the "Off" position.
Ground-fault breaker	Square D types QOB-EPD, EDB-EPD

CIRCUIT BREAKER AMPERAGE RATING

120 Vac	20 A, 30 A, 40 A, 50 A
208 / 240 / 277 Vac	20 A, 30 A, 40 A, 50 A

MAIN CONTACTOR

3 pole

APPROVALS

Intertek

ETL LISTED
CONFORMS TO
ANSI/UL STD. 508
UL STD. 508A

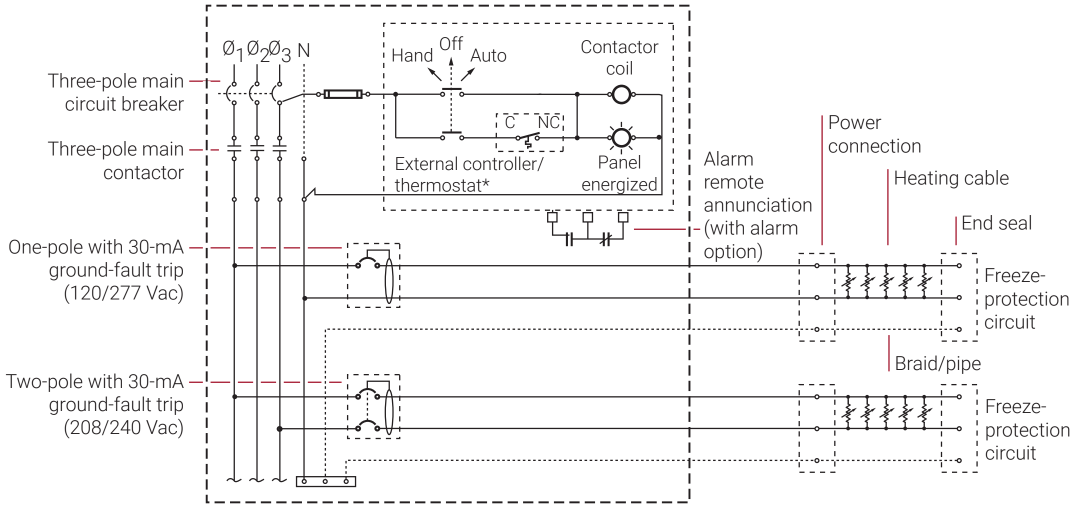
CERTIFIED TO
CAN/CSA C22.2 NO. 14

Intertek

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

HTPG TYPICAL FREEZE-PROTECTION APPLICATION SCHEMATIC



HTPG CATALOG NUMBER

HTPG comes in a variety of configurations. The following chart outlines the elements that constitute a configuration and the corresponding catalog number.

HTPG - Voltage - Panelboard - C.B. type - # of C.B./# of poles (rating) - Enclosure - MCB - Options

HTPG - 277/480 - 30 - 2 - 14/1P (30) - 4X - 200 - H

Voltage

120/208 120/240* 277/480

Panelboard size

18 = 18 space panelboard (277 V only)
30 = 30 space panelboard
42 = 42 space panelboard
54 = 54 space panelboard (277 V only)

Circuit breaker type

2 = GFCB (30-mA trip) without alarm
3 = GFCB (30-mA trip) with bell alarm
4 = GFCB (30-mA trip) with relay alarm (includes terminal block option). Not available for 277 V

Number of circuit breakers/number of poles (circuit breaker rating) see prior page

# of breakers (no bell alarm option)

	120 V (1P)	**208 V (2P)**	**240 V (2P)**	**277V (1P)**
18	(1–18)	(1–8)	(1–8)	(1–8)
30	(1–30)	(1–14)	(1–14)	(1–14)
42	(1–42)	(1–20)	(1–20)	(1–20)
54	–	–	–	(1–26)

# of breakers (bell alarm option)

	120 V (1P)	**208 V (2P)**	**240 V (2P)**	**277 V (1P)**
18	(1–8)	(1–6)	(1–6)	(1–8)
30	(1–14)	(1–10)	(1–10)	(1–14)
42	(1–20)	(1–14)	(1–14)	(1–20)
54	–	–	–	(1–26)

Option

0 = None
A = Alarm horn (requires C.B. type 3 or 4)
B = Alarm beacon (requires C.B. type 3 or 4)
C = Heat-trace contactor failure light
D = Door disconnect
E = Environmental purge (TYPE 4 or 4X enclosures only)
G = Panel power-on light
H = Space heater and thermostat
L = Individual circuit breaker trip indication lights (requires C.B. type 4)
P = Heat-trace energized light
T = Terminal blocks (prewired)
W = Wired for ETI controller
Z = Z-purge system (TYPE 4 or 4X enclosures only)
SP = Special requirement: Must contain complete description of variance

MCB

Main circuit breaker and contactor

Panelboard size	**120/208**	**120/240**	**277/480**
18	50, 100	50, 100	30, 50, 70, 125
30	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
42	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
54	–	–	50, 70, 125, 175, 225

Enclosure

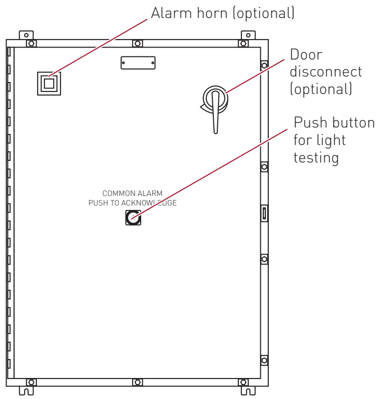
12 = TYPE 12 (indoors)
4 = TYPE 4 (outdoors)
4X = TYPE 4X (stainless steel–outdoors)

* Single phase

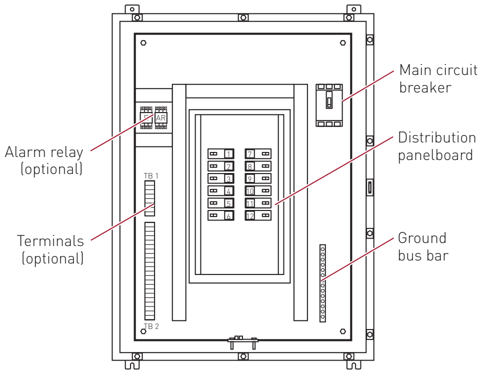
HTPI

nVent
RAYCHEM

HEAT-TRACING POWER DISTRIBUTION PANEL FOR INDIVIDUAL CONTROL GROUND-FAULT PROTECTION, MONITORING, AND OPTIONAL ALARM PANEL



Alarm option shown above



PRODUCT OVERVIEW

The nVent RAYCHEM HTPI is a dedicated power distribution, monitoring, and alarm panel for heat-tracing applications. It is intended for applications requiring tight band temperature maintenance with individual line-sensing control. The wall-mounted enclosure contains an assembled circuit-breaker panelboard.

Panels can be equipped with standard circuit breakers without alarms, ground-fault breakers, or ground-fault breakers with alarms.

LOAD POWER

120 / 208 / 240 / 277 Vac

AMBIENT OPERATING TEMPERATURE

32°F (0°C) to 122°F (50°C) (without space heater option)

FIELD WIRE SIZE

14–8 AWG (15–30 Amp C.B.), 8–4 AWG (40–50 Amp C.B.)

CIRCUIT BREAKER TYPES*

Ground-fault breaker	Square D types QOB-EPD, EHB-EPD
Standard circuit breaker	Square D type QOB

* To comply with NEC Article 427-55(a), circuit breakers are equipped with the means for lockout in the “Off” position.

CIRCUIT BREAKER AMPERAGE RATING

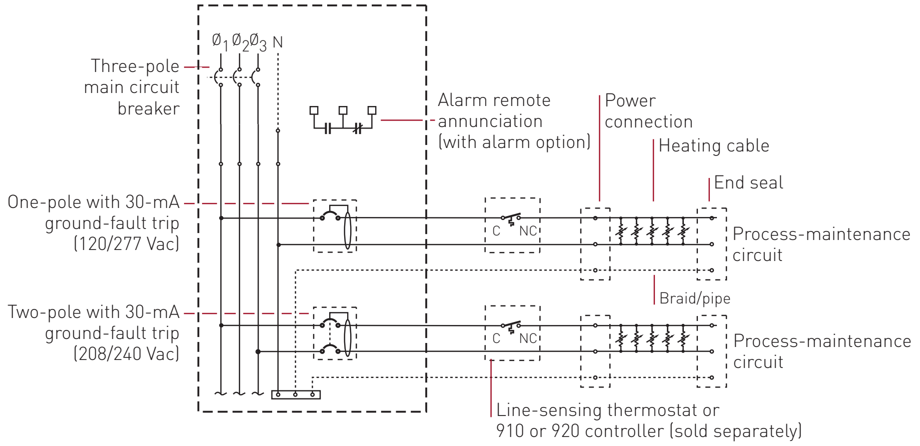
120 Vac	20 A, 30 A, 40 A*, 50 A*	* Overcurrent C.B. only
208 / 240 / 277 Vac	20 A, 30 A, 40 A, 50 A	

APPROVALS

ETL LISTED
CONFORMS TO
ANSI/UL STD. 508
UL STD. 508A

CERTIFIED TO
CAN/CSA C22.2 NO. 14

HTPI TYPICAL PROCESS MAINTENANCE APPLICATION SCHEMATIC



HTPI CATALOG NUMBER

HTPI comes in a variety of configurations. The following chart outlines the elements that constitute a configuration and the corresponding catalog number.

HTPI - Voltage - Panelboard - C.B. type - # of C.B./# of poles (rating) - Enclosure - MCB - Options

HTPI - 277/480 - 30 - 2 - 10/1P (20) - 4X - 200 - H

Voltage

120/208 120/240* 277/480

Panelboard size

18 = 18 space panelboard
30 = 30 space panelboard
42 = 42 space panelboard
54 = 54 space panelboard (277 V only)

Circuit breaker type

1 = Overcurrent circuit breakers**
2 = GFCB (30-mA trip) without alarm
3 = GFCB (30-mA trip) with bell alarm
4 = GFCB (30-mA trip) with relay alarm (includes terminal block option). Not available for 277 V

Number of circuit breakers/number of poles (circuit breaker rating) see prior page

# of breakers (no bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277V (1P)	277 V** (std. C.B.) (1P)
18	(1–18)	(1–8)	(1–8)	(1–7)	(1–17)
30	(1–29)	(1–14)	(1–14)	(1–13)	(1–29)
42	(1–41)	(1–20)	(1–20)	(1–19)	(1–41)
54	–	–	–	(1–25)	–

# of breakers (bell alarm option)

	120 V (1P)	208 V (2P)	240 V (2P)	277 V (1P)
18	(1–8)	(1–6)	(1–8)	(1–7)
30	(1–14)	(1–9)	(1–9)	(1–13)
42	(1–20)	(1–13)	(1–13)	(1–19)
54	–	–	–	(1–25)

Option

0 = None
A = Alarm horn (requires C.B. type 3 or 4)
B = Alarm beacon (requires C.B. type 3 or 4)
D = Door disconnect
E = Environmental purge (TYPE 4 or 4X enclosures only)
G = Panel power-on light
H = Space heater and thermostat
L = Individual circuit breaker trip indication lights (requires C.B. type 4)
T = Terminal blocks (prewired)
Z = Z-purge system (TYPE 4 or 4X enclosures only)
SP= Special requirement: Must contain complete description of variance

MCB

Main circuit breaker size or MLO for no main breaker

Panelboard size	**120/208**	**120/240**	**277/480**
18	50, 100	50, 100	30, 50, 70, 125
30	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
42	50, 100, 150, 200, 225	50, 60, 80, 150, 175, 200, 225	50, 70, 125, 175, 225
54	–	–	50, 70, 125, 175, 225

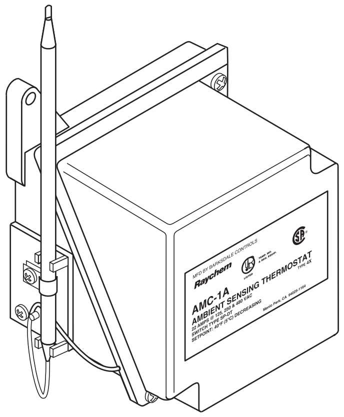
Enclosure

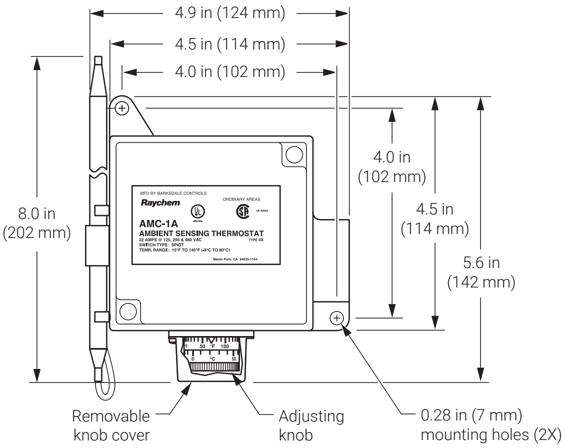
1 = TYPE 1 (indoors)
12 = TYPE 12 (indoors)
4 = TYPE 4 (outdoors)
4X = TYPE 4X (stainless steel–outdoors)

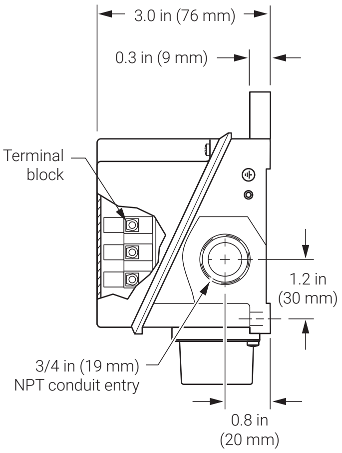
* Single phase
** Overcurrent circuit breakers require ground-fault protection from controller

AMC-1A

AMBIENT-SENSING THERMOSTAT FOR NONHAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM AMC-1A ambient-sensing thermostat is designed to control heat-tracing systems used for freeze protection in nonhazardous locations. The thermostat responds to ambient temperature changes and has an adjustable set point. The AMC-1A can be used to control a single heat-tracing circuit or as a pilot control of a contactor switching multiple heat-tracing circuits.

SPECIFICATIONS

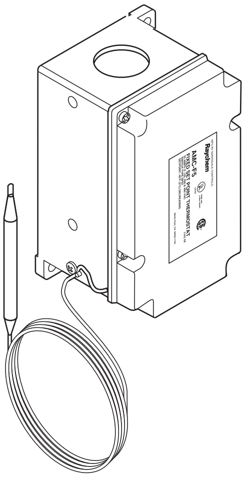
Enclosure	TYPE 4X, polyurethane-coated cast-aluminum housing, stainless-steel hardware
Entries	One 3/4-in (19 mm) NPT conduit hub
Set point range	15°F to 140°F (–9°C to 60°C)
Sensor exposure limits	–40°F to 160°F (–40°C to 71°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	SPDT
Electrical rating	22 A at 125 / 250 / 480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Set point repeatability	±3°F (±1.7°C)
Sensor type	Fixed fluid-filled (silicone) bulb and capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

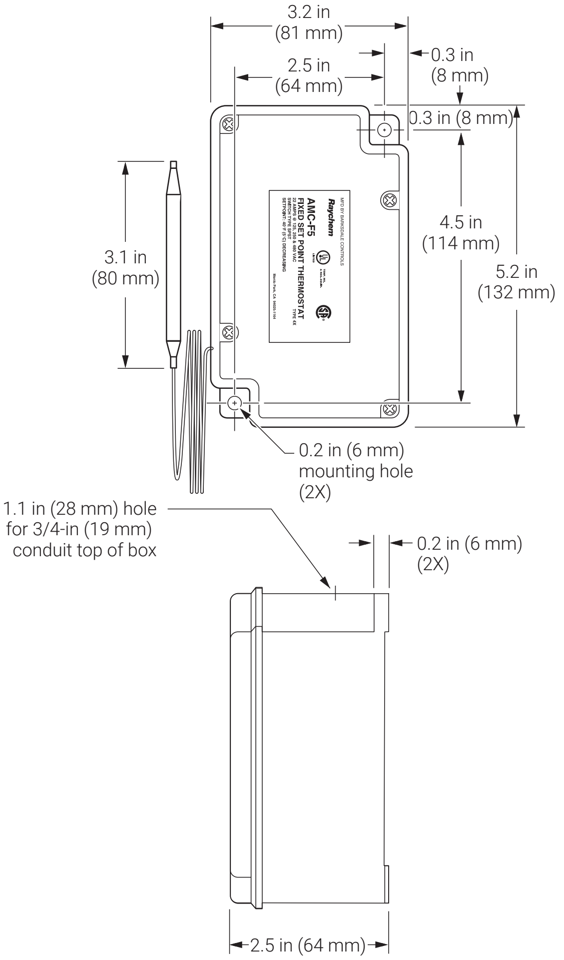
APPROVALS

AMC-F5

nVent
RAYCHEM

FIXED SET POINT FREEZE PROTECTION THERMOSTAT FOR NONHAZARDOUS LOCATIONS





PRODUCT OVERVIEW

The nVent RAYCHEM AMC-F5 thermostat is designed to control heat-tracing systems used for freeze protection in nonhazardous locations. The thermostat has a fixed set point of 40°F (5°C) and can be used for ambient-sensing or line-sensing. It can be used to control a single heat-tracing circuit or as a pilot control of a contactor switching multiple heat-tracing circuits.

SPECIFICATIONS

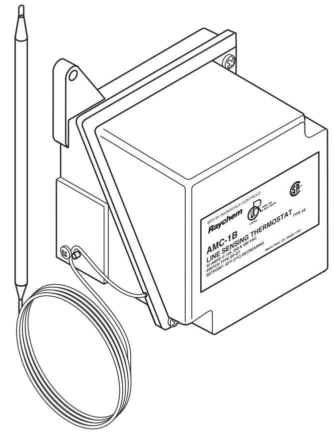
Enclosure	TYPE 4X, UV-resistant thermoplastics
Entries	One 3/4-in (19 mm) through hole
Set point	40°F (5°C) nonadjustable
Sensor exposure limits	–30°F to 140°F (–34°C to 60°C)
Housing exposure limits	–30°F to 140°F (–34°C to 60°C)
Switch	SPST
Electrical rating	22 A at 125 / 250 / 480 Vac
Accuracy	±3°F (±1.7°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Set point repeatability	±3°F (±1.7°C)
Sensor type	Fluid-filled (silicone) bulb and 2.5 ft (0.8 m) capillary
Sensor material	Tin-plated copper
Connection	Two 14 AWG (2 mm^2) pigtails One ground screw

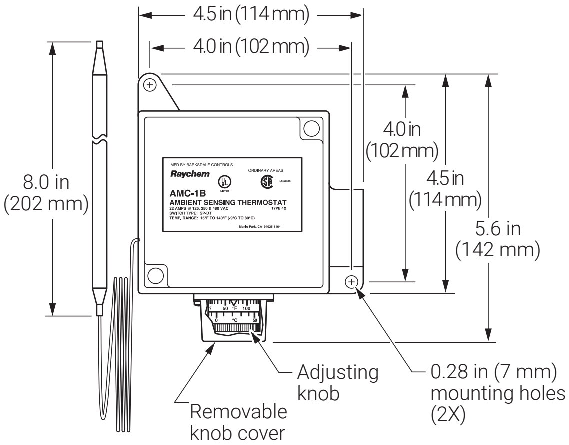
APPROVALS

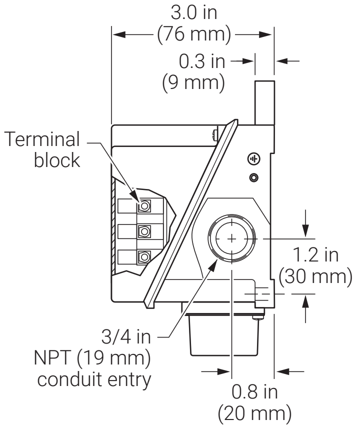
UL LISTED

AMC-1B

LINE-SENSING THERMOSTAT FOR NONHAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM AMC-1B line-sensing thermostat is designed to control heat-tracing systems in nonhazardous locations. The AMC-1B senses pipe or tank wall temperatures and can be used to control a single heat-tracing circuit or as a pilot control of a contactor switching multiple heat-tracing circuits. It can also be used to indicate low-temperature or high-temperature alarm conditions.

SPECIFICATIONS

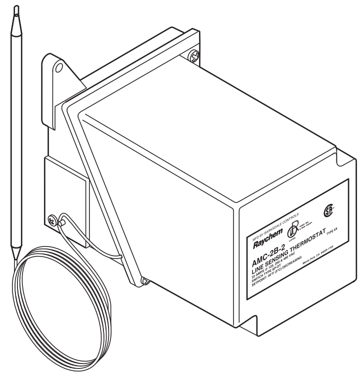
Enclosure	TYPE 4X, polyurethane-coated cast-aluminum housing, stainless steel hardware
Entries	One 3/4-in NPT conduit hub
Set point range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	SPDT
Electrical rating	22 A at 125 / 250 / 480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Set point repeatability	±3°F (±1.7°C)
Sensor type	Fluid-filled (silicone) bulb and 9 ft (2.7 m) capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

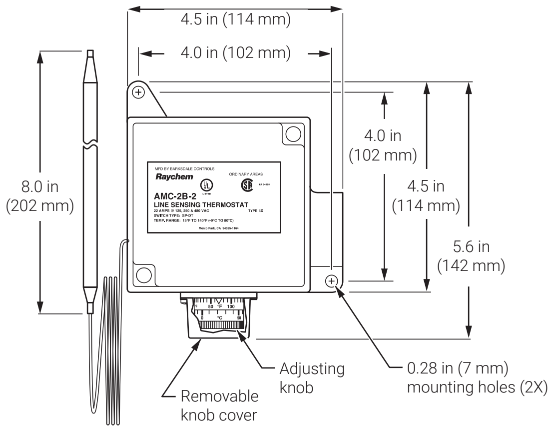
APPROVALS

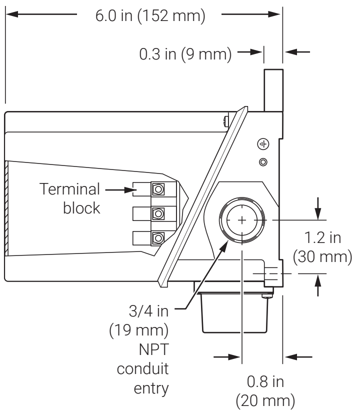
LISTED

AMC-2B-2

DOUBLE-POLE LINE-SENSING THERMOSTAT FOR NONHAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM AMC-2B-2 line-sensing thermostat is designed to control heat-tracing systems in nonhazardous locations. The thermostat functions as a double-pole single-throw (DPST) switch, opening and closing the electrical connection to both heating-cable bus wires.

The AMC-2B-2 senses pipe or tank wall temperatures and is used to control one heat-tracing circuit directly.

SPECIFICATIONS

Enclosure	TYPE 4X, polyurethane-coated cast-aluminum housing, stainless-steel hardware
Entries	One 3/4-in (19 mm) NPT conduit hub
Set point range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	DPST
Electrical rating	22 A at 208–240 Vac
Relay coil	208–240 Vac, 4 VA
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Setpoint repeatability	±3°F (±1.7°C)
Sensor type	Fluid-filled (silicone) bulb and 9 ft (2.7 m) capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

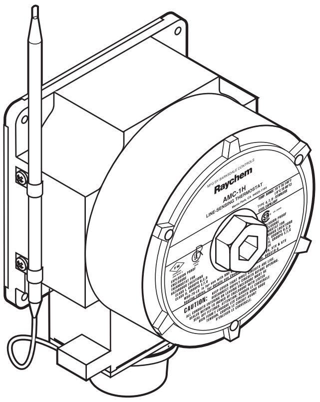
APPROVALS

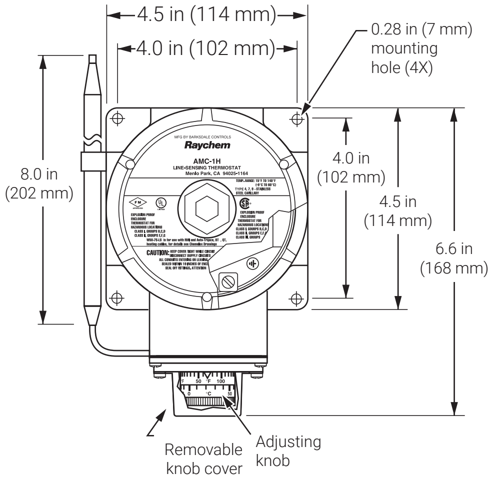
LISTED

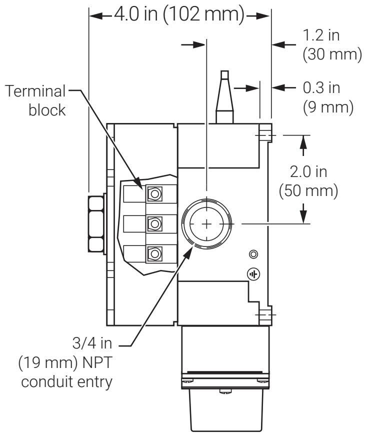
AMC-1H

nVent
RAYCHEM

AMBIENT-SENSING THERMOSTAT FOR HAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM AMC-1H ambient-sensing thermostat is designed to control heat-tracing systems used for freeze protection in hazardous locations. The thermostat responds to ambient temperature changes and has an adjustable set point. The AMC-1H can be used to control a single heat-tracing circuit or as a pilot control of a contactor switching multiple heat-tracing circuits.

SPECIFICATIONS

Enclosure	TYPE 4, 7, 9 lacquer-coated cast-aluminum housing, stainless steel hardware
Entries	One 3/4-in (19 mm) NPT conduit hub
Set point range	15°F to 140°F (–9°C to 60°C)
Sensor exposure limits	–40°F to 160°F (–40°C to 71°C)
Housing exposure limits	–40°F to 140°F (–40°C to 60°C)
Switch	SPDT
Electrical rating	22 A at 125 / 250 / 480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Setpoint repeatability	±3°F (±1.7°C)
Sensor type	Fixed fluid-filled (silicone) bulb and capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

APPROVALS

Hazardous Locations

UL LISTED FM APPROVED

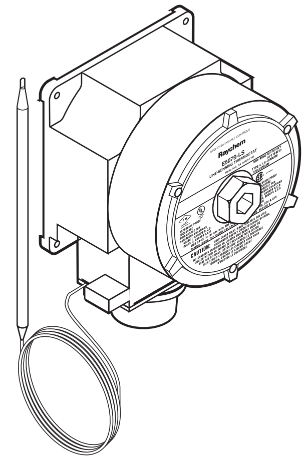
Class I, Div. 1 and 2, Groups B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

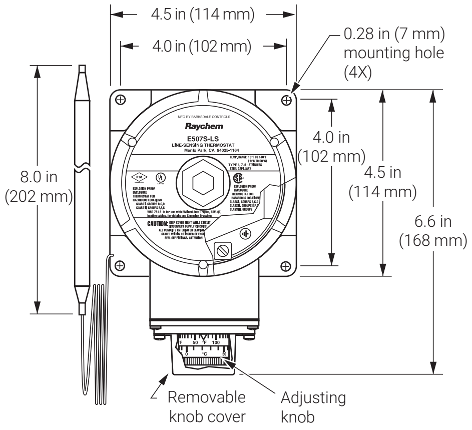
TECHNICAL DATA SHEETS

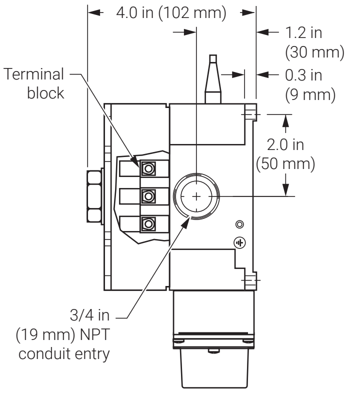
E507S-LS

nVent
RAYCHEM

LINE-SENSING THERMOSTAT FOR HAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM E507S-LS thermostat is designed for controlling heat-tracing systems in hazardous locations. The E507S-LS senses pipe or tank wall temperatures and can be used to control a single heat-tracing circuit or as a pilot control of a contactor switching multiple heat-tracing circuits. It can also be used to indicate low-temperature or high-temperature alarm conditions.

SPECIFICATIONS

Enclosure	TYPE 4, 7, 9, lacquer-coated cast-aluminum housing, stainless steel hardware
Entries	One 3/4-in (19 mm) NPT conduit hub
Set point range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 140°F (–40°C to 60°C)
Switch	SPDT
Electrical rating	22 A at 125 / 250 / 480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Setpoint repeatability	±3°F (±1.7°C)
Sensor type	Fluid-filled (silicone) bulb and 9 ft (2.7 m) capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

APPROVALS

Hazardous Locations

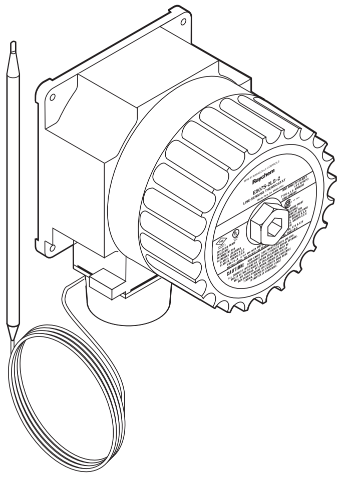
LISTED APPROVED

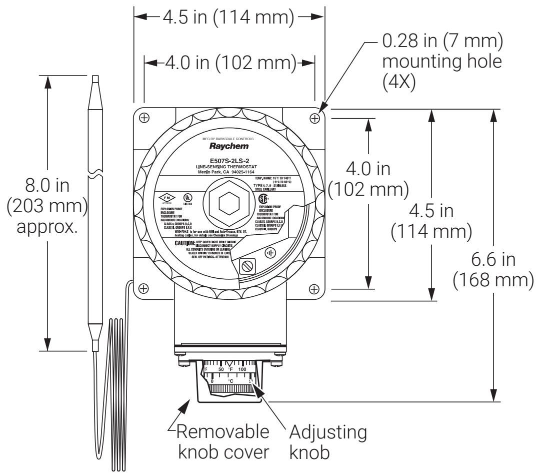
Class I, Div. 1 and 2, Groups B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

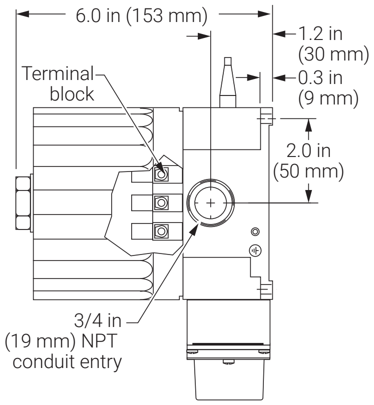
E507S-2LS-2

nVent
RAYCHEM

DOUBLE-POLE LINE-SENSING THERMOSTAT FOR HAZARDOUS LOCATIONS







PRODUCT OVERVIEW

The nVent RAYCHEM E507S-2LS-2 thermostat is designed to control heat-tracing systems in hazardous locations. The thermostat functions as a double-pole single-throw (DPST) switch, opening and closing the electrical connection to both heating cable bus wires.

The E507S-2LS-2 senses pipe or tank wall temperatures and is used to control one heat-tracing circuit directly.

SPECIFICATIONS

Enclosure	TYPE 4, 7, 9, lacquer-coated cast-aluminum housing, stainless steel hardware
Entries	One 3/4-in NPT conduit hub
Set point range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 140°F (–40°C to 60°C)
Switch	DPST
Electrical rating	22 A at 208 / 240 Vac
Relay coil	208–240 Vac, 4 VA
Accuracy	±6°F (±3.3°C)
Deadband	2°F to 12°F (1.1°C to 6.7°C) above actuation temperature
Set point repeatability	±3°F (±1.7°C)
Sensor type	Fluid-filled (silicone) bulb and 9 ft (2.7 m) capillary
Sensor material	300 series stainless steel
Connection terminals	Screw terminals, 10–14 AWG (2–5 mm^2)

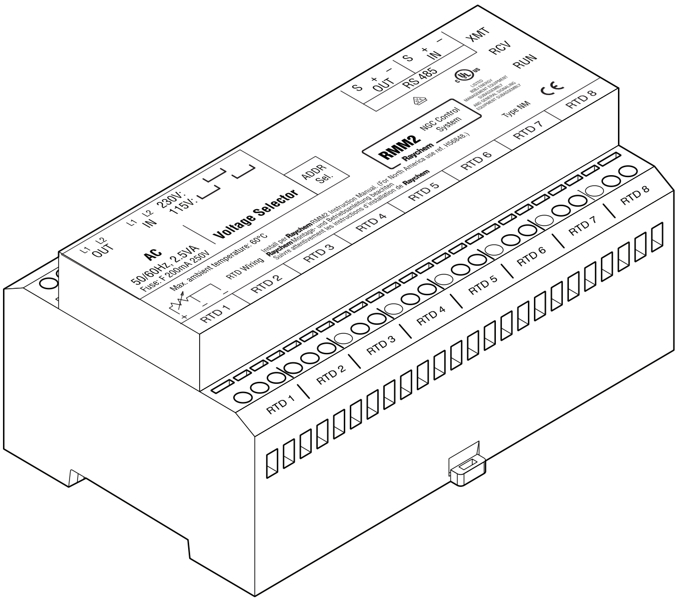
APPROVALS

Hazardous Locations

Class I, Div. 1 and 2, Groups B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

RMM2

HEAT-TRACING REMOTE MONITORING MODULE



RMM2 without enclosure

PRODUCT OVERVIEW

The remote monitoring module nVent RAYCHEM (RMM2) provides temperature monitoring capability for the NGC heat-tracing control and monitoring systems. The RMM2 accepts up to eight RTDs that measure pipe, vessel, or ambient temperatures in a heat-tracing system. Multiple RMM2s communicate with a single NGC controller to provide centralized monitoring of temperatures. A single, twisted pair RS-485 cable connects up to 16 RMM2s for a total monitoring capacity of 128 temperatures.

Control and monitoring

The RMM2 modules are used to aggregate RTD wires in one remote location and send the information back to the control system through a single twisted pair cable. This helps reduce installation costs since only one conduit run returns to the controller, rather than eight. The RMM2s are placed near desired measurement locations in nonhazardous or hazardous locations. Multiple temperature sensor inputs are networked over a single cable, significantly reducing installation cost.

Alarms

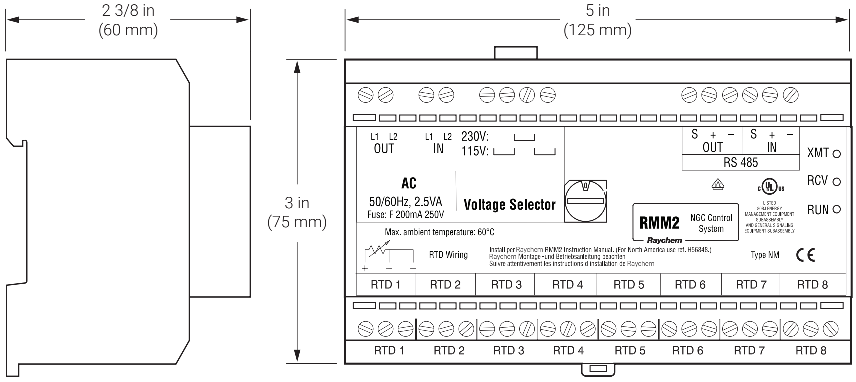
Each temperature sensor connected to a RMM2 may have individual low- and high-temperature alarms. Alarm limits are set and alarm conditions are reported at the control panel. Additional alarms are triggered for failed temperature sensors and communication errors. Alarms may be reported remotely through an alarm relay in the control system or through an RS-485 connection to a host computer supporting the Modbus® protocol.

Configurations

The RMM2 clips to a DIN 35 rail and can be mounted in a choice of enclosures, as required for the area classification and environment. For aggressive environments and Division 2 hazardous locations, nVent offers a glass-reinforced polyester TYPE 4X enclosure.

DIMENSIONS

Figure 1



GENERAL

	RMM2
Area of use (with appropriate enclosure)	Nonhazardous or hazardous locations
Approvals	Nonhazardous locations c UL us LISTED **80BJ ENERGY MANAGEMENT EQUIPMENT SUBASSEMBLY AND GENERAL SIGNALING EQUIPMENT SUBASSEMBLY** **Type NM**
Ambient operating temperature range	−40°F to 140°F (−40°C to 60°C)
Ambient storage temperature range	−40°F to 140°F (−40°C to 60°C)
Relative humidity	5% to 95%, noncondensing
Supply voltage (nominal)	115/230 Vac, ±10%, jumper selectable. (The default voltage is 230 Vac. A jumper is supplied to convert to 115 Vac.)
Internal power consumption	< 3 W

RMM2 WITH DIVISION 2 ENCLOSURE

	RMM2-4X
Protection	TYPE 4X
Approvals	Hazardous locations c UL us LISTED **9Z63 TEMPERATURE INDICATING EQUIPMENT FOR USE IN HAZARDOUS LOCATIONS** Class I, Division 2, Groups A, B, C, D Class II, Division 2, Groups F, G
Material	Glass-reinforced polyester, silicone gasket, stainless steel hardware
Entries	Six 3/4-in (19 mm) NPT conduit entrance holes, four plugged
Mounting	Surface mounting dimensions are shown in Figure 2

TEMPERATURE SENSOR INPUTS

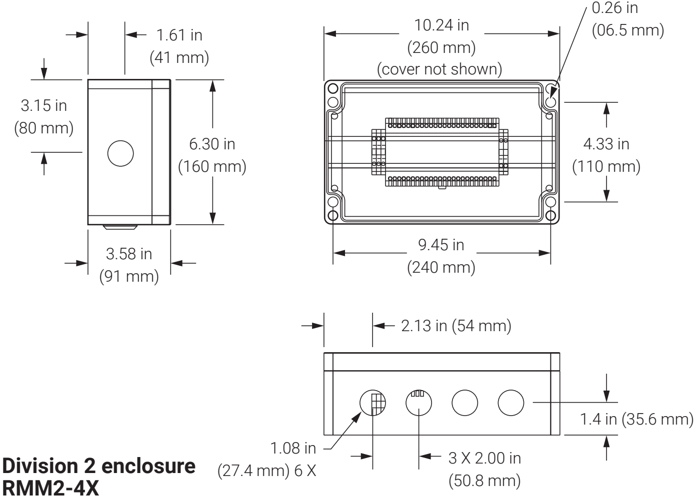
Type	100 Ω platinum RTD, 3-wire, α =0.00385 Ω/Ω/°C
Quantity per RMM2	Up to 8 RTDs can be extended with a 3-conductor shielded cable of 20 Ω maximum per conductor

COMMUNICATION TO NGC CONTROLLER

Type	RS-485
Cable	One shielded twisted pair
Length	4000 ft (1200 m) maximum
Quantity	Up to 16 RMM2s may be connected to one NGC-30
Address	Switch-selectable on RMM2, 16 addresses, 0–9, A-F

ENCLOSURE DIMENSIONS

Figure 2



Division 2 enclosure
RMM2-4X

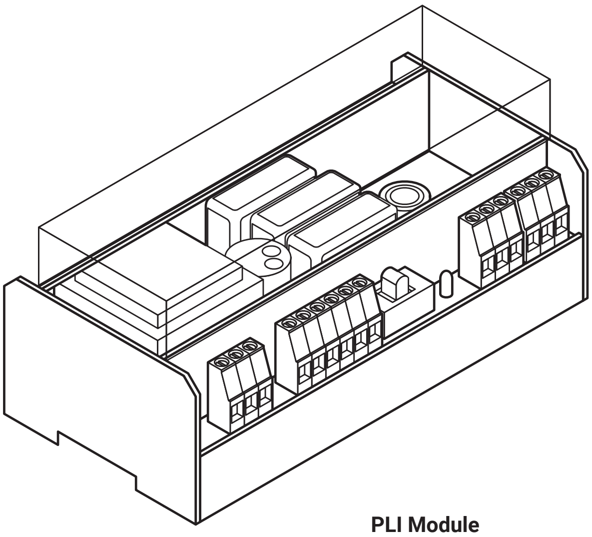
CONNECTION TERMINALS

Power supply	24–12 AWG
RTD, communications	24–12 AWG

ORDERING DETAILS

	Catalog number	Part number	Weight
Remote monitoring module (RMM2)			
RMM2, eight RTD inputs, no enclosure	RMM2	051778-000	1.5 lb (0.7 kg)
RMM2 with TYPE 4X enclosure	RMM2-4X	523420-000	4 lb (1.8 kg)
Cables			
RTD extension cable, 1000-ft reel	MONI-RTD-WIRE	962661-000	20 lb (9.1 kg)
RS-485 cable, 1000-ft reel	MONI-RS485-WIRE	549097-000	17 lb (7.7 kg)

HEAT-TRACING POWER-LINE CARRIER INTERFACE FOR HAZARDOUS LOCATIONS



PLI Module

PRODUCT OVERVIEW

nVent RAYCHEM PLI (Power Line Carrier Interface) modules provide temperature-monitoring capability for heat-tracing control and monitoring systems by communicating the temperature data to the control system over the heat-tracing bus wires and the AC power line, eliminating the need for RTD wiring. The PLI module receives input from special transmitters connected to the heat-tracing cable. The transmitters provide pipe temperatures from RTDs and continuity confirmation; they are typically located at the front and/or end of the heat-tracing circuit. For further information regarding the special transmitters, please refer to nVent RAYCHEM SES, SPC and 700-TT-R transmitter datasheets and installation instructions.

A single twisted-pair RS-485 cable connects the PLI modules to a nVent RAYCHEM NGC-controller.

CONTROL AND MONITORING

PLI modules collect temperature data for control and monitoring of the heat-tracing system by the NGC controller panel. For example the NGC-30 can accept up to 127 temperature inputs from SES/SPC or 255 temperature inputs 700-TT-R transmitters per PLI module and up to four PLI modules per NGC-30 controller. PLI modules are placed in the NGC-30 control panel.

POWER-LINE CARRIER TECHNOLOGY

The PLI system uses frequency-shift keying to encode digital data on the power-line network. Digital ones and zeros are transmitted by coupling high-frequency signals onto the heat-tracing bus wires and the AC power line. The digital data are transmitted in packets that contain error-checking fields to validate the correctness of the data. Since no additional wiring isrequired to bring temperature and continuity data back to a central location, installation and maintenance costs are significantly reduced.

CONFIGURATIONS

The PLI modules are designed to be local to the distribution transformer that supplies power to the heat-tracing circuits. Only one PLI module may be used on the secondary side of each heat-tracing transformer. A front-end filter (FEF) is required on the primary side of each transformer to provide electrical noise isolation between the plant environment and the heat-tracing power-line network environment. This ensures that transmissions between the PLI module and the 700-TT-R, SES or SPC transmitters are reliable and error-free.

The PLI module is an electronic device mounted in an enclosure that is to be clipped to a DIN 35-mm rail in a nonhazardous, indoor location.

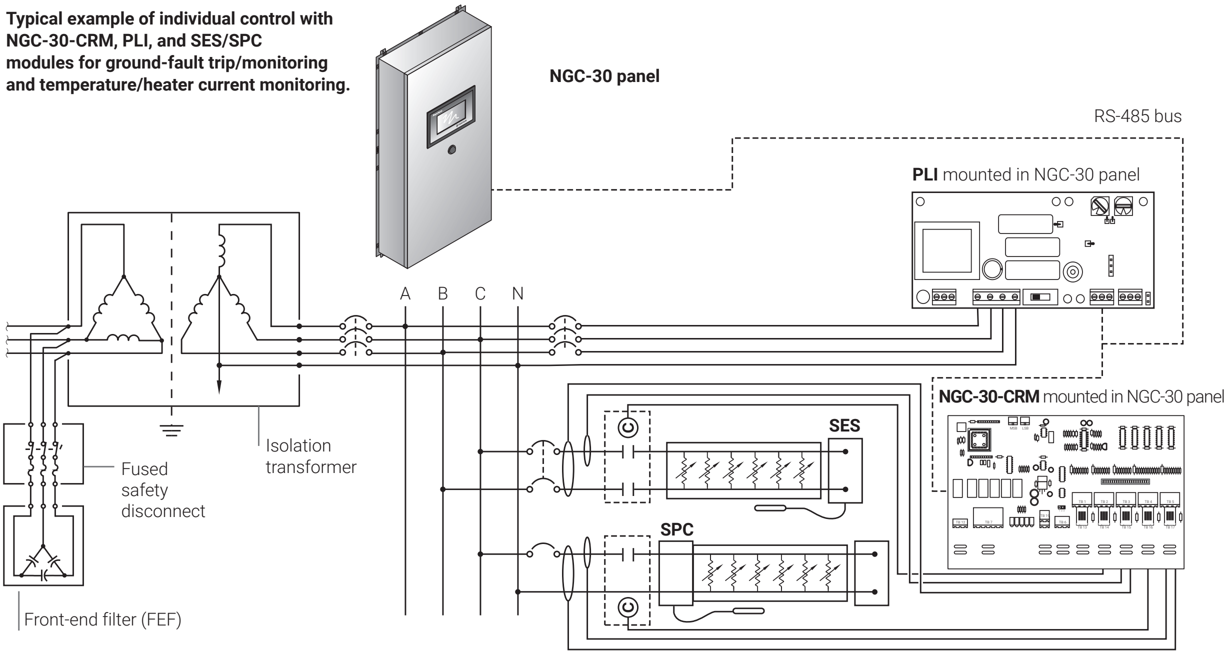
GENERAL

Area of use	Nonhazardous locations Hazardous indoor locations...in TYPE 7 panels Hazardous outdoor locations...in TYPE 4,7,9 panels
Approvals	c UL us LISTED **80BJ OPEN ENERGY MANAGEMENT SYSTEM ACCESSORY**
Supply voltage	100–120 Vac, 208–240 Vac, switch-selectable; 50/60 Hz
Internal power consumption	< 5 W
Operating temperature	–13°F to 140°F (–25°C to 60°C)
Storage temperature	–40°F to 167°F (–40°C to 75°C)

TEMPERATURE SENSORS; USE WITH 700-TT-R, SES, OR SPC TRANSMITTERS

Type	100-ohm platinum RTD, three-wire, α =0.00385 ohm/ohm/°C Can be extended with a three-conductor shielded cable of 20-ohm maximum per conductor.
Quantity per PLI	255 x 700-TT-R; 127 x SES or SPC **Note:** The 700-TT-R and SES/SPC transmitters cannot be used on the same PLI module.

LINE-SENSING CONTROL AND MONITORING



Typical example of individual control with NGC-30-CRM, PLI, and SES/SPC modules for ground-fault trip/monitoring and temperature/heater current monitoring.

COMMUNICATIONS TO NGC CONTROLLER

Type	RS-485
Connection terminals	28–12 AWG (0.08–2.5 mm^2)
Cable	One shielded twisted pair
Length	4000 ft (1200 m) maximum total
Address	Switch-selectable,1–99

CONNECTION TERMINALS

Control power	Two terminals, 24–12 AWG (0.2–3.3 mm^2)
Power-line interface (PLI)	Four terminals, 24–12 AWG (0.2–3.3 mm^2)

DIMENSIONS

Length x width x height	6 in (152 mm) x 2-7/8 in (73 mm) x 2-1/2 in (64 mm)

MOUNTING

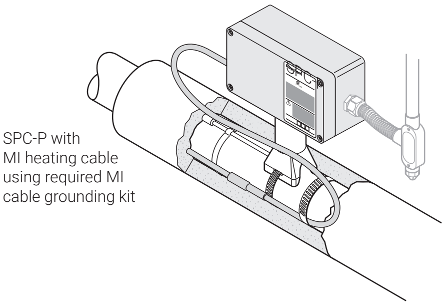
Method	Mounts on a DIN 35-mm rail

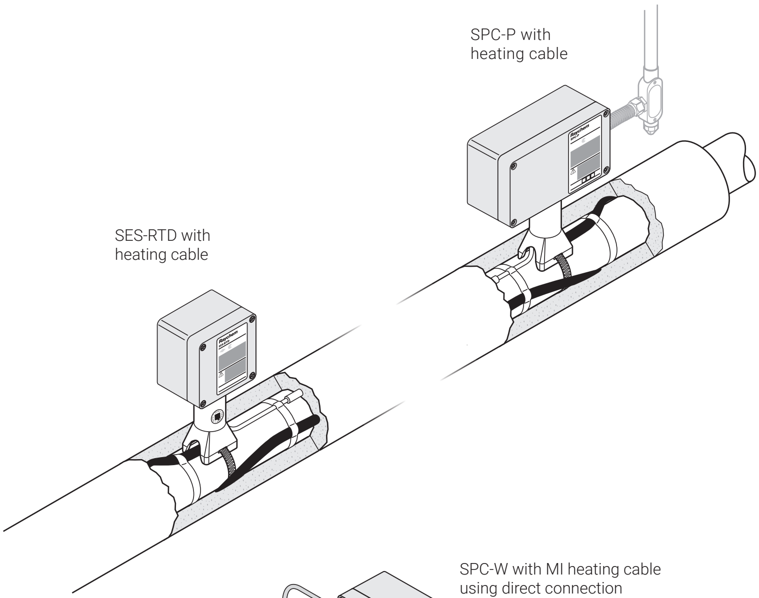
ORDERING DETAILS

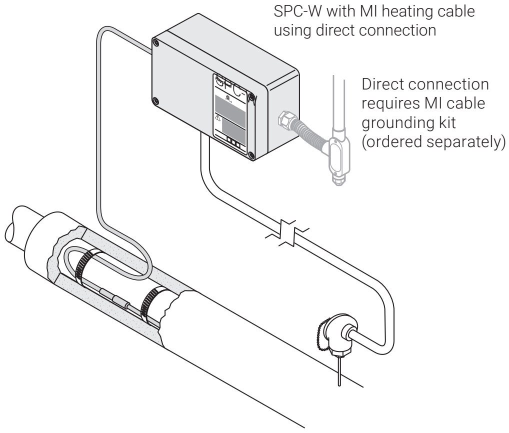
	Catalog number	Part number	Weight
PLI modules			
Interface unit	PLI	488323	1.0 lb (0.4 kg)
Accessories			
Front-end filter	FEF-480V FEF-600V	922847 P000000312	15 lb (6.8 kg) 15 lb (6.8 kg)
RS-485 bus 1000-ft reel	MONI-RS485-WIRE	549097	17 lb (7.5 kg)

SES AND SPC

"SMART END SEAL" AND "SMART POWER CONNECTION"







PRODUCT OVERVIEW

The nVent RAYCHEM SES and SPC series of transmitters are used in freeze protection and process temperature maintenance applications. The system is unique in that the heating cable bus wires and power cables carry the monitoring signals. No additional field wiring is necessary.

The SES series of transmitters typically are placed at the end of a heating cable circuit to seal the end of the heating cable. The SES series comes in two types: temperature/continuity transmitter (SES-RTD) and continuity transmitter (SES-CONT).

The SPC series of transmitters typically are placed at the front of a heating cable circuit to provide a power connection to the heating cable. The SPC series comes in two types: pipe-mount (SPC-P) and wall-mount (SPC-W).

The SES-RTD, SPC-P and SPC-W transmitters replace conventional RTD sensing elements and associated wiring, sending temperature and continuity information to the central NGC controller. The SES-CONT provides heating cable circuit continuity only.

The SES transmitter is designed for use only with 120 V and 208-277 V nVent RAYCHEM BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT heating cables.

The SPC-P transmitter is designed for use only with 120 V and 208-277 V BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT heating cables and nVent RAYCHEM Type A & D MI heating cables.

The SPC-W transmitter is designed for use with an external junction box to support all 120 V and 208–277 V heating cables that are approved for the appropriate area classification. The SPC-W transmitter also supports the direct connection of 120 V and 208–277 V RAYCHEM Type A & D MI heating cables.

The SES/SPC transmitters require a programmable NGC controller, a Power Line Carrier Interface (PLI) module, and an optional power-switching contactor panel. Up to 127 strategically placed SES/SPC transmitters communicate with one PLI module (one PLI module per heat-tracing transformer). A typical controller, the NGC-30, can support up to four PLI modules

SYSTEM REQUIREMENTS

The SES/SPC system requires a dedicated heat-tracing transformer of 112.5 kVA or less and a MoniTrace 700-FEF front end filter to provide electrical noise isolation between the plant environment and the heat-tracing power. Connect only the heat tracing to the secondary of this transformer. Do not connect high power/noise sources such as variable-frequency drives to the primary of this transformer.

SPECIFICATIONS

Function	SES-CONT:	Digital continuity transmitter
	SES-RTD:	Digital temperature and continuity transmitter
	SPC-P:	Digital temperature and continuity transmitter with pipe-mount power connection enclosure
	SPC-W:	Digital temperature and continuity transmitter with wall-mount power connection enclosure
Address	Switch selectable with three rotary switches, 127 addresses, 1–127	
Cables supported	SES:	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT
	SPC-P:	BTV-CR, BTV-CT, QTVR-CT, XTV-CT, KTV-CT and VPL-CT, Type A & D MI
	SPC-W with external junction box:	
		Heating cables that are approved for the appropriate area classification
	SPC-W with direct connection:	
		Type A & D MI
Cable voltage rating	120 V and 208–277 V	
Maximum circuit breaker rating	50 A	
Operating voltage	SES-CONT-1, SES-RTD-1, SPC-P-1, SPC-W-1:	90–132 Vac / 60 Hz
	SES-CONT-2, SES-RTD-2, SPC-P-2, SPC-W-2:	185–304 Vac / 60 Hz
Operating temperature range	–40°F to 140°F (–40°C to 60°C)	
Enclosure rating	TYPE 4X	
Maximum conductor size	SPC-P:	8 AWG
Entries	SPC-P:	1 x 0.5", 1 x 0.75"
	SPC-W:	1 x 0.5", 2 x 0.75"
Storage temperature range	–40°F to 167°F (–40°C to 75°C)	
Temperature measurement range	SES-RTD, SPC-P:	–40°F to 500°F (–40°C to 260°C) using RTD supplied with kit
	SPC-W:	–90°F to 590°F (–68°C to 310°C) using 100 Ω platinum RTD, 3-wire, α= 0.00385 ohms/ohm/°C shielded cable of 15 Ω maximum per conductor
Temperature accuracy	± 2% of actual (± 3°F minimum)	
Relative humidity	5% to 90%, noncondensing	

APPROVALS

SES:
Hazardous Locations

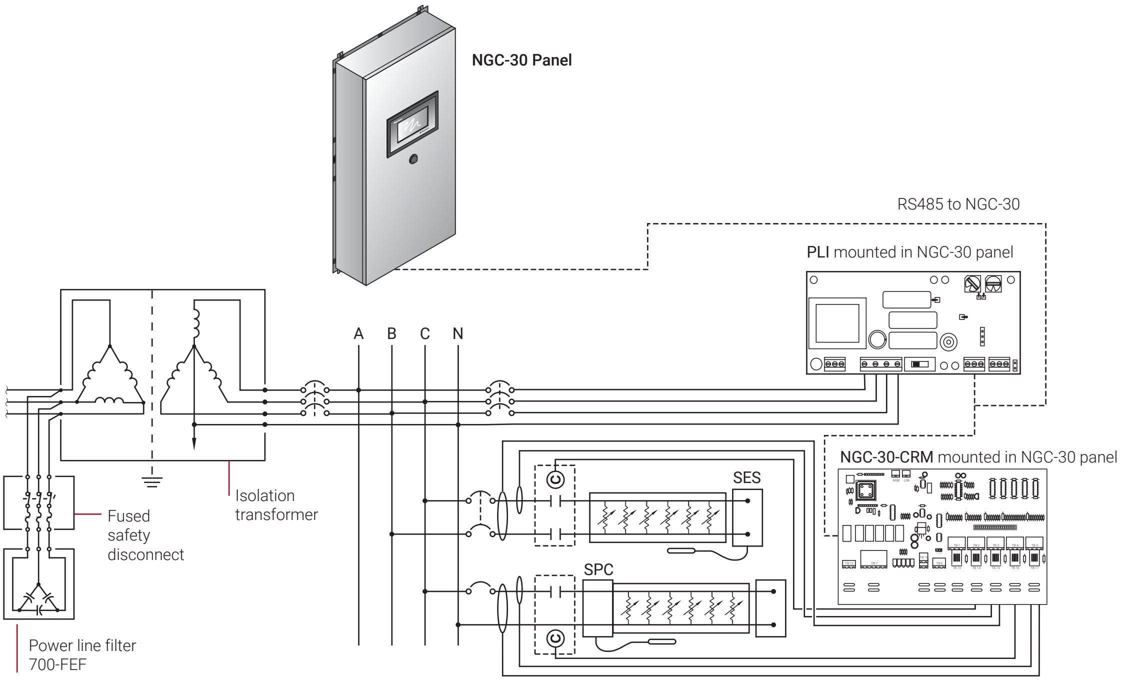
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

SPC:
Hazardous Locations

Class I, Div. 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

LINE-SENSING CONTROL AND MONITORING

Typical example of individual circuit control with NGC-30-CRM, PLI module, and SES transmitter for ground-fault trip/monitoring and temperature/heater current monitoring

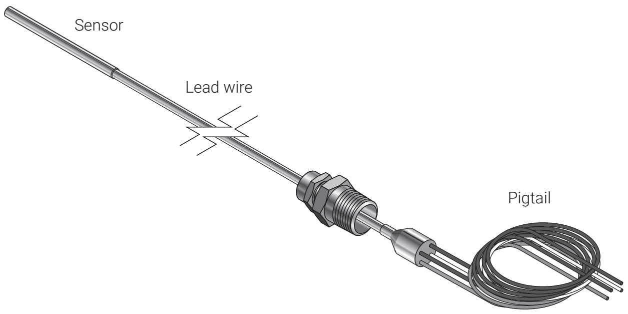


ORDERING DETAILS

Description	Catalog number	Part number	Weight (lbs)
120 V temperature/continuity transmitter with end seal enclosure	SES-RTD-1	265212-000	3.2
208–277 V temperature/continuity transmitter with end seal enclosure	SES-RTD-2	677596-000	3.2
120 V continuity transmitter with end seal enclosure	SES-CONT-1	293536-000	3.0
208–277 V continuity transmitter with end seal enclosure	SES-CONT-2	398720-000	3.0
120 V temperature/continuity transmitter with pipe-mount power connection enclosure	SPC-P-1	P000001049	4.4
208–277 V temperature/continuity transmitter with pipe-mount power connection enclosure	SPC-P-2	P000001050	4.4
120 V temperature/continuity transmitter with wall-mount power connection enclosure	SPC-W-1	P000001051	4.0
208–277 V temperature/continuity transmitter with wall-mount power connection enclosure	SPC-W-2	P000001052	4.0
Spare parts			
120 V replacement transmitter board	SES-TT-1	815918-000	0.8
208–277 V replacement transmitter board	SES-TT-2	771274-000	0.8
Replacement RTD and stand assembly	SES-RTD-Replace	693618-000	0.8

RTD-MTO

RESISTANCE TEMPERATURE DETECTOR (RTD) FOR TEMPERATURE MEASUREMENT UP TO 1100°F (593°C)



PRODUCT OVERVIEW

These three-wire platinum nVent RAYCHEM RTD's (resistance temperature detectors) are designed to withstand highly corrosive applications and are typically used with control and monitoring systems when accurate temperature control is required. The Alloy 825 sheathed lead wire is rugged, yet flexible, allowing the sensor to get around obstructions or into areas where a rigid conduit is not practical.

SPECIFICATIONS

Sensor	
Housing	304 stainless steel
Nominal dimensions	3 in (76 mm) length, 1/4 in (6.4 mm) diameter
Accuracy	±1°F (0.5°C) at 32°F (0°C)
Range	–76°F to 1100°F (–60°C to 593°C)
Resistance	100 ohms at 0°C α =0.00385 ohms/ohm/°C
Lead Wire	
Outer sheath	Alloy 825 stainless steel - 3/16 in (4.8 mm) in diameter
Length*	RTD10 – 10.2 ft (3.1 M) RTD20 – 20.2 ft (6.1 M) **Note:** RTDs are available in lengths of 1, 3, 7, 15, 25, 30, 50, 75, and 100 ft. Contact nVent for additional information.
Maximum exposure temperature	1100°F (593°C)
Conduit connector	1/2" NPT, 303 MX stainless steel
Pigtail	
Length*	24 in (61 cm)
Pigtail wire size (each of 4)	16 AWG, stranded tinned copper **Note:** The length of RTD extension wires is determined by the wire gauge used. To reduce the likelihood that electrical noise will affect temperature measurement, keep RTD extension wires as short as possible. Use shielded instrument cable such as nVent RAYCHEM MONI-RTD-WIRE (22 AWG, PVC insulation, –30°F to 140°F, –20°C to 60°C) or Belden 83553 (22 AWG, FEP insulation, –95°F to 395°F, –70°C to 200°C).
Electrical Connection	For connection only to Class 2 circuits

* Tolerance on length is ±3%.

ADDITIONAL MATERIALS REQUIRED

Pipe straps

APPROVALS

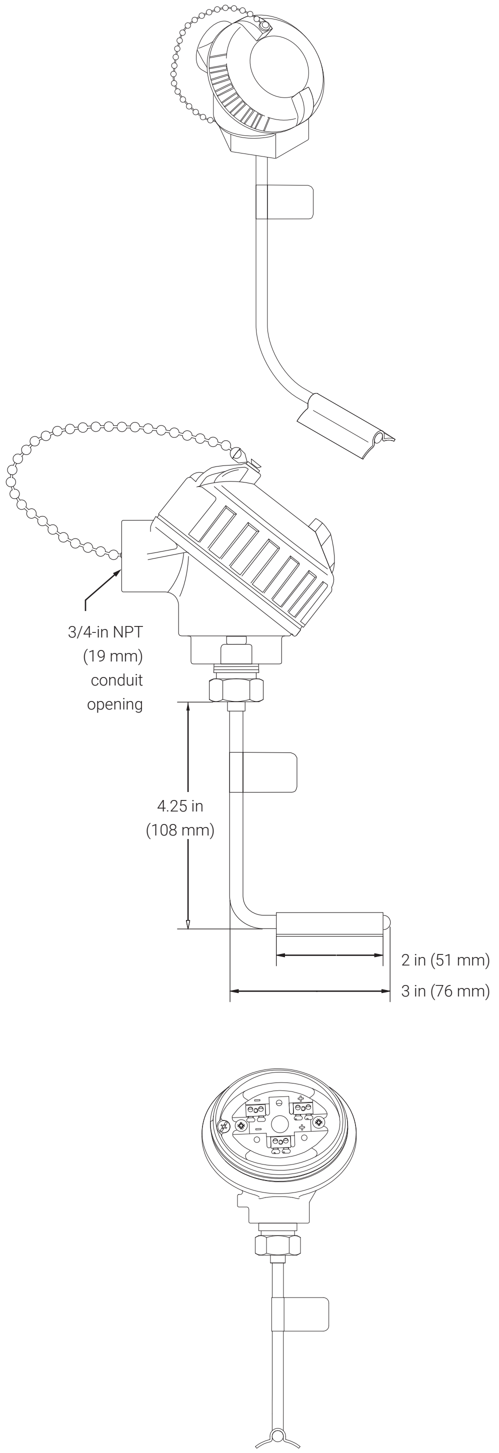
Hazardous Locations

Class I, Div. 1 & 2, Groups A, B, C, D
Class II, Div. 1 & 2, Groups E, F, G
Class III

The RTD10 and RTD20 are approved for Division 1 and 2 only when used with the appropriately rated enclosure suitable for the specific hazardous location.

RTD4AL

RTD TEMPERATURE SENSOR
FOR TEMPERATURE MEASUREMENT UP TO 900°F (482°C)



PRODUCT OVERVIEW

The nVent RAYCHEM RTD4AL is a three-wire platinum RTD (resistance-temperature detector) typically used with monitoring and control systems that require accurate temperature control. The RTD4AL kit can be used with a wide variety of nVent RAYCHEM monitoring and control systems.

SPECIFICATIONS

Sensor housing	Aluminum; TYPE 4X
Sensor sheath	316 stainless steel
Range	–100°F to 900°F (–73°C to 482°C) maximum
Accuracy	±1°F (0.5°C) at 32°F (0°C)
Resistance	100 ohms at 0°C α =0.00385 ohms/ohm/°C
Connection	3/4-in (19 mm) NPT conduit hub **Note:** The length of RTD extension wires is determined by the wire gauge used. To reduce the likelihood that electrical noise will affect temperature measurement, keep RTD extension wires as short as possible. Use shielded instrument cable such as nVent RAYCHEM MONI-RTD-WIRE (22 AWG, PVC insulation, –30°F to 140°F, –20°C to 60°C) or Belden 83553 (22 AWG, FEP insulation, –95°F to 395°F, –70°C to 200°C).

ADDITIONAL MATERIALS REQUIRED

Pipe strap, conduit, 16–22 AWG shielded instrument cable

KIT CONTENTS

One RTD temperature sensor

APPROVALS

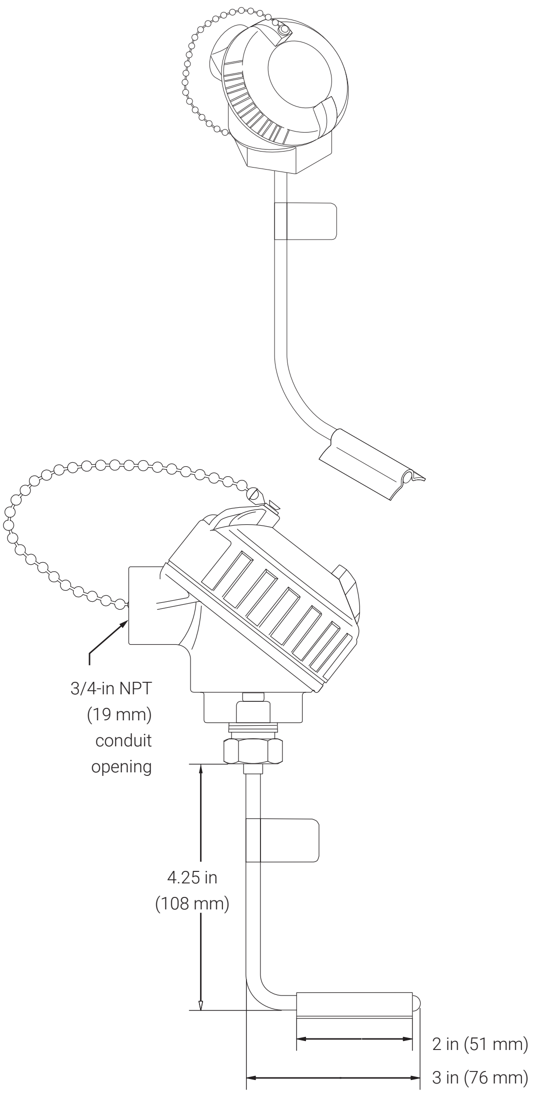
The RTD4AL is CSA certified to U.S. and Canadian standards.

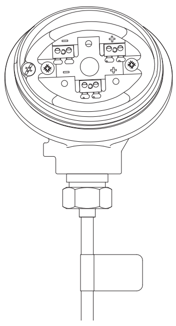
Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G

RTD7AL

nVent RAYCHEM

RTD TEMPERATURE SENSOR FOR TEMPERATURE MEASUREMENT UP TO 900°F (482°C) IN DIVISION 1 LOCATIONS





PRODUCT OVERVIEW

The RTD7AL temperature sensor is a three-wire platinum RTD (resistance-temperature detector) typically used with monitoring and control systems when accurate temperature control is required. The sensor is explosion-proof and approved for Division 1 hazardous locations. The RTD7AL can be used with a wide variety of nVent RAYCHEM monitoring and control systems.

SPECIFICATIONS

Sensor housing	Aluminum; Type 4x
Sensor sheath	316 stainless steel
Range	–100°F to 900°F (–73°C to 482°C) maximum
Accuracy	±1°F (0.5°C) at 32°F (0°C)
Resistance	100 ohms at 0°C α =0.00385 ohms/ohm/°C
Connection	3/4-in (19 mm) NPT conduit hub **Note:** The length of RTD extension wires is determined by the wire gauge used. To reduce the likelihood that electrical noise will affect temperature measurement, keep RTD extension wires as short as possible. Use shielded instrument cable such as nVent RAYCHEM MONI-RTD-WIRE (22 AWG, PVC insulation, –30°F to 140°F, –20°C to 60°C) or Belden 83553 (22 AWG, FEP insulation, –95°F to 395°F, –70°C to 200°C).
Operating Ambient	–40°F to 212°F (–40°C to 100°C) for all gas groups except Group A. –4°F to 212°F (–20°C to 100°C) for gas Group A

ADDITIONAL MATERIALS REQUIRED

Pipe strap, conduit, 16–22 AWG shielded instrument cable

KIT CONTENTS

One RTD temperature sensor

APPROVALS

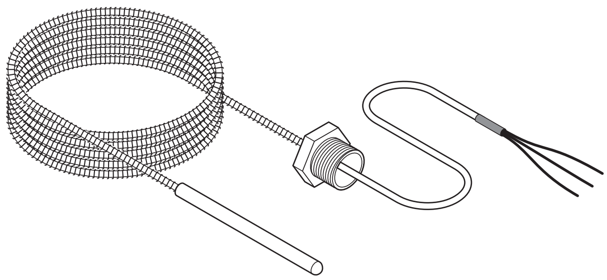
The RTD7AL is CSA certified to U.S. and Canadian standards.

Class I, Div. 1, Groups C, D
Class II, Div. 1, Groups E, F, G

TECHNICAL DATA SHEETS

RTD3CS AND RTD10CS

RTD TEMPERATURE SENSORS
FOR TEMPERATURE MEASUREMENT UP TO 400°F (204°C)



PRODUCT OVERVIEW

The nVent RAYCHEM RTD3CS and RTD10CS are three-wire platinum RTD (resistance temperature detectors) typically used with monitoring and control systems such as the nVent RAYCHEM 910 controller when accurate temperature control is required.

The RTD3CS and RTD10CS can be installed directly to the controller using the supplied 1/2" conduit fitting or to an RTD junction box where RTD extension wire is used.

SPECIFICATIONS

SENSOR

Housing	316 stainless steel
Dimensions	3-in (76 mm) length 3/16-in (8 mm) diameter
Sensing area	1-1/2 in (38 mm)
Accuracy	±1°F (0.5°C) at 32°F (0°C)
Range	–76°F to 400°F (–60°C to 204°C)
Resistance	100 ohms at 0°C α =0.00385 ohms/ohm/°C

EXTENSION WIRES

Wire size (each of three)	20 AWG, stranded tinned copper **Note:** The length of RTD extension wires is determined by the wire gauge used. To reduce the likelihood that electrical noise will affect temperature measurement, keep RTD extension wires as short as possible. Use shielded instrument cable such as nVent RAYCHEM MONI-RTD-WIRE (22 AWG, PVC insulation, –30°F to 140°F, –20°C to 60°C) or Belden 83553 (22 AWG, FEP insulation, –95°F to 395°F, –70°C to 200°C).
Wire insulation rating	300 V
Length	RTD3CS: 3-ft (0.3 m) flexible armor, 18-in (457 mm) lead wire RTD10CS: 10-ft (3 m) flexible armor, 18-in (457 mm) lead wire
Outer shield	Stainless steel flexible armor (not suitable for underground applications)
Maximum exposure temperature	400°F (204°C)
Conduit bushing	1/2-in (12.7 mm) NPT

ADDITIONAL MATERIALS REQUIRED

AT-180 aluminum tape

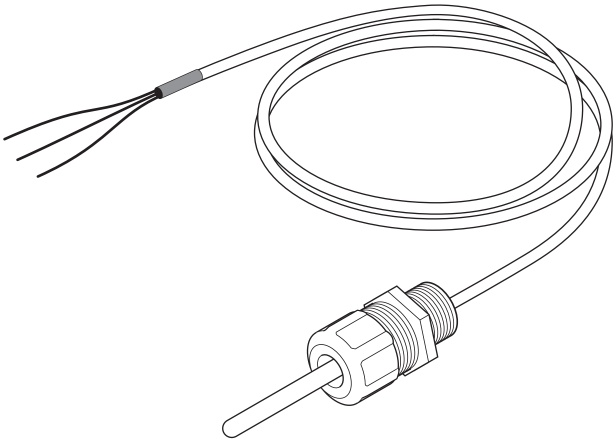
APPROVALS

Approvals associated with control device. Not to be used in Division 1 areas.

RTD-200

nVent
RAYCHEM

RTD TEMPERATURE SENSOR FOR AMBIENT SENSING



PRODUCT OVERVIEW

The nVent RAYCHEM RTD-200 is a three-wire platinum RTD (resistance temperature detector) typically used with electronic control systems that require accurate ambient temperature sensing. The RTD-200 comes with a 1/2" NPT fitting that installs to the appropriate conduit box. This allows mounting of the RTD in a typical ambient location. This also allows for splicing of RTD extension wire back to the controller.

SPECIFICATIONS

Sensor	
Housing	316 stainless steel
Dimensions	3-in (7.6 mm) length, 1/4-in (6 mm) diameter
Accuracy	± 0.3°F (± 0.2°C)
Range	–100°F to 300°F (–73°C to 149°C)
Resistance	100 ohms ± 0.25 ohm at 0°C α=0.00385 ohms/ohm/°C
Extension wire	
Wire size (each of three)	22 AWG **Note:** The length of RTD extension wires is determined by the wire gauge used. To reduce the likelihood that electrical noise will affect temperature measurement, keep RTD extension wires as short as possible. Use shielded instrument cable such as nVent RAYCHEM MONI-RTD-WIRE (22 AWG, PVC insulation, –30°F to 140°F, –20°C to 60°C) or Belden 83553 (22 AWG, FEP insulation, –95°F to 395°F, –70°C to 200°C).
Wire dielectric strength	600 V
Length	6 ft (1.8 m)
Outer jacket	Fluoropolymer
Maximum exposure temperature	300°F (149°C)
Sensor fitting	1/2-in (12.7 mm) NPT with sealing washer and nut

APPROVALS

Approvals associated with control device. Not to be used in Division 1 areas.

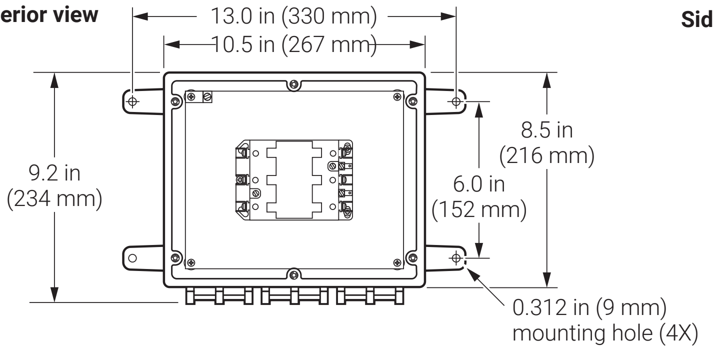
E104, E304, and E307

THREE-POLE CONTACTORS E104 – 100 A THREE-POLE CONTACTOR FOR NONHAZARDOUS LOCATIONS

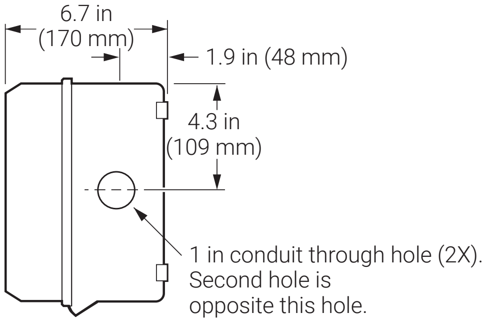
DESCRIPTION

Three-pole, 100 amp per pole, 600 Vac maximum contactor housed in a TYPE 4X enclosure with two 1-inch conduit entries. When ordering, select coil voltage (110–120, 208–240, 277, 480, or 600 Vac).

Interior view



Side view



SPECIFICATIONS

Enclosure	TYPE 4X thermoplastic; UL Listed, CSA Certified
Power connection	Screw terminals, 14–4 AWG (2 to 20 mm^2)
Contactor rating	100 A per pole, 600 Vac maximum, UL Recognized, CSA Certified
Order with appropriate coil:	

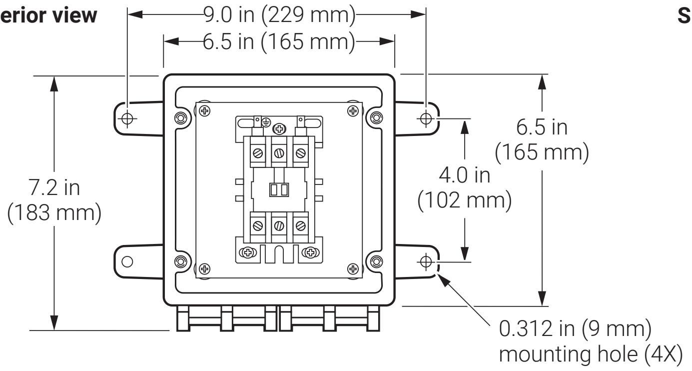
COIL RATING	CATALOG NUMBER
110–120 Vac	nVent RAYCHEM E104-100-120
208–240 Vac	E104-100-208 / 240
277 Vac	E104-100-277
480 Vac	E104-100-480
600 Vac	E104-100-600

NVENT RAYCHEM E304 – 40 A THREE-POLE CONTACTOR FOR NONHAZARDOUS LOCATIONS

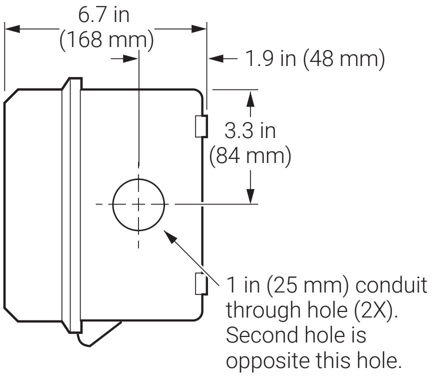
DESCRIPTION

Three-pole, 40 amp per pole, 600 Vac maximum contactor housed in TYPE 4, 7, 9 aluminum enclosure with two 1-inch NPT entries. The enclosure is approved for use in Class I, Groups B, C, D; Class II, Groups E, F, G; and Class III. When ordering, select coil voltage (110–120, 208–240, 277, 480, or 600 Vac).

Interior view



Side view



SPECIFICATIONS

Enclosure	TYPE 4X thermoplastic; UL Listed, CSA Certified
Power connection	Screw terminals, 14–4 AWG (2 to 20 mm^2)
Contactor rating	40 A per pole, 600 Vac maximum, UL Listed, CSA Certified

Order with appropriate coil:

COIL RATING	CATALOG NUMBER
110–120 Vac	E304-40-120
208–240 Vac	E304-40-208 / 240
277 Vac	E304-40-277
480 Vac	E304-40-480
600 Vac	E304-40-600

APPROVALS

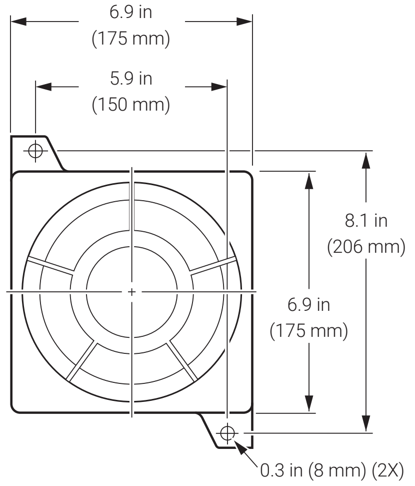
Nonhazardous locations
(E304 only)

NVENT RAYCHEM E307 – 40 A THREE-POLE CONTACTOR FOR HAZARDOUS LOCATION

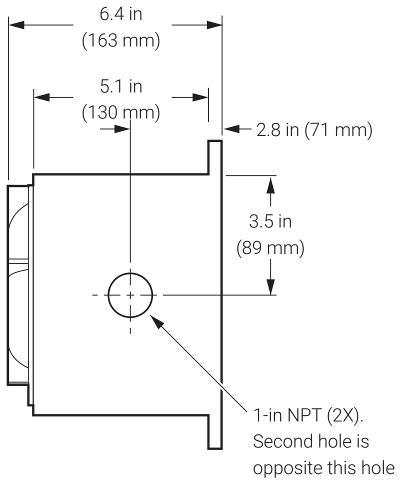
DESCRIPTION

Three-pole, 40 amp per pole, 600 Vac maximum contactor housed in TYPE 4, 7, 9 aluminum enclosure with two 1-inch NPT entries. The enclosure is approved for ause in Class I, Groups B, C, D; Class II, Groups E, F, G; and Class III. When ordering, select coil voltage (110–120, 208–240, 277, 480, or 600 Vac)..

Top view



Side view



SPECIFICATIONS

Enclosure	TYPE 4, 7, 9 cast aluminum, UL Listed, CSA Certified, FM Approved
Power connection	Pressure lugs for 14–4 AWG (2 to 20 mm^2) wire
Contactor rating	40 A per pole, 600 Vac maximum, UL Recognized, CSA Certified

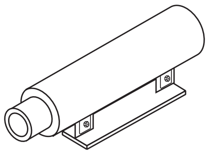
Order with appropriate coil:

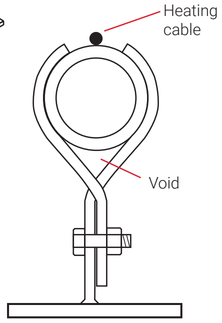
COIL RATING	CATALOG NUMBER
110–120 Vac	E307-40-120
208–240 Vac	E307-40-208 / 240
277 Vac	E307-40-277
480 Vac	E307-40-480
600 Vac	E307-40-600

INTERLOCK

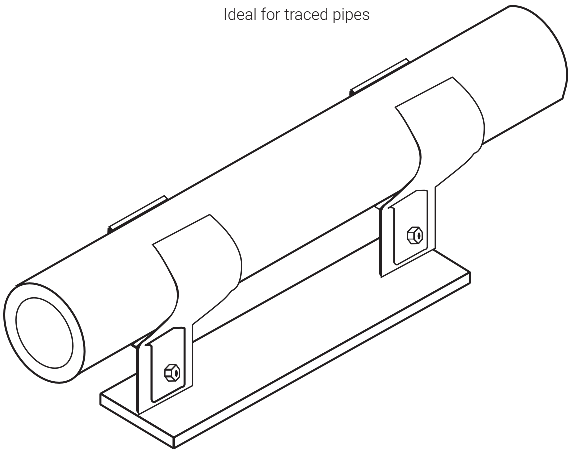
nVent RAYCHEM

CLAMP-ON PIPE SHOE





Ideal for traced pipes



PRODUCT OVERVIEW

The nVent RAYCHEM Interlock clamp-on pipe shoe is a patented pipe support designed to eliminate field welding requirements for pipe supports, while overcoming the many disadvantages associated with the clamp-on pipe shoes that are available on the market today.

The Interlock pipe shoe is more cost effective when compared to either conventional clamp-on pipe supports or field welded pipe supports and can be used on all pipe applications including bare pipe, painted pipe, insulated pipe, or heat-traced pipe.

Interlock pipe shoes may reduce the amount of heat loss at supports to a negligible level.

The Interlock pipe shoe is designed for use on nominal pipe sizes ranging from 1-in (25.4 mm) through 8-in (203.2 mm), and is available in heights of 3-in (76.2 mm), 4-in (101.6 mm), and 6-in (152.4 mm) to accommodate varying thicknesses of pipe insulation. The Interlock shoe is made from hot dip galvanized A-36 carbon steel for corrosion protection.

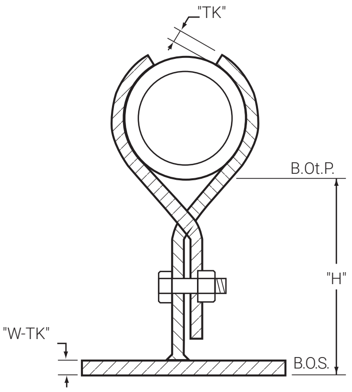
BENEFITS

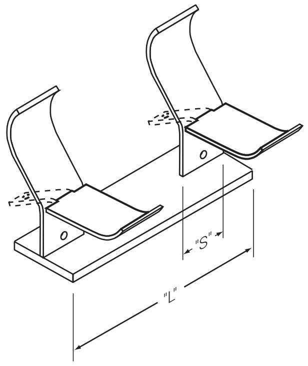
Reduced heat loss	The clamps of a conventional clamp-on pipe shoe extend radially outward from the pipe, increasing the labor and reducing the integrity of insulation local to the support. Interlock, with its unique cross section, offers reduced installation time and increased insulation integrity.
Increased pipe rack utilization	Because of its minimal profile, the Interlock shoe allows for better rack utilization by reducing the clearance required to accommodate the extended clamps of conventional shoes.
No pipe corrosion	Corrosion has historically been a major problem with conventional clamp-on shoes. Protective coatings tend to deteriorate between the support and the pipe bottom because of moisture or other trapped contaminates. Because the Interlock shoe does not have a saddle that will collect moisture or other corrosive media, the corrosion problem associated with conventional clamp-on pipe supports is not an issue.
Traced pipes	The Interlock shoe is the only clamp-on shoe that allows for direct contact between the heat tracing and the pipe. Heat tracing can be installed between the clamp tongs, allowing for maximum heat transfer. The minimal profile of the Interlock shoe reduces heat loss significantly more than other clamp-on shoes.

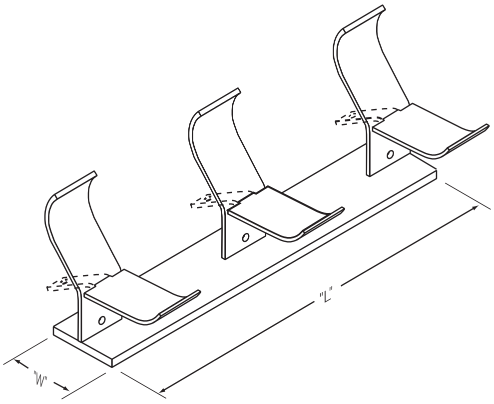
OPERATING TEMPERATURES

Temperature	The standard Interlock shoe (made of A-36 carbon steel) can be used in services from −20°F (−28.9°C) to 400°F (204.4°C).

DIMENSIONS







MATERIALS OF CONSTRUCTION

Material	Interlock shoe is made out of A-36 carbon steel, but is also available in other materials of construction for special applications.
Base	Depending on the application, includes either two or three support tongs welded to the Interlock shoe. These support tongs have a lever gap stamped in their base through which a mating tong is inserted. When the mating tong is bolted to the support tong, the pipe ends of the tong are drawn together, gripping the pipe.
Assembly	The entire assembly is galvanized (6 mil thick) for corrosion protection.

PRODUCT SPECIFICATIONS

Pipe size inch (mm)	L inch (mm)	H inch (mm)	W inch (mm)	S inch (mm)	W-TK inch (mm)	TK inch (mm)	Plate	Bolt/Nut
1 (25.4),1.5 (38.1),	12 (304.8), 18 (457.2)	3 (76.2), 4 (101.6)	3 (76.2)	3 (76.2)	3/8 (9.525)	3/16 (4.762)	A-36	1/2" (12.7 mm)
2 (50.8)	12 (304.8), 18 (457.2)	6 (152.4)	4 (101.6)	3 (76.2)	3/8 (9.525)	3/16 (4.762)	C.S.	A449 w/2 H nut
3 (76.2), 4 (101.6)	12 (304.8), 18 (457.2)	3 (76.2), 4 (101.6)	3 (76.2)	3 (76.2)	3/8 (9.525)	1/4 (6.35)	A-36	1/2" (12.7 mm)
	12 (304.8), 18 (457.2)	6 (152.4)	6 (152.4)	3 (76.2)	3/8 (9.525)	1/4 (6.35)	C.S.	A449 w/2 H nut
6 (152.4)	12 (304.8),18 (457.2)	3 (76.2), 4 (101.6)	4 (101.6)	4 (101.6)	3/8 (9.525)	1/4 (6.35)	A-36	1/2" (12.7 mm)
	12 (304.8), 18 (457.2)	6 (152.4)	6 (152.4)	4 (101.6)	3/8 (9.525)	1/4 (6.35)	C.S.	A449 w/2 H nut
8 (203.2)	12 (304.8), 18 (457.2)	3 (76.2), 4 (101.6)	4 (101.6)	4 (101.6)	3/8 (9.525)	5/16 (7.938)	A-36	1/2" (12.7 mm)
	12 (304.8), 18 (457.2)	6 (152.4)	6 (152.4)	4 (101.6)	3/8 (9.525)	5/16 (7.938)	C.S.	A449 w/2 H nut

INTERLOCK ORDERING MATRIX: A / B / C / D

1 - 3 - 12 - B

Example

A = Pipe size – 1" (25.4 mm), 1.5" (38.1 mm), 2" (50.8 mm), 3" (76.2 mm), 4" (101.6 mm), 6" (152.4 mm), 8" (203.2 mm)

B = Shoe height – 3" (76.2 mm), 4" (101.6 mm), 6" (152.4 mm)

C = Shoe length – 12" (304.8 mm), 18" (457.2 mm)

D = Isolation/heat trace thermal boot – n/a, B

ORDERING INFORMATION

2 Clamp – 12 inch (304.8 mm) Long Support

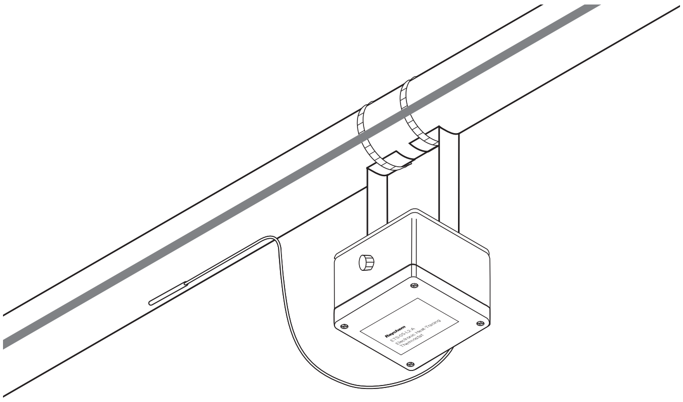
Nominal pipe size – inch (mm)	Height – inch (mm)	Catalog number	Weight – lbs (kg)
1 (25.4)	3 (76.2)	1-3-12	6.50 (2.948)
1 (25.4)	4 (101.6)	1-4-12	7.00 (3.175)
1 (25.4)	6 (152.4)	1-6-12	9.75 (4.423)
1.5 (38.1)	3 (76.2)	1.5-3-12	7.00 (3.175)
1.5 (38.1)	4 (101.6)	1.5-4-12	7.50 (3.402)
1.5 (38.1)	6 (152.4)	1.5-6-12	10.50 (4.763)
2 (50.8)	3 (76.2)	2-3-12	7.25 (3.289)
2 (50.8)	4 (101.6)	2-4-12	7.75 (3.515)
2 (50.8)	6 (152.4)	2-6-12	10.75 (4.876)
3 (76.2)	3 (76.2)	3-3-12	8.25 (3.742)
3 (76.2)	4 (101.6)	3-4-12	8.50 (3.856)
3 (76.2)	6 (152.4)	3-6-12	13.25 (6.01)
4 (101.6)	3 (76.2)	4-3-12	11.25 (5.103)
4 (101.6)	4 (101.6)	4-4-12	11.50 (5.216)
4 (101.6)	6 (152.4)	4-6-12	17.25 (7.824)
6 (152.4)	3 (76.2)	6-3-12	16.75 (7.598)
6 (152.4)	4 (101.6)	6-4-12	17.00 (7.711)
6 (152.4)	6 (152.4)	6-6-12	22.50 (10.21)
8 (203.2)	3 (76.2)	8-3-12	22.00 (9.979)
8 (203.2)	4 (101.6)	8-4-12	23.50 (10.66)
8 (203.2)	6 (152.4)	8-6-12	29.50 (13.38)
Isolation insert for 12"		-B	—

3 Clamp – 18 inch (457.2 mm) Long Support

Nominal pipe size – inch (mm)	Height – inch (mm)	Catalog number	Weight – lbs (kg)
1 (25.4)	3 (76.2)	1-3-18	9.75 (4.423)
1 (25.4)	4 (101.6)	1-4-18	10.50 (4.763)
1 (25.4)	6 (152.4)	1-6-18	14.75 (6.69)
1.5 (38.1)	3 (76.2)	1.5-3-18	10.50 (4.763)
1.5 (38.1)	4 (101.6)	1.5-4-18	11.25 (5.103)
1.5 (38.1)	6 (152.4)	1.5-6-18	15.75 (7.144)
2 (50.8)	3 (76.2)	2-3-18	10.88 (4.935)
2 (50.8)	4 (101.6)	2-4-18	11.75 (5.33)
2 (50.8)	6 (152.4)	2-6-18	16.00 (7.257)
3 (76.2)	3 (76.2)	3-3-18	12.50 (5.67)
3 (76.2)	4 (101.6)	3-4-18	12.75 (5.783)
3 (76.2)	6 (152.4)	3-6-18	20.00 (9.072)
4 (101.6)	3 (76.2)	4-3-18	17.00 (7.711)
4 (101.6)	4 (101.6)	4-4-18	17.25 (7.824)
4 (101.6)	6 (152.4)	4-6-18	26.00 (11.79)
6 (152.4)	3 (76.2)	6-3-18	25.00 (11.34)
6 (152.4)	4 (101.6)	6-4-18	25.50 (11.57)
6 (152.4)	6 (152.4)	6-6-18	33.75 (15.31)
8 (203.2)	3 (76.2)	8-3-18	33.00 (14.97)
8 (203.2)	4 (101.6)	8-4-18	35.25 (15.99)
8 (203.2)	6 (152.4)	8-6-18	44.25 (20.07)
Isolation insert for 18" (457.2 mm)		-B	—

ETS-05-XX-A

SURFACE SENSING ELECTRONIC THERMOSTAT



PRODUCT OVERVIEW

The nVent RAYCHEM ETS-05-XX-A electronic surface sensing thermostat provides accurate temperature control for heating cables.

The ETS-05-XX-A is available in two versions. The ETS-05-L2-A is for temperatures up to 199°C (390°F), while the ETS-05-H2-A can be used for temperatures up to 499°C (930°F).The maximum nominal load is 32 A for both thermostats. Temperature setting is accurate via digital rotary switches inside the enclosure.

The ETS-05-XX-A has a LED indicator which indicates the status of the thermostat (powered on/off), the status of the heat-tracing cable (powered on/off) and the status of the sensor. In case of sensor failure the thermostat can switch to an on or off state, depending upon the users requirement.

PRODUCT CHARACTERISTICS

	ETS-05-L1-A-KIT **ETS-05-L2-A-KIT**	**ETS-05-H1-A** **ETS-05-H2-A**
Application	Surface sensing-Pipe Mount	Surface sensing-Wall Mount
Area of use	Hazardous area: Zone 1 or Zone 2 (Gas) or Zone 21 (Dust) CL I, DIV 2 Ordinary Locations	

APPROVALS/CERTIFICATION

C FM US APPROVED Hazardous Locations	In Combination with Pipe Stand: CL I, ZN1 AEx e ia mb IIC T5..T3 Gb ZN 21 AEx tb IIIC T100°C..T150°C Ex e ia mb IIC T5..T3 Gb Ex tb IIIC T100°C..T150°C Db CLI, DIV 2, Groups B, C, D CL II, DIV 2, Groups E, F, G Class III TYPE 4X, IP66	When Used without Pipe Stand: CL I, ZN 1 AEx e ia mb IIC T5 Gb ZN 21 AEx tb IIIC T100°C Ex e ia mb IIC T5 Gb Ex tb IIIC T100°C Db CL I, DIV 2, Groups B, C, D CL II, DIV 2, Groups E, F, G Class III TYPE 4X, IP66

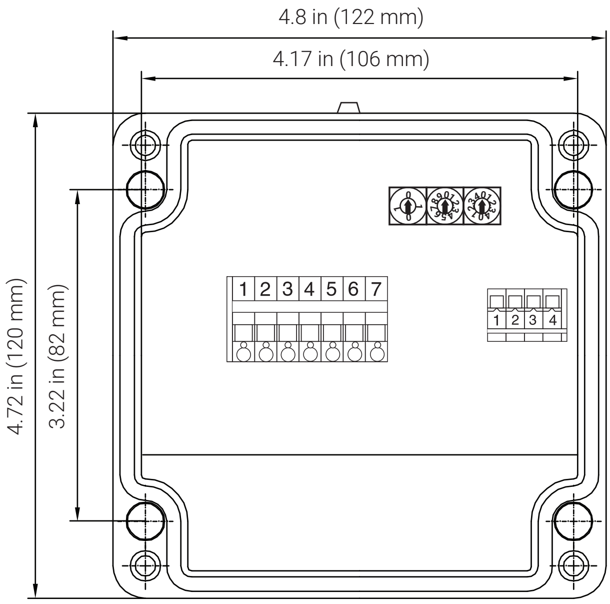
PRODUCT SPECIFICATION

Temperature setpoint range	0°C to 199°C (32°F to 390°F)	0°C to 499°C (32°F to 930°F)
Temperature measurement range	–55°C to 260°C (-67°F to 500°F)	–55°C to 585°C (-67°F to1085°F)
Sensor type	100 Ohm RTD, included in ETS-05-Lx-A-KIT (part of the pipe stand)	100 Ohm RTD (not included with thermostat)
Maximum sensor lead resistance	20 Ohm	20 Ohm
Ingress protection	IP66	IP66
Switching accuracy	±1 K at 5°C (41°F)	±1 K at 5°C (41°F), 2°C at 499°C (930°F)
Switching differential (Hysteresis)	≈ 3°C (5°F)	≈ 3°C (5°F)
Output relay	Single Pole change over type (SPST)	Single Pole change over type (SPST)
Switching capacity	32 A resistive load	32 A resistive load
Ambient temperature range	–40°C to + 60°C (–40°F to + 140°F)	–40°C to + 60°C (–40°F to + 140°F)
Supply voltage	L1-A: 99-132 VAC -10% L2-A: 195-277 VAC -2.5%	H1-A: 99-132 VAC -10% H2-A: 195-277 VAC -2.5%
Internal power consumption	3 VA	3 VA
Terminal size	max. 6 mm2 (10AWG)	max. 6 mm2 (10AWG)
Cable entries	2 x 3/4" 1 x Pipe stand	2 x 3/4" 1 x 3/4" Gland for power cable in
Mounting Method	JB-RTD-STAND (included in kit)	Wall-Mount

LED STATUS INDICATIONS

Green: ETS-05 powered on, heat-tracing cable off	Green: ETS-05 powered on, heat-tracing cable off
Yellow: ETS-05 powered on, heat-tracing cable on	Yellow: ETS-05 powered on, heat-tracing cable on
Red flashing: Sensor failure - controller in fail safe mode	Red flashing: Sensor failure - controller in fail safe mode

DIMENSIONS (IN MM)



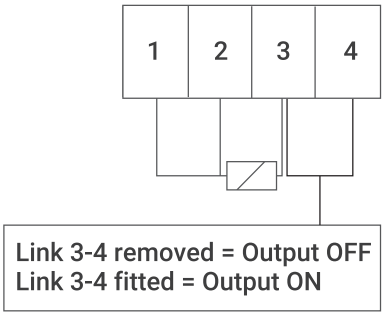
POWER TERMINALS

1	2	3	4	5	6	7
Line Out	Neutral Out	Neutral Supply	Line Supply	Earth	Earth	Earth

Terminals 2 and 3 are joined electrically

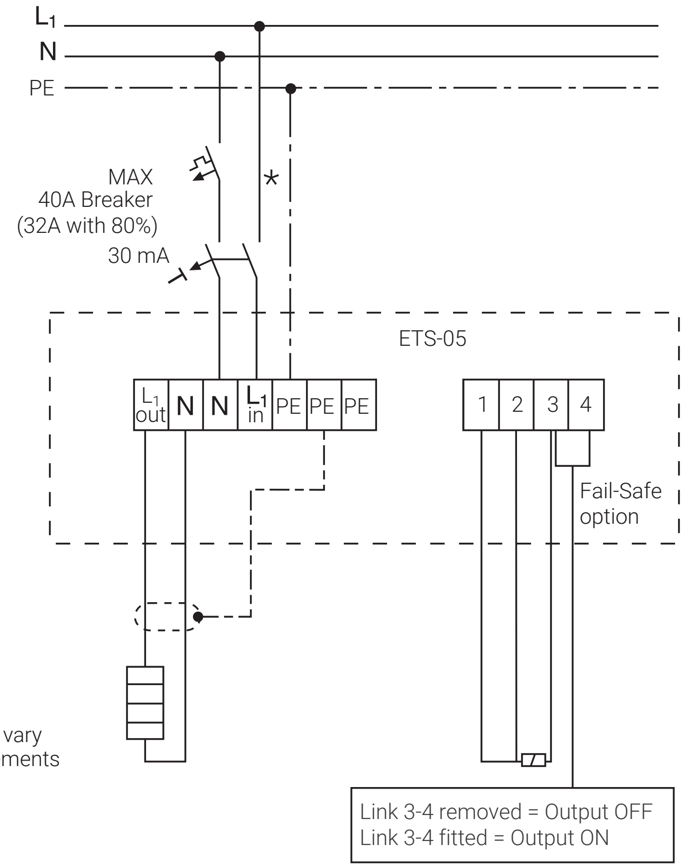
Terminals 5, 6 and 7 are joined electrically

SENSOR/FAILURE MODE SELECT TERMINALS



Terminals 1 to 3 allow for the connection of a three wire PT100 sensor.
Terminals 3 to 4 allow the user to select the default heating status on sensor error.
Without a link fitted the heating will turn OFF if a sensor error is detected.
With a link fitted the heating will turn ON if a sensor error is detected (default).

TYPICAL WIRING DIAGRAM FOR DIRECT SWITCHING



* Circuit breaker configurations may vary according to local standards/requirements

MOUNTING METHOD

JB-RTD-STAND: P000001997

SB-101: 990944-000

ORDERING DETAILS

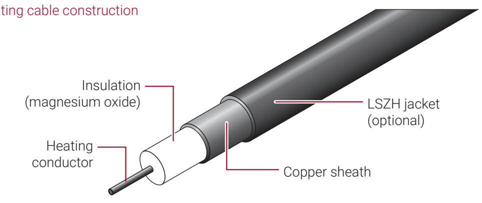
ETS-05 Thermostats (Thermostat Only)		ETS-05-H1-A: 1244-015664 ETS-05-H2-A: 1244-015665
ETS-05 Thermostat Kits (Includes Pipe Stand)	ETS-05-L1-A KIT: 1244-017701 ETS-05-L2-A KIT: 1244-017702	

MI HEATING CABLE

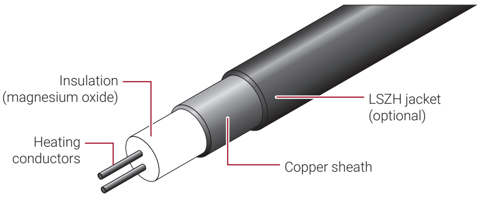
nVent RAYCHEM

COPPER AND LSZH JACKETED COPPER SHEATHED MI CABLE FOR COMMERCIAL AND INDUSTRIAL APPLICATIONS

Heating cable construction



Single-conductor cable (61 series)



Dual-conductor cable (32, 62 series)

10 YEAR Product warranty

PRODUCT OVERVIEW

The copper sheath provides an ideal ground path and allows for a rugged yet flexible heating cable that is easy to install. Each heating cable includes a heated section that is joined to a preterminated nonheating cold lead which is ready to connect into a junction box. For corrosive or embedded applications, such as concrete or asphalt snow melting, a cable with a Low Smoke Zero Halogen (LSZH) jacket is required. For embedded applications the red LSZH jacket enhances cable visibility during concrete or asphalt placement. Refer to the tables below for the complete list of approved applications.

For additional information or applications requiring stainless steel sheathed heating cables, contact your nVent representative or call (800) 545-6258.

APPROVED APPLICATIONS AND POWER OUTPUT FOR NONHAZARDOUS AREAS

Bare copper-sheathed heating cable	**c-CSA-us**	**FM**	**UL**	**Max. power output W/ft (W/m)**	
Snow melting on metal roofs	Yes	No	No	15	(49)
De-icing of metal gutters and downspouts	Yes	No	No	15	(49)
De-icing of nonmetallic gutters and downspouts	Yes	No	No	5	(16)
Freeze protection of metal pipes and vessels[2]	Yes	Yes	No	18	(59)
Process temperature maintenance (pipes and vessels)[2]	Yes	Yes	No	18	(59)
LSZH jacketed copper-sheathed heating cable					
Snow melting in concrete and mastic asphalt slab	Yes	No	Yes	30	(99)
Snow melting in road-grade asphalt slab	Yes	No	Yes	25	(82)
Snow melting in sand/limestone screenings (pavers)	No[1]	No	No	20	(66)
Snow melting on nonmetal roof	Yes	No	No	8	(26)
Pool and Spa Decks	Yes[3]	No	No	35	(115)
De-icing of metal gutters and downspouts	Yes	No	No	8	(26)
De-icing of nonmetallic gutters and downspouts	Yes	No	No	5	(16)
Floor heating in concrete slab	Yes	No	No	10	(33)
Frost heave protection - embedded in concrete	Yes	No	No	7	(23)
Freeze protection of metal pipes and vessels – internal	Yes	No	No	8	(26)
Freeze protection of metal pipes and vessels – external	Yes	No	No	8	(26)
Freeze protection of nonmetallic pipes and vessels – internal	Yes	No	No	4	(13)
Freeze protection of nonmetallic pipes and vessels – external	Yes	No	No	4	(13)

[1] Special permission for paver snow melting is required from the Authority Having Jurisdiction.

[2] When designing heating cables for pipe and vessel tracing, the "Max. power output (W/ft)" values may have to be decreased to ensure that the sheath temperature does not exceed the maximum exposure temperature (see page 2) of the cable.

[3] Pool and spa deck approval - Canada only.

APPROVED APPLICATIONS AND POWER OUTPUT FOR HAZARDOUS AREAS

Bare copper-sheathed heating cable	c-CSA-us	FM	UL	Max. power output W/ft (W/m)	
Process temperature maintenance (pipes and vessels)[3]	Yes	Yes	No	18	(59)
Freeze protection of metal pipes and vessels[3]	Yes	Yes	No	18	(59)
De-icing of metal gutters and downspouts[3]	Yes	No	No	15	(49)
De-icing of nonmetallic gutters and downspouts	Yes	No	No	5	(16)
LSZH jacketed copper-sheathed heating cable					
Snow melting in concrete and mastic asphalt slab	Yes	No	No	30	(99)
Snow melting in road-grade asphalt slab	Yes	No	No	25	(82)
De-icing of metal gutters and downspouts	Yes	No	No	8	(26)
De-icing of nonmetallic gutters and downspouts	Yes	No	No	5	(16)
Freeze protection of metal pipes and vessels – external	Yes	No	No	8	(26)
Freeze protection of nonmetallic pipes and vessels – external	Yes	No	No	4	(13)

[2] When designing heating cables for pipe and vessel tracing, and de-icing of metal gutters and downspouts, the “Max. power output (W/ft)” values may have to be decreased to ensure that the sheath temperature does not exceed the maximum exposure temperature of the cable (see below) or the autoignition temperature of gases and vapors present in the hazardous area. For assistance designing heating cables for hazardous areas, contact nVent Technical Support at (800) 545-6258.

TEMPERATURE RATINGS

Maximum exposure temperature	392°F (200°C) Bare copper-sheathed heating cable 194°F (90°C) LSZH-jacketed heating cable* * LSZH-jacketed cables may be exposed to higher temperatures during installation in asphalt.
Minimum installation temperature	-76°F (-60°C) Bare copper-sheathed heating cable -4°F (-20°C) for UL, -22°F (-30°C) for CSA LSZH-jacketed heating cable

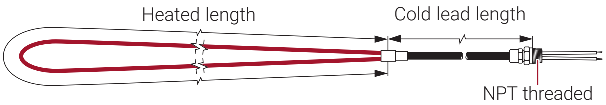
TEMPERATURE ID NUMBER (T-RATING)

To be established by calculating the maximum sheath temperature. Contact nVent for assistance.

BASIC HEATING CABLE DESIGN CONFIGURATIONS

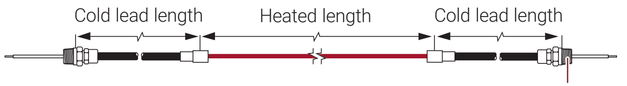
Heating cables are supplied as complete factory-fabricated assemblies consisting of the heated section joined to a length of nonheating cold lead section, preterminated with an NPT-threaded connector and ready to connect into a junction box.

Design A



Design A: Single conductor cable (61 series only)

Design B

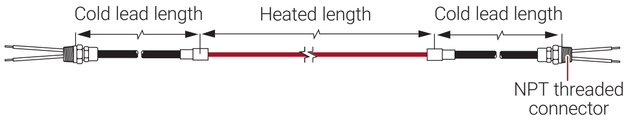


Design B: Single conductor cable (61 series only)

Design D

Design D: Dual conductor cable (32, 62 series only)

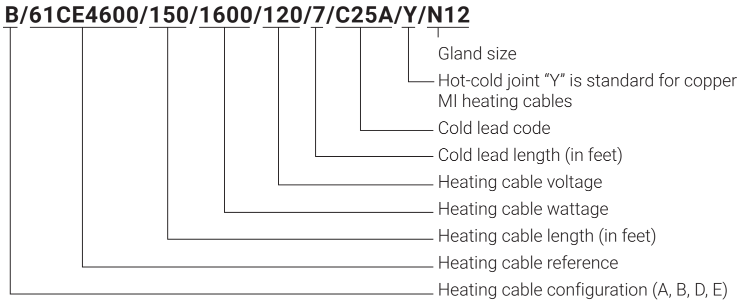
Design E



Design E: Dual conductor cable (32, 62 series only)

HEATING CABLE CATALOG NUMBER

To order an nVent RAYCHEM MI heating cable, it is important to understand the format of our catalog number.



In the above heating cable catalog number, the length of the heated section and the cold lead are in feet. For metric lengths, the heating cable catalog number would include a suffix "M" after the length, as shown below. A LSZH jacket on the heated section and a LSZH jacket on the cold lead have also been included in the following:
B/61RE4600-RD/45.7M/1600/120/2.1M/R25A/Y/N12

Options

Add suffix "/PE" at the end of the catalog number for pulling eye (Design D cables only).

Add suffix "/RG1" at the end of the catalog number for 1" reverse gland (used to make a watertight seal) for Designs A and D cables. Design D cables also available with 1/2" or 3/4" reverse gland ("/RG34" for 3/4" or "/RG12" for 1/2").

Examples

Snow melting for area 1200 sq ft (spacing 7")
6 cables **B/61RE3150-RD/343/7000/600/15/R25A/Y/N12**

- Heating cable configuration is Design B
- 600 V rated single conductor LSZH jacketed cable, resistance at 20°C is 0.150 Ω/ft (0.492 Ω/m)
- Each heating cable length is 343 ft (104.5 m)
- Each heating cable wattage is 7000 W at 600 V
- Cold lead is 15 ft (4.5 m) with LSZH jacket
- Cold lead code is R25A
- 1/2-in NPT gland connector

Pipe tracing for 2 in x 50 ft pipe
1 cable **D/32CD3800/52/340/120/3/C22A/Y/N12**

- Heating cable configuration is Design D
- 300 V rated two conductor cable, resistance at 20°C is 0.80 Ω/ft (2.625 Ω/m)
- Heating cable length is 52 ft (15.9 m)
- Heating cable wattage is 340 W at 120 V
- Cold lead is 3 ft (0.9 m)
- Cold lead code is C22A
- 1/2-in NPT gland connector

HEATING CABLE REFERENCE DECODING

6 1 C D 3 6 1 0
Digit 1 2 3 4 5 6 7 8

6 1 R D 3 6 1 0-RD
Digit 1 2 3 4 5 6 7 8 9

Digit number	Description	
1	Maximum voltage rating	3 = 300 V, 6 = 600 V
2	Number of conductors	1 or 2
3	Sheath material	C = Copper, R = LSZH jacket
4	Conductor material	C, D, or E
5	Move decimal point to left indicated number of places	1, 2, 3, 4, 5, or 6 places
6 to 8	Cable resistance (Ω/ft) to 3 whole numbers (use with digit 5)	3610 = 0.610 Ω/cable foot at 20°C
9	Jacket color - use only with LSZH jacketed cables	-RD = red color LSZH jacket

COLD LEADS FOR COPPER-SHEATHED HEATING CABLES

Cold leads for copper MI heating cables are available in bare copper or for superior mechanical and corrosion resistance LSZH jacketed copper. Use LSZH jacketed copper for all embedded heating cable applications, such as snow melting and floor heating.

Bare copper cold lead code	LSZH jacketed cold lead code	Maximum voltage (V)	Maximum current (A)	Gland size (NPT)	Gland size reference for catalog number	Tail size (AWG)
Design A, D, E						
C22A	R22A	600	22	1/2"	N12	14
C29A	R29A	600	29	1/2"	N12	12
C38A	R38A	600	38	3/4"	N34	10
C50A	R50A	600	50	3/4"	N34	8
C67A	R67A	600	67	3/4"	N34	6
C90A	R90A	600	90	1"	N1	4
Design B						
C25A	R25A	600	25	1/2"	N12	14
C30A	R30A	600	30	1/2"	N12	12
C40A	R40A	600	40	1/2"	N12	10
C60A	R60A	600	60	1/2"	N12	8
C80A	R80A	600	80	1/2"	N12	6
C105A	R105A	600	105	3/4"	N34	4

SERIES 61 MI HEATING CABLE SPECIFICATIONS (600 V, SINGLE CONDUCTOR)

Heating cable reference	Nom. cable resistance at 20°C		Nominal cable diameter		Max. unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
61CD3610	0.610	2.00	0.120	3.0	11712	3571	35	52.1
61CD3390	0.390	1.28	0.132	3.4	9689	2954	45	67.0
61CD3300	0.300	0.984	0.160	4.1	6595	2011	45	67.0
61CD3200	0.200	0.656	0.168	4.3	5987	1825	56	83.3
61CE3150	0.150	0.492	0.148	3.8	7718	2353	49	72.9
61CE3105	0.105	0.344	0.174	4.4	5230	1594	52	77.4
61CE4800	0.0800	0.262	0.182	4.6	4948	1508	54	80.4
61CE4600	0.0600	0.197	0.194	4.9	4269	1301	56	83.3
61CE4400	0.0400	0.131	0.185	4.7	4686	1429	58	86.2
61CE4300	0.0300	0.0980	0.192	4.9	4340	1323	65	96.6
61CE4200	0.0200	0.0660	0.205	5.2	3564	1086	74	110.2
61CC4100	0.0100	0.0328	0.198	5.0	4624	1409	58	86.3
61CC5651	0.00651	0.0214	0.194	4.9	4187	1277	67	99.7
61CC5409	0.00409	0.0134	0.223	5.7	3394	1034	84	125.2
61CC5258	0.00258	0.00846	0.230	5.8	3076	938	98	146.1
61CC5162	0.00162	0.00531	0.246	6.2	2693	821	117	174.2
61CC5102	0.00102	0.00335	0.277	7.0	2056	627	154	229.1
61CC6641	0.000641	0.00210	0.298	7.6	1688	515	179	266.3
61CC6403	0.000403	0.00132	0.340	8.6	1331	406	236	351.1

Notes: 1) To specify an LSZH jacket on the heating cable, replace the “C” (first letter in cable reference) with “R” and add a “-RD” suffix (red jacket colour) after the cable reference number.
Example: 61CD3610 becomes 61RD3610-RD for red jacketed version.

2) Tolerance on cable resistance is ± 10%.

SERIES 32 MI HEATING CABLE SPECIFICATIONS (300 V, DUAL CONDUCTOR)

Heating cable reference	Nom. cable resistance at 20°C		Nominal cable diameter		Max. unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
32CD3800	0.800	2.62	0.165	4.2	5800	1768	46	68.5
32CD3600	0.600	1.97	0.175	4.4	5676	1730	59	87.8
32CD3400	0.400	1.31	0.183	4.6	4686	1428	60	89.4
32CD3300	0.300	0.984	0.190	4.8	4158	1267	62	92.1
32CE3200	0.200	0.656	0.185	4.7	4686	1428	60	89.4
32CE3125	0.125	0.410	0.195	5.0	4026	1227	65	96.6
32CE3100	0.100	0.328	0.208	5.3	3564	1086	65	96.6
32CE4700	0.0700	0.230	0.230	5.8	3300	1006	110	163.7
32CE4440	0.0440	0.144	0.260	6.6	2244	684	140	208.2
32CE4280	0.0280	0.092	0.300	7.6	1782	543	182	270.8

Notes: 1) To specify a LSZH jacket on the heating cable, replace the “C” (first letter in cable reference) with “R” and add a “-RD” suffix (red jacket colour) after the cable reference number.
Example: 32CD3800 becomes 32RD3800-RD for red jacketed version.

2) Tolerance on cable resistance is ± 10%.

SERIES 62 MI HEATING CABLE SPECIFICATIONS (600 V, DUAL CONDUCTOR)

Heating cable reference	Nom. cable resistance at 20°C		Nominal cable diameter		Max. unjointed cable length		Nominal weight	
	Ω/ft	Ω/m	in	mm	ft	m	lb/1000 ft	kg/1000 m
62CE4950	0.0950	0.312	0.283	7.2	1890	576	129	192
62CE4700	0.0700	0.230	0.309	7.9	1400	427	150	223.2
62CE4440	0.0440	0.144	0.340	8.6	1170	357	181	269.4
62CE4280	0.0280	0.0920	0.371	9.4	965	294	224	333.8
62CC4200	0.0200	0.0656	0.252	6.4	2500	762	109	242.0
62CC4130	0.0130	0.0427	0.309	7.9	1647	502	150	223.2
62CC5818	0.00818	0.0268	0.340	8.6	1217	371	189	281.2
62CC5516	0.00516	0.0169	0.371	9.4	1062	324	236	351.1
62CC5324	0.00324	0.0106	0.402	10.2	876	267	275	409.1
62CC5204	0.00204	0.00669	0.449	11.4	706	215	353	525.3

Notes: 1) To specify a LSZH jacket on the heating cable, replace the “C” (first letter in cable reference) with “R” and add a “-RD” suffix (red jacket colour) after the cable reference number.
Example: 62CE4950 becomes 62RE4950-RD for red jacketed version.

2) Tolerance on cable resistance is ± 10%.

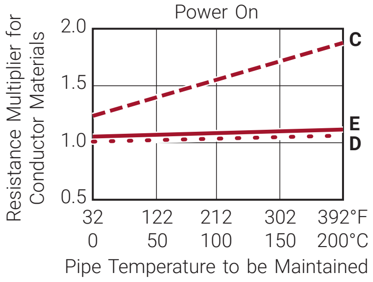
RESISTANCE CORRECTION FACTOR

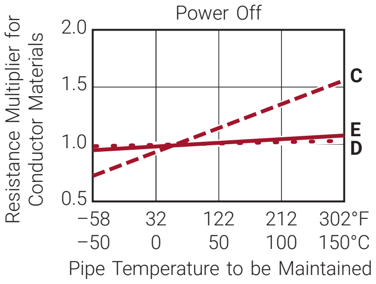
Various conductor materials behave differently. Based on the application, use the table or graphs below for approximate adjustment of power and resistance as a function of temperature. For detailed design, contact nVent for further assistance.

Applications: Snow melting, floor warming, roof and gutter de-icing, frost-heave prevention

Conductor material	Correction factor
C	1.15
D	1.0
E	1.0

Applications: Freeze protection for pipes and vessels, process temperature maintenance for pipes and vessels





APPROVALS

Also refer to application tables on previous pages

Nonhazardous Locations

***Hazardous Locations**
Class I, Div 1 & 2, Groups A, B, C, D
Class II, Div 1 & 2, Groups E, F, G
Class III

* Polymer jacketed MI Heating Cables are not FM approved.

Nonhazardous Locations

***Hazardous Locations**
Class I, Div 1* & 2, Groups A, B, C, D
Class II, Div 1 & 2, Groups E, F, G
Class III

* Polymer jacketed MI Heating Cables are not approved for CID1 locations

Nonhazardous Locations

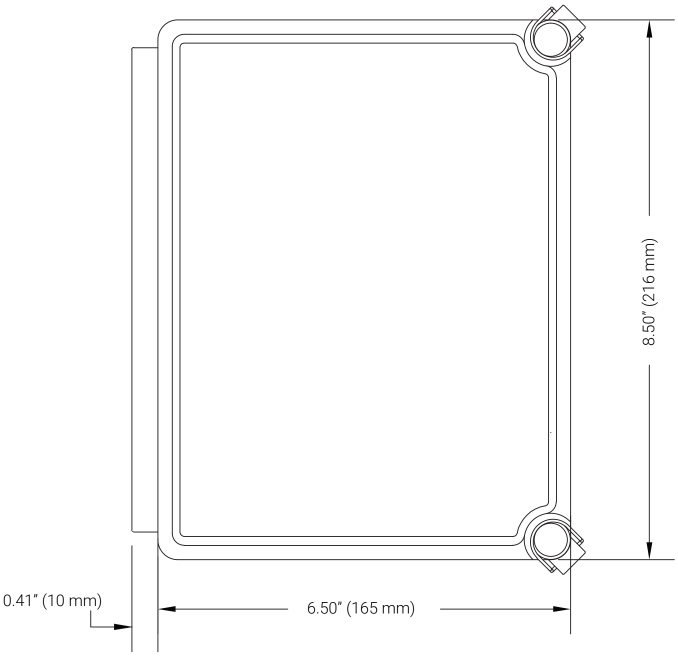
Zone:
US: Class I Zone 1 AEx e IIC T*
Canada: Ex e IIC T*

GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of nVent, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection. Many nVent RAYCHEM control and monitoring systems meet the ground-fault protection requirement.

MIJB-864-A

MI POWER AND SPLICE BOX JUNCTION BOX WITH PRE-DRILLED EARTHING PLATE FOR USE WITH MI HEATING UNITS



FRONT VIEW

PRODUCT OVERVIEW

The efficient design and simple construction of these enclosures make them durable in corrosive environments, yet aesthetically pleasing.

Corner latches provide unobstructed access. The continuous hinge pin provides a secure seal and double latching creates added security.

Typically, it is used as a single cable power junction box or splice box:

- One power cable in and two MI cables out
- One power cable in, one power cable out and one MI cable out
- Two D or E design MI cables in and two D or E design MI cables out (splice box)
- Three B design MI cables in and three B design MI cables out (splice box)
- Star termination for 3-phase B design MI cables
- 3-phase energization of three B design MI cables

CONSTRUCTION

- Compression molded fibreglass has outstanding chemical and temperature resistance qualities and exhibits excellent weatherability and physical properties
- Light gray finish inside and out
- Gasket assures water-tight and dust-tight seal
- Polyester mounting tabs and stainless steel attachment screws are provided with each enclosure
- Two corrosion resistant polyester quick release latches are located in corners to provide unobstructed access to enclosure
- Removable hinged cover attached to body with stainless steel hinge pin
- Hinge pin and bail are corrosion resistant Type 316 stainless steel
- Padlock provisions included in each latch
- Inside dimensions: 8" high x 6" wide x 4" deep (200 x 150 x100 mm)
- Box includes earthing plate on three sides and back of box and is pre-punched for eight ½" and three ¾" hubs
- Entries: Up to 8 x ½" and 3 x ¾" - Use a step bit to drill out or enlarge any holes in fibreglass required for hubs/ connectors

APPROVALS

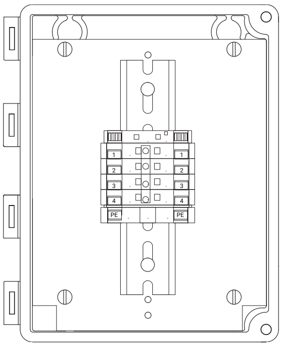
CSA approved Type 4X enclosure and certified electrical assembly

Area classification - Hazardous locations CL I Division 2 (Zone 2), Groups A,B,C,D T5
Enclosure type: Type 4X

Ambient temperature rating: –50°C to +40°C

Enclosure flammability evaluated per UL 508A

ELECTRICAL SPECIFICATIONS



Maximum operating voltage 600Vac

Maximum 65A per terminal, rated 18AWG to 6AWG

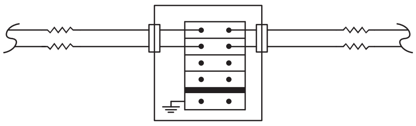
Maximum 65A per terminal, rated 18AWG to 6AWG

Consider MI cold lead cable gland size, hub size and power cable size in selecting appropriate box

Power cable gland and hubs for MI cold lead glands not included

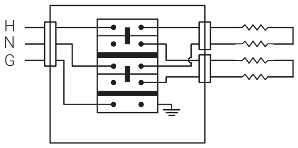
TYPICAL ELECTRICAL CONNECTION OPTIONS

MIJB-864-A-SPLC



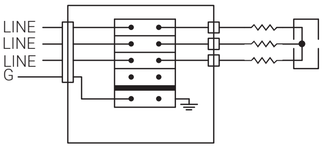
- USED TO SPLICE E DESIGN MI CABLES WITH E OR D DESIGN CABLES.
- FIELD TO REMOVE 4-POLE JUMPER.

MIJB-864-A-PARALLEL

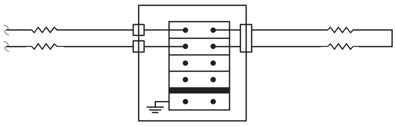


- USE WITH A, E OR D DESIGN MI CABLES.
- FIELD TO CUT 4-POLE JUMPER INTO TWO 2-POLES, AND INSTALL LOOSE END PLATE (INCLUDED)

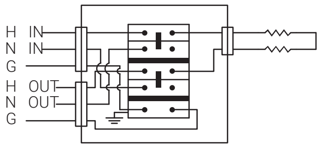
MIJB-864-A-3PWR



- USE WITH B DESIGN MI CABLES.
- USE AN MIJB-864-A-STAR TO TERMINATE OR A MIJB-864-A-SPLC TO CONTINUE THE 3-PHASE HEATER CABLE.
- FIELD TO REMOVE 4-POLE JUMPER.

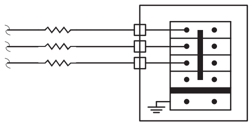


- USED TO SPLICE B DESIGN TO A DESIGN MI CABLES.
- FIELD TO REMOVE 4-POLE JUMPER.

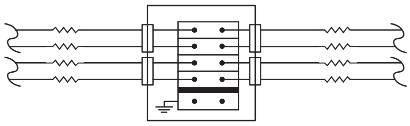


- USE WITH A, E OR D DESIGN MI CABLES.
- FIELD TO CUT 4 POLE JUMPER INTO TWO 2-POLES, AND INSTALL LOOSE END PLATE (INCLUDED)

MIJB-864-A-STAR

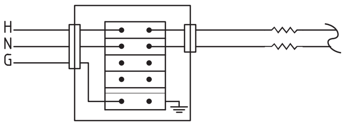


- USED TO TERMINATE 3 PHASE B DESIGN MI CABLES.



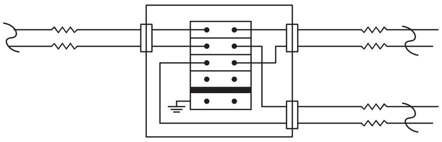
- USED TO SPLICE E-TYPE MI CABLES WITH E OR D DESIGN CABLES.
- FIELD TO REMOVE 4-POLE JUMPER.

MIJB-864-A-PWR

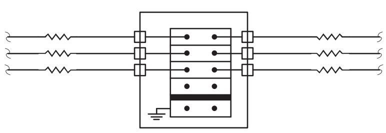


- USE WITH A, E OR D DESIGN MI CABLES.
- FIELD TO CUT 4 POLE JUMPER INTO TWO 2-POLES, AND INSTALL LOOSE END PLATE (INCLUDED)

MIJB-864-A-SERIEST

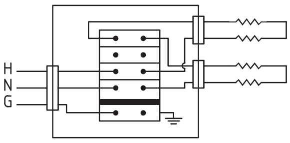


- USE WITH A, E OR D DESIGN MI CABLES.
- FIELD TO REMOVE 4-POLE JUMPER.



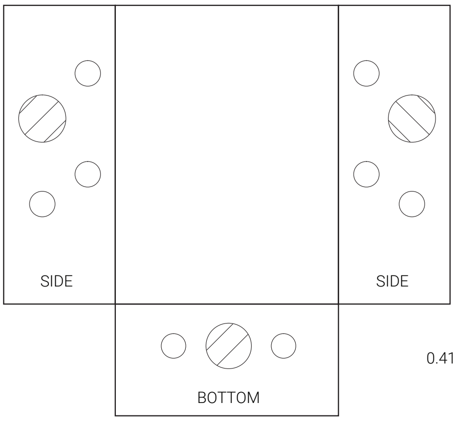
- USED TO SPLICE B DESIGN MI CABLES. (TYPICALLY 3 PHASE)
- FIELD TO REMOVE 4-POLE JUMPER.

MIJB-864-A-SERIES



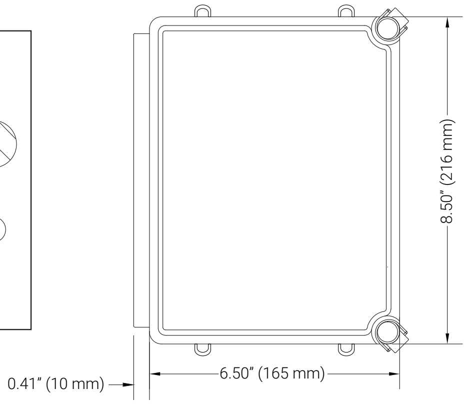
- USE WITH A, E OR D DESIGN MI CABLES.
- FIELD TO REMOVE 4-POLE JUMPER.

ENCLOSURE DETAIL



EARTHING PLATE DETAIL

⊘ 1-1/8" HOLE FOR 3/4" CONDUIT HUB/CONNECTOR
○ 7/8" HOLE FOR 1/2" CONDUIT HUB/CONNECTOR



FRONT VIEW

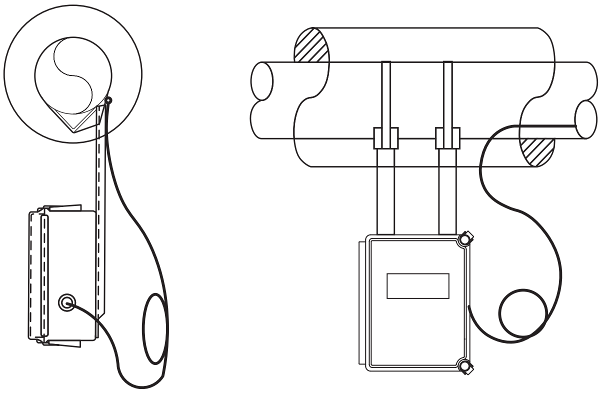
- Junction boxes can be mounted using holes in back and screws provided, or using four mounting tabs supplied
- Hinge can be moved to other side of box by rotating earthing plate 180°
- Earthing plate is fabricated from galvanized steel, and is bonded to internal PE terminal block for bonding of hubs and connectors
- No bonding wires are required between the hubs, connectors and PE terminal blocks.

GENERAL

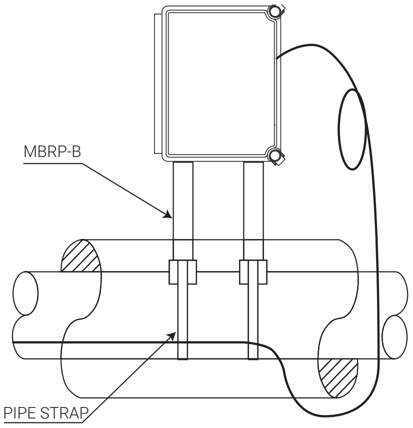
Lamacoids are not included.

Two mounting brackets (MBRP-B) and two pipe straps or alternate mounting method must be ordered separately for installation on pipe.

ENCLOSURE MOUNTING BRACKET

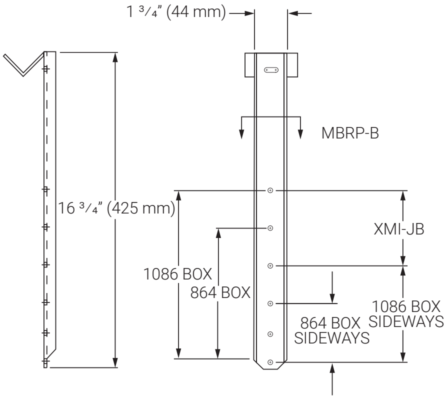


BOTTOM MOUNT



MBRP-B Product Overview

- Mounting bracket for MIJB series fiberglass enclosures which enables enclosure installation and connection prior to application of insulation and cladding
- Installation time reduction as electrician does not need to return after cladding is installed
- 304SS Stainless steel pipe support bracket for nVent RAYCHEM MIJB-864-A, MIJB-1086-A and MIJB-1086-B fiberglass enclosures
- Two brackets are required to support each enclosure. Each bracket requires one pipe strap
- Suitable for pipe temperatures up to 900°F (480°C)
- Stainless steel is a poor conductor of heat so the bracket is not hot or a heat sink



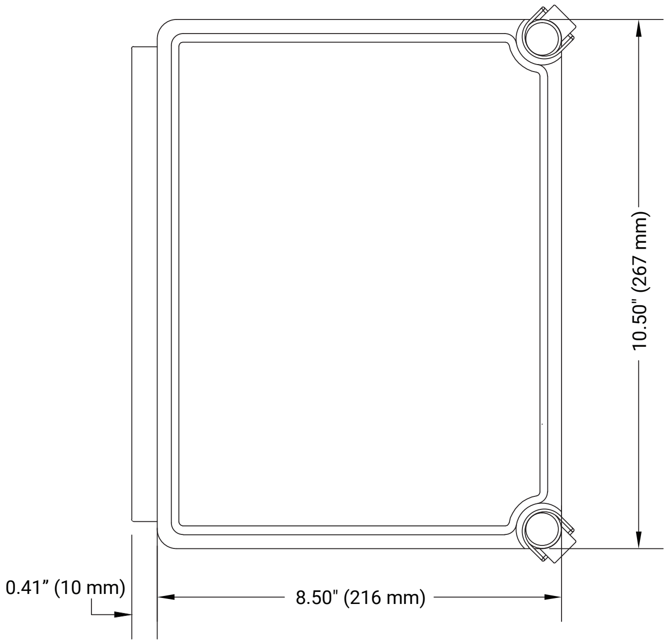
SIDE VIEW FRONT VIEW

ORDERING DETAILS

Description	Catalog number	Part number	Weight/lbs
Enclosure	MIJB-864-A	T0002069	4.50 lbs
Spare Parts and Accessories			
Mounting Bracket for MIJB series fiberglass enclosures	MBRP-B	T0002003	1.1 lbs

MIJB-1086-A

MI POWER JUNCTION BOX
JUNCTION BOX WITH PRE-DRILLED EARTHING PLATE
FOR USE WITH MI HEATING UNITS



FRONT VIEW

PRODUCT OVERVIEW

The efficient design and simple construction of these enclosures make them durable in corrosive environments, yet aesthetically pleasing.

Corner latches provide unobstructed access.

The continuous hinge pin provides a secure seal and double latching creates added security.

Typical uses include power, splice and end box for 3-phase system. It accommodates up to three power cables:

- One power cable in and up to three MI cables out
- One power cable in, one power cable out and two MI cables out
- Two D or E design MI cables in and two D or E design MI cables out (splice box)
- Three B design MI cables in and three B design MI cables out (splice box)

CONSTRUCTION

- Compression molded fibreglass has outstanding chemical and temperature resistance qualities and exhibits excellent weatherability and physical properties
- Light gray finish inside and out. Gasket assures water-tight and dust-tight seal
- Polyester mounting tabs and stainless steel attachment screws are provided with each enclosure
- Two corrosion resistant polyester quick release latches are located in corners to provide unobstructed access to enclosure
- Removable hinged cover attached to body with stainless steel hinge pin
- Hinge pin and bail are corrosion resistant Type 316 stainless steel. Padlock provisions included in each latch
- Inside dimensions: 10” high x 8” wide x 6” deep (250 x 200 x 150 mm)
- Box includes earthing plate on three sides and back of box and is pre-punched for eleven ½” and eight ¾” hubs
- Entries: Up to 11 x ½” and 8 x ¾” - Use a step bit to drill out or enlarge any holes in fibreglass required for hubs/connectors

APPROVALS

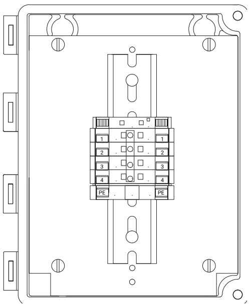
CSA approved Type 4X enclosure and certified electrical assembly

Area classification - Hazardous locations CL I Division 2 (Zone 2), Groups A,B,C,D T5
Enclosure type: Type 4X

Ambient temperature rating: –50°C to +40°C

Enclosure flammability evaluated per UL 508A

ELECTRICAL SPECIFICATIONS



Maximum operating voltage 600Vac

Maximum 65A per terminal, rated 18AWG to 6AWG

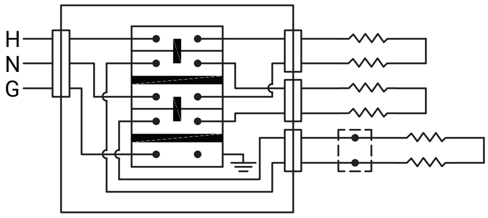
Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG but remain at 65A

Consider MI cold lead cable gland size, hub size and power cable size in selecting appropriate box

Power cable gland and hubs for MI cold lead glands not included

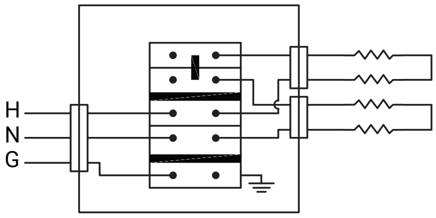
TYPICAL ELECTRICAL CONNECTION OPTIONS

MIJB-1086-A-PARALLEL

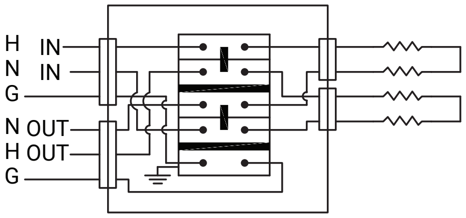


- USE WITH A, E OR D DESIGN MI CABLES.
- POWER WIRES TO BE FIELD ROUTED FROM MARSHALLING BOX TO INDIVIDUAL EHT POWER BOXES (I.E. MIJB-864-A-PWR,JBS, ETC...).

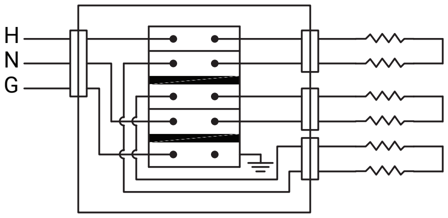
MIJB-1086-A-SERIES



- FIELD TO REMOVE ONE 2-POLE JUMPER AS SHOWN.
- USE WITH A, E OR D DESIGN MI CABLES.

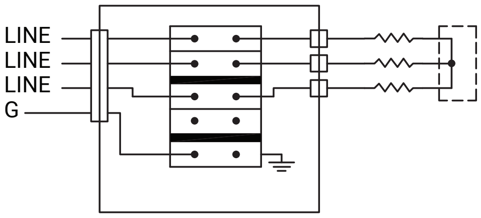


- USE WITH A, E OR D DESIGN MI CABLES.



-FIELD TO REMOVE TWO 2-POLE JUMPERS AS SHOWN.
-USE WITH A, E OR D DESIGN MI CABLES.

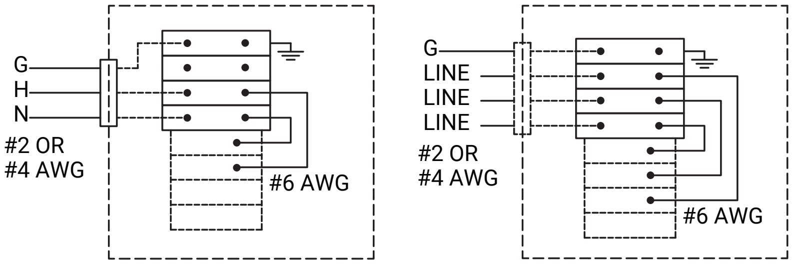
MIJB-1086-A-3PWR



- FIELD TO REMOVE TWO 2-POLE JUMPERS AS SHOWN.
- USE WITH B DESIGN MI CABLES.
- USE A MIJB-864-A-STAR TO TERMINATE OR AN MIJB-864-A-SPLC TO CONTINUE THE 3-PHASE HEATER CABLE.

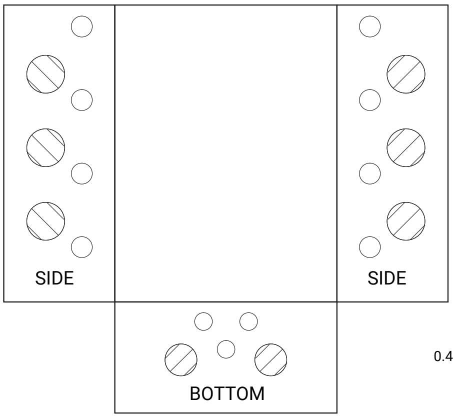
POWER CABLE DOWNSIZING OPTION:

MIJB-LPWR-KIT



- USED TO DOWNSIZE #2 OR #4 AWG POWER CABLES.
- ORDER MIJB-LPWR-KIT SEPARATELY IF REQUIRED.
- CONSISTS OF 3 POWER TERMINAL BLOCKS, 1 GROUND TERMINAL BLOCK, AND #6 AWG JUMPER WIRES.

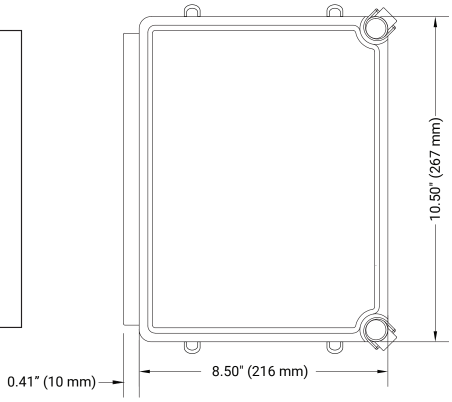
ENCLOSURE DETAIL



EARTHING PLATE DETAIL

⊘ 1-1/8" HOLE FOR 3/4" CONDUIT HUB/CONNECTOR

○ 7/8" HOLE FOR 1/2" CONDUIT HUB/CONNECTOR



FRONT VIEW

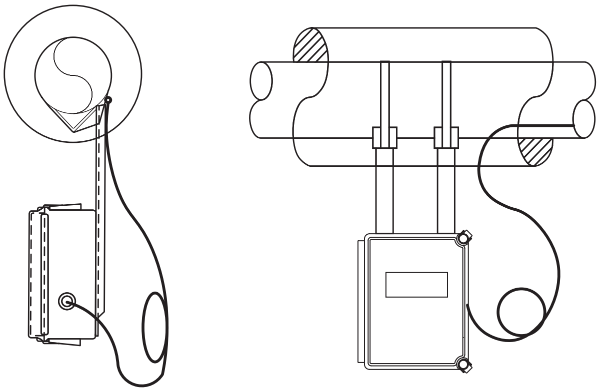
- Junction boxes can be mounted using holes in back and screws provided, or using four mounting tabs supplied
- Hinge can be moved to other side of box by rotating earthing plate 180°
- Earthing plate is fabricated from galvanized steel and is bonded to internal PE terminal block for bonding of hubs and connectors
- No bonding wires are required between the hubs, connectors and PE terminal blocks.

GENERAL

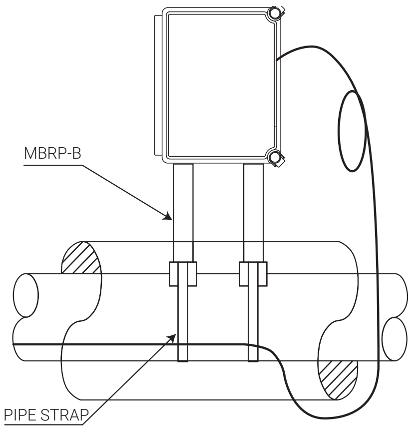
Lamacoids are not included.

Two mounting brackets (MBRP-B) and two pipe straps or alternate mounting method must be ordered separately for installation.

ENCLOSURE MOUNTING BRACKET

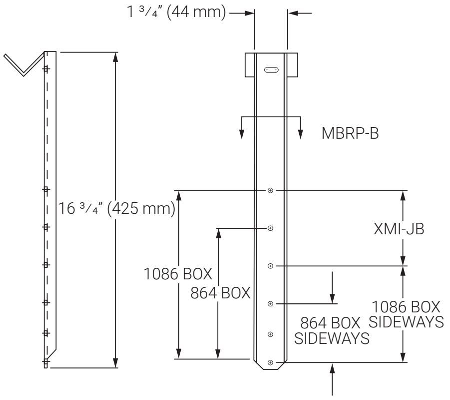


BOTTOM MOUNT



MBRP-B Product Overview

- Mounting bracket for MIJB series fiberglass enclosures which enables enclosure installation and connection prior to application of insulation and cladding
- Installation time reduction as electrician does not need to return after cladding is installed
- 304SS Stainless steel pipe support bracket for MIJB-864-A, nVent RAYCHEM MIJB-1086-A and MIJB-1086-B fiberglass enclosures
- Two brackets are required to support each enclosure. Each bracket requires one pipe strap
- Suitable for pipe temperatures up to 900°F (480°C)
- Stainless steel is a poor conductor of heat so the bracket is not hot or a heat sink



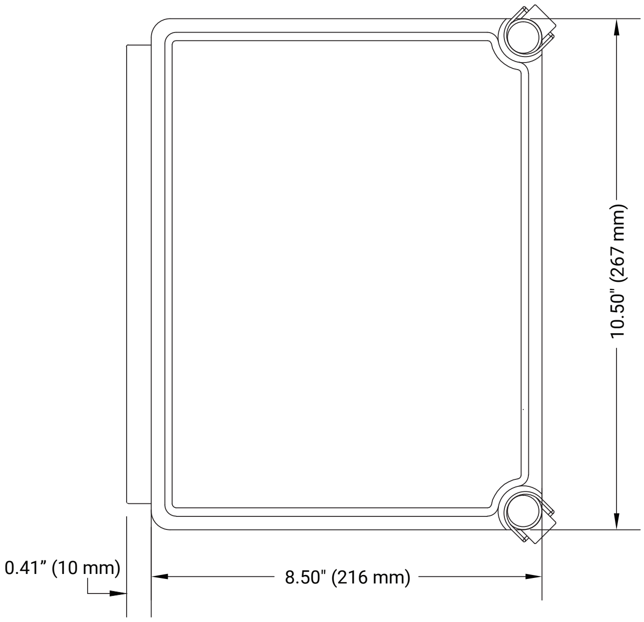
SIDE VIEW FRONT VIEW

ORDERING DETAILS

Description	Catalog number	Part number	Weight/lbs
Enclosure	MIJB-1086-A	T0002053	8.00lbs
Spare Parts and Accessories			
Mounting Bracket for MIJB series fiberglass enclosures	MBRP-B	T0002003	1.1lbs
Terminal kit for MIJB-1086 model	MIJB-LPWR-KIT	T1005000	0.5lbs

MIJB-1086-B

MI POWER AND MARSHALLING BOX JUNCTION BOX WITH PRE-DRILLED EARTHING PLATE FOR USE WITH MI HEATING UNITS



FRONT VIEW

PRODUCT OVERVIEW

The efficient design and simple construction of these enclosures make them durable in corrosive environments, yet aesthetically pleasing

Corner latches provide unobstructed access

The continuous hinge pin provides a secure seal and double latching creates added security

Typical uses include power or marshalling, splice and end box for 3-phase systems

Accommodates up to 7 outgoing heating cables and one incoming power cable

It can also be used as a marshalling box – one incoming power cable and 5 outgoing power cables

Three phase applications include power, splice and end box.

CONSTRUCTION

- Compression molded fibreglass has outstanding chemical and temperature resistance qualities and exhibits excellent weather ability and physical properties
- Light gray finish inside and out. Gasket assures water-tight and dust-tight seal
- Polyester mounting tabs and stainless steel attachment screws are provided with each enclosure
- Two corrosion resistant polyester quick release latches are located in corners to provide unobstructed access to enclosure
- Removable hinged cover attached to body with stainless steel hinge pin
- Hinge pin and bail are corrosion resistant Type 316 stainless steel
- Padlock provisions included in each latch
- Inside dimensions: 10” high x 8” wide x 6” deep (250 x 200 x 150 mm)
- Box includes earthing plate on three sides and back of box and is pre-punched for eleven ½” and eight ¾” hubs
- Entries: Up to 11 x ½” and 8 x ¾” - Use a step bit to drill out or enlarge any holes in fibreglass required for hubs/connectors

APPROVALS

CSA approved Type 4X enclosure and certified electrical tassembly

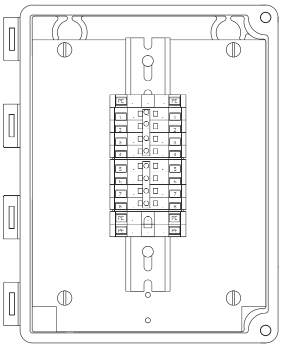
Area classification - Hazardous locations CL I Division 2 (Zone 2),

Groups A,B,C,D T5 Enclosure type: Type 4X

Ambient temperature rating: –50°C to +40°C

Enclosure flammability evaluated per UL 508A

ELECTRICAL SPECIFICATIONS



Maximum operating voltage 600Vac

Maximum 65A per terminal, rated 18AWG to 6AWG

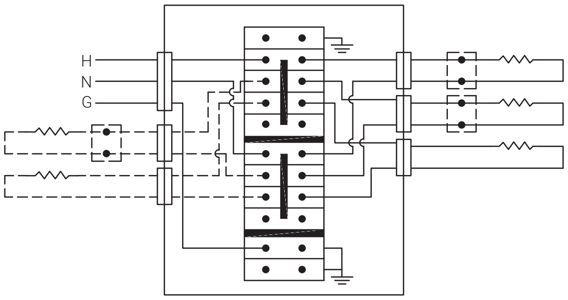
Consider MI cold lead cable gland size, hub size and power cable size in selecting appropriate box

Power cable gland and hubs for MI cold lead glands not included

Order a separate MIJB-LPWR-KIT for #2 or #4AWG power cable to downsize to #6AWG but remain at 65A.

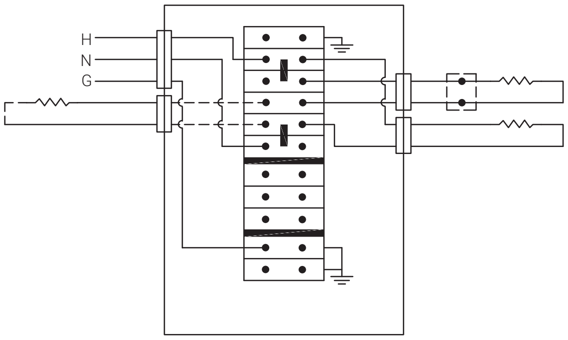
TYPICAL ELECTRICAL CONNECTION OPTIONS (SEE MIJB-1086-A FOR OTHER POSSIBILITIES)

MIJB-1086-B-MARSH



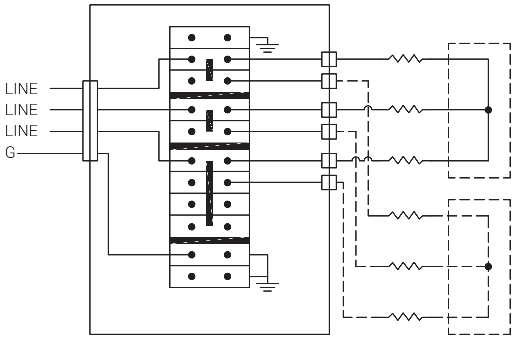
- POWER WIRES TO BE FIELD ROUTED FROM MARSHALLING BOX TO INDIVIDUAL EHT POWER BOXES,(ie MJB-864-A, JBS, etc.)
- THERE ARE SIX GROUND CABLE CONNECTIONS THAT ARE AVAILABLE THAT CAN LIMIT THE NUMBER OF CABLE CONNECTIONS THAT CAN BE MADE IN THIS BOX. MI CABLES DO NOT USE A GROUND CABLE CONNECTION.

MIJB-1086-B-SERPAR



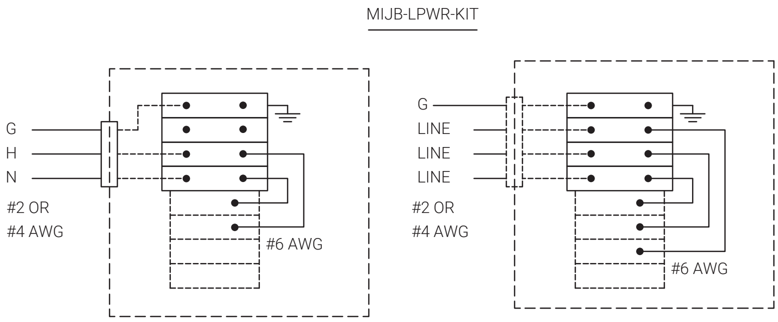
- FOR SERIES-PARALLEL CONFIGURATION
- POWER WIRES TO BE FIELD ROUTED FROM MARSHALLING BOX TO INDIVIDUAL EHT POWER BOXES (ie. MJB-864-A-PWR, JBS, etc) AS REQUIRED.
- FIELD TO CUT 4-POLE JUMPER INTO 2-POLE JUMPER AND INSERT AS SHOWN.
- USE WITH D OR E DESIGN MI CABLE.

MIJB-1086-B-3PWR



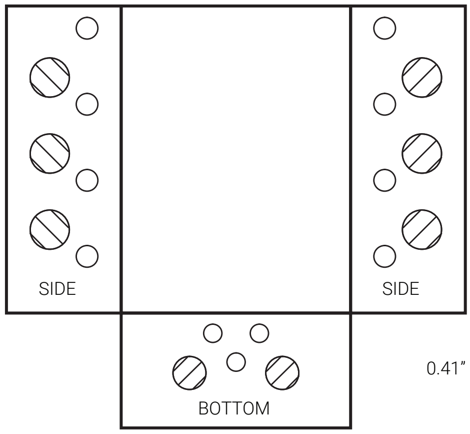
- USE A MJB-864-STAR TO TERMINATE OR MJB-864-A-SPLC TO CONTINUE.
- FIELD TO CUT 4-POLE JUMPER INTO 2-POLE JUMPERS AND INSERT WITH END PLATES (INCLUDED) AS SHOWN.
- USE WITH B DESIGN MI CABLE.

POWER CABLE DOWNSIZING OPTION:



- USED TO DOWNSIZE #2 OR #4 AWG POWER CABLES.
- ORDER MIJB-LPWR-KIT SEPARATELY IF REQUIRED.
- CONSISTS OF 3 POWER TERMINAL BLOCKS, 1 GROUND TERMINAL BLOCK, AND #6 AWG JUMPER WIRES.

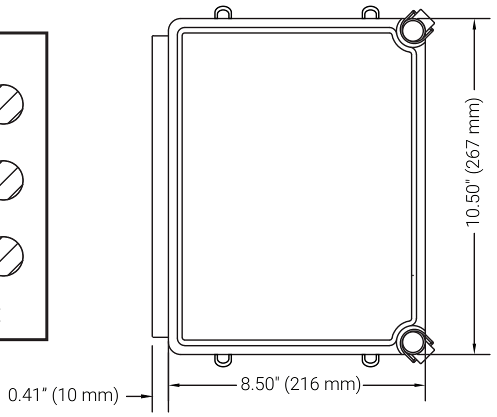
ENCLOSURE DETAIL



EARTHING PLATE DETAIL

⊘ 1-1⁄8” HOLE FOR 3⁄4” CONDUIT HUB/CONNECTOR

○ 7⁄8” HOLE FOR 1⁄2” CONDUIT HUB/CONNECTOR



FRONT VIEW

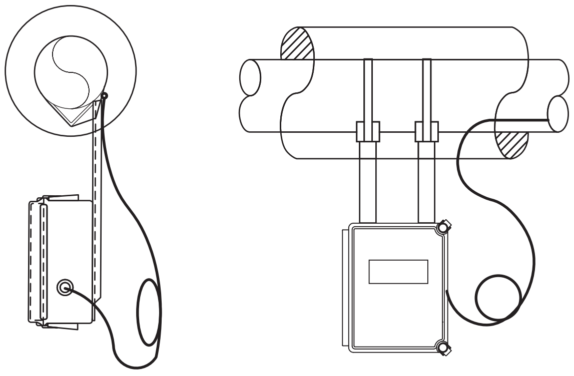
- Junction boxes can be mounted using holes in back and screws provided, or using four mounting tabs supplied
- Hinge can be moved to other side of box by rotating earthing plate 180°
- Earthing plate is fabricated from galvanized steel and is bonded to internal PE terminal block for bonding of hubs and connectors
- No bonding wires are required between the hubs, connectors and PE terminal blocks.

GENERAL

Lamacoids are not included.

Two mounting brackets (MBRP-B) and two pipe straps or alternate mounting method must be ordered separately for installation on pipe.

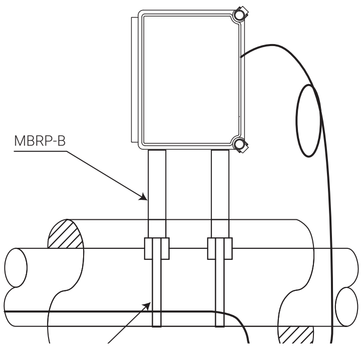
ENCLOSURE MOUNTING BRACKET

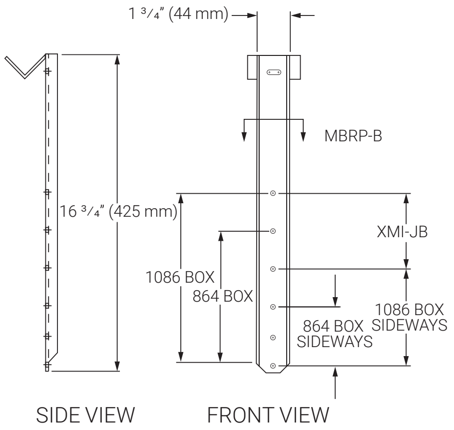


BOTTOM MOUNT

MBRP-B Product Overview

- Mounting bracket for MIJB series fiberglass enclosures which enables enclosure installation and connection prior to application of insulation and cladding
- Installation time reduction as electrician does not need to return after cladding is installed
- 304SS Stainless steel pipe support bracket for MIJB-864-A, MIJB-1086-A and nVent RAYCHEM MIJB-1086-B fiberglass enclosures
- Two brackets are required to support each enclosure each bracket requires one pipe strap
- Suitable for pipe temperatures up to 900°F (480°C)
- Stainless steel is a poor conductor of heat so the bracket is not hot or a heat sink





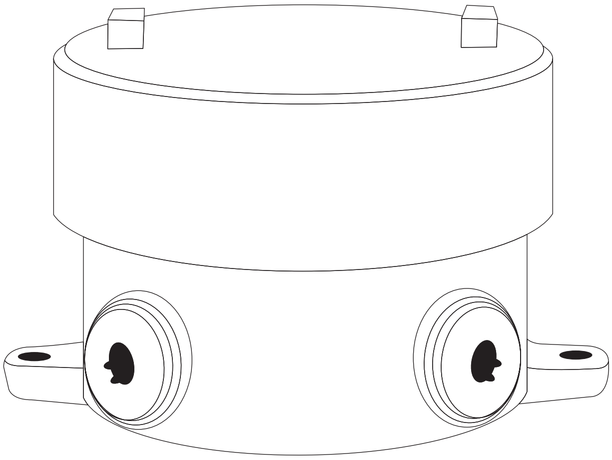
ORDERING DETAILS

Description	Catalog number	Part number	Weight/lbs
Enclosure	MIJB-1086-B	T0002056	8.00lbs
Spare Parts and Accessories			
Mounting Bracket for MIJB series fiberglass enclosures	MBRP-B	T0002003	1.1lbs
Terminal kit for MIJB-1086 model	MIJB-LPWR-KIT	T1005000	0.5lbs

XMI-JB

nVent
RAYCHEM

HAZARDOUS LOCATION CAST ENCLOSURE FOR MI HEATING UNITS IN CID1 APPLICATIONS



PRODUCT OVERVIEW

Hazardous area (CID1) or ordinary area applications

MI power connection box

MI splice connection box

Enables conduit connection for power supply

Provides easy access to terminations for maintenance and future system changes

RTD connection box

CONSTRUCTION

- Aluminum Body and Cover (Copper-free aluminum (less than 4/10 of 1%)
- Electrostatically applied powder coating finish
- External threaded body provides additional wiring room, cover opening 3 ½" (89 mm)
- Smooth, rounded integral bushing in each hub protects conductor insulation
- Cover and gasket furnished with box as standard, Type 4X
- 5 x ¾" threaded hub locations (One in base, 4 on sides)
- 3 x ¾" close up plugs
- 2 reducer bushings ¾" x ½"
- Two cast in mounting lugs
- Dimensions: 4 ½" x 3 ½" (114 x 89 mm)

APPROVALS

Class I, Div.1 (Zone 1) & Div. 2 (Zone 2), Groups B, C, D
Class II, Div. 1 & 2, Groups E, F, G
Class III
Enclosure Type: Type 4X

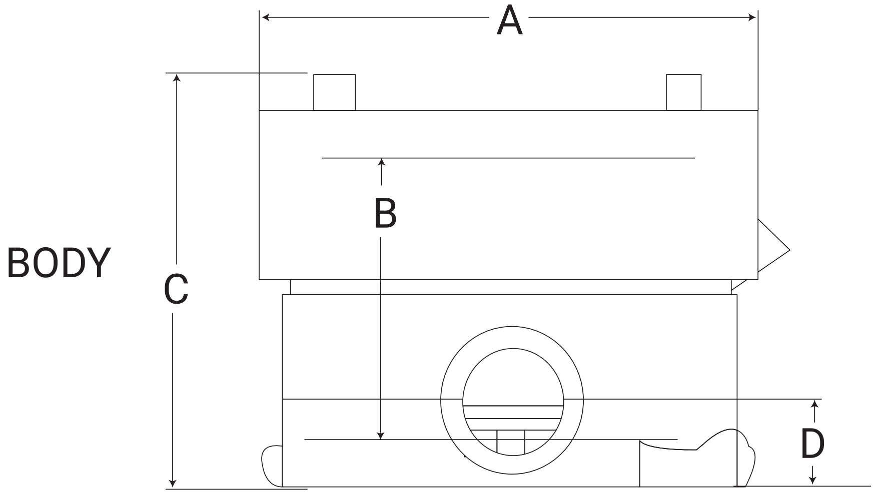
ELECTRICAL SPECIFICATIONS

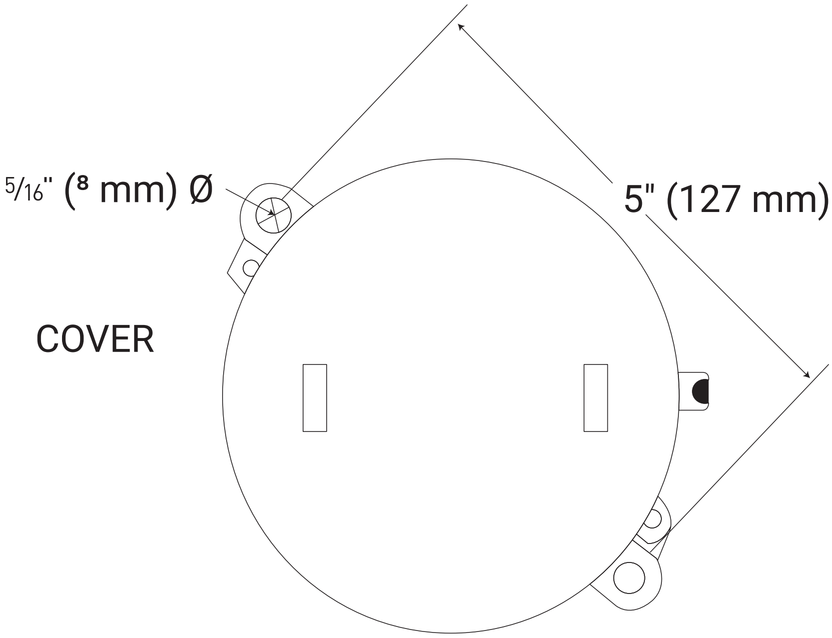
Green ground screw
4 pole terminal strip (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG)
Maximum operating voltage 600Vac
Power cable gland not included
Space to tap an external bonding connection - when a metal junction box is used for MI splices, a bonding conductor is required

ENCLOSURE DETAIL

XMI-JB

Catalog Number	Hub Size	Dimensions A	 B	 C	 D	Cover Opening	Volume CU. in.
XMI-JB	3/4"	4 1/2" (114 mm)	2 3/8 " (60 mm)	3 1/2" (89 mm)	11/16" (17 mm)	3 1/2" (89 mm)	25





ORDERING DETAILS

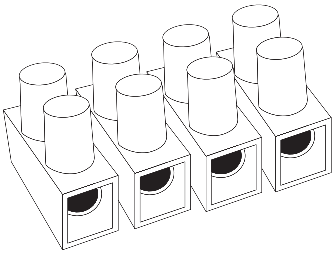
Description	Catalog number	Part number	Weight/lbs
Enclosure	XMI-JB	XMI-JB	3.5lbs

XMI-JB

Spare Parts and Accessories

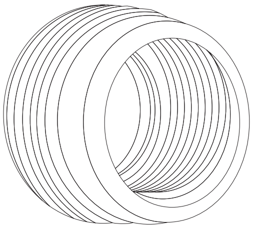
Terminal Strip	4POLETSTRIP	4POLETSTRIP	0.1lbs

- 4 pole terminal strip (CSA-600 Vac, 65 A, 18–6 AWG /UL-300 Vac, 65 A, 18–6 AWG) for use with XMI-JB enclosure
- May be used for additional RTD connections



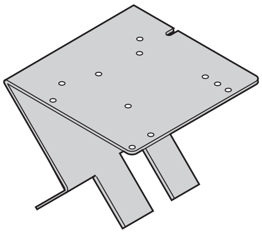
Reducer Bushing	PTRDBH3412	PTRDBH3412	0.1 lbs

- Zinc plated steel reducer bushing for use with XMI-JB enclosure
- Reduces ¾” NPT tapered hole to ½” NPT
- Body length 23/32” (18 mm)
- Class I, Div. 1 & 2, Groups A,B,C,D
- Class I, Zone 1, Groups IIC, IIB, IIA
- Class II, Div 1 & 2, Groups E,F,G



Support Bracket	UMB	263757-000	1.0 lbs

- Pipe mounted support bracket
- Material: 304 stainless steel
- Accommodates 3" (76 mm) of insulation
- Order pipe strap separately (allow 1 ½" (40 mm) extra length on strap)



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HEAT-TRACING DESIGN REQUEST FORM

Contact information	Name	
	Company	
	Fax no./e-mail	Date
	Telephone	Fax
Project parameters	Project name	
	Done for	
	Done by	
Design parameters	Temperatures	Maintain temperature (°F)
		Ambient temperature (°F) Minimum Maximum
		Process temperature (°F)
		Maximum exposure temperature (°F)
		Minimum start-up temperature (°F)
		System (fluid) limit temperature (°F) ☐ Check if temperature sensitive
	Voltage	○ 120 Vac ○ 208 Vac ○ 240 Vac ○ 277 Vac ☐ Other
	Location	○ Indoors ○ Outdoors
	Maximum outer diameter	
	Area classification	Class Division/ Zone Group ☐ Nonhazardous
	Temperature rating	○ T1 ○ T2 ○ T2C ○ T2D ○ T3 ○ T4 ○ T5 ○ T6 ☐ Nonhazardous
	Pipe material	○ Metal ○ Other, please specify
	Monitoring options	☐ Temperature ☐ Ground-fault current ☐ Line current ☐ Continuity

Heat-Tracing Design Request Form

PIPING INFORMATION

Line ID	Reference no.	Diameter (in)	Insulation thickness (in)	Pipe length (ft)	Pipe supports		Valves		Flanges
					Type	Number	Type	Number	Number
1									
2									
3									
4									

Note: nVent RAYCHEM heating cables are factory terminated to the required length. They can not be altered in the field.

SELF-REGULATING/POWER-LIMITING DESIGN WORKSHEET

Thermal Design, Heating Cable, Component, and Accessory Selection

DESIGN CRITERIA

Location	Area classification	Area T-rating	Pipe maintain temp. (T_m)	Minimum ambient temp. (T_a)	Delta temp. ($\Delta T = T_m - T_a$)	Start-up temp.	Process operation and limit temp.	System limit temp.
○ indoors ○ outdoors								
Example Outdoors	Hazardous CID2	T2 (300°C)	80°F	−20°F	100°F	0°F	200°F	500°F

THERMAL DESIGN

Line ID	Pipe size (inches)	$\Delta T = T_m - T_a$	Insulation thickness (inches)	Base heat loss Q_B (f=1)	Insulation type/f	Corrected heat loss $Q_T = Q_B \times f$
Example example1	4	100	2	6.6	Cal sil 1.5	9.8

HEATING CABLE SELECTION

Line ID	Q_T heat loss (watts/ft)	T_m maintain temperature	T_{exp} maximum exposure temp.	Chemical exposure	Voltage	Pipe material	Heating cable selected
Example example1	9.8	80	200	organics	240	CS	10QTVR2-CT

Self-Regulating/Power-Limiting Design Worksheet

CALCULATION OF HEATING CABLE LENGTH

1.	2.	3.	4.	5.	6.	7.	8.
Line ID	**Feet of pipe**	**Spiral ratio**	**Feet for pipe (col 2 x col 3)**	**Feet for valves (# of valves x ft/valve)**	**Feet for supports (# of supports x ft/support)**	**Extra cable for connection kits (3ft per kit)**	**Total heating cable length (Columns 4+5+6+7)**
Example example1	200	1	200	2 x 4.3 = 8.6	10 x 1.5 = 15	6 x 3 = 18	241.6

CALCULATION OF CIRCUIT BREAKER SIZING

Line ID	Heater type	Total heating cable length	Start-up temperature	Circuit breaker sizing
Example example1	10QTVR2-CT	241.6	0°F	30 A 320 / 40 A 390

CONNECTION KITS AND ACCESSORIES

Line ID	Heating cable selected	Area classification	Number of circuits	Power connection kit/ quantity	Splice/ quantity	Tee/quantity	End seal kit/ quantity
Example 1001	10QTVR2-CT	CID2	1	JBS-100-A/1	S-150/0	T-100/2	E-100-L/3
			Column Totals:				

Self-Regulating/Power-Limiting Design Worksheet

CALCULATION OF ACCESSORY PIPE STRAPS

Line ID **Pipe straps**	**Units**	**Straps per kit**	**Total**	**Line ID** **Pipe straps**	**Units**	**Straps per kit**	**Total**	**Line ID** **Pipe straps**	**Units**	**Straps per kit**	**Total**
Example Power connections	1	1	1	Power connections				Power connections			
Splice kits	0	0	0	Splice kits				Splice kits			
Tees	2	2	4	Tees				Tees			
End seals	3	1	3	End seals				End seals			
		Total straps	8			**Total straps**				**Total straps**	

Line ID **Pipe straps**	**Units**	**Straps per kit**	**Total**	**Line ID** **Pipe straps**	**Units**	**Straps per kit**	**Total**	**Line ID** **Pipe straps**	**Units**	**Straps per kit**	**Total**
Power connections				Power connections				Power connections			
Splice kits				Splice kits				Splice kits			
Tees				Tees				Tees			
End seals				End seals				End seals			
		Total straps				**Total straps**				**Total straps**	

ATTACHMENT TAPE REQUIREMENTS

1.	**2.**	**3.**	**4.**	**5.**	**6.**
Line ID	**Feet of pipe**	**Adhesive tape chosen**	**Pipe diameter (inches)**	**Rolls per 100 feet**	**Total rolls of tape (col 2/100) x col 5**
Example 1001	200	GT-66	4	6	12
				Total	

Self-Regulating/Power-Limiting Design Worksheet

ELECTRIC-TRACED LABEL AND CONTROLS

1. Line ID	2. Feet of pipe	3. Electric-traced labels required (col 2/10)	4. Control chosen
Example 1001	200	20	
		Total	

Note: For design of Factory Mutual CID1 systems, the Approval for Class I, Division 1 Hazardous Locations in USA form (H56897) and the Required Installation Record for Class I, Division 1 Hazardous Locations in USA form (H57426) must be completed.

TANK DESIGN WORKSHEET

DESIGN CRITERIA

Location	Tank maintain temp. (Tm)	Minimum ambient temperature (Ta)	Delta temp. (ΔT = Tm – Ta)	Start-up temperature	Process operating temperature	System limit temperature	Max. intermittent exposure temp.
○ indoors ○ outdoors							
Example Outdoors	80°F	–20°F	100°F	0°F	200°F	500°F	200°F

Insulation type and thickness	Tank wall material	Tank wall thickness	Fluid in tank	Area classification	Area T-rating	Chemical exposure
	○ metal ○ plastic			○ nonhazardous ○ hazardous CID2 ○ hazardous CID1		○ none ○ mild inorganics ○ organics/corrosives
Example Cal sil 1.5"	Metal	0.25"	Heavy oil	Hazardous CID2	T2 (300°C)	Organics/corrosives

CALCULATION OF TANK HEAT LOSS

nVent provides a wide selection of heat-tracing solutions for tanks and vessels. For detailed information about tank heating products, refer to the Tank Heating design guide (H56887).

$Q_T = Q_V + Q_S + Q_A$

Where:

Q_T = Total heat loss of the tank

Q_V = Heat loss through the insulated body of the tank

Q_S = Heat loss through the tank support mechanism (slab, legs, saddle, or other base support)

Q_A = Heat loss through accessories such as manholes, handholds, ladders, or handrails

Calculation of Q_V, heat loss through insulated tank body:

Geometry of tank	Formula for surface area
Cylindrical	π x D x h plus ends
Truncated cone	π x (D + d) x S/2 plus ends

Tank Design Worksheet

Calculation of surface area $(A_{body}) = \pi DH$

Add ends if required $(A_{end}) = \pi D2/4$ or
$(A_{end}) = (\pi D2/4) \times 2$

Total insulated surface area (ft2) A_V $(A_V = A_{body} + A_{ends})$ (ft2)

Note: If different areas of the tank surface have different types of insulation or different thicknesses of insulation, a different (qv) heat loss rate and (f) insulation adjustment factor should be calculated for each area and the total heat losses should be added. Q_V is the total heat loss through the insulated portions of the tank wall.

$Q_V = A_V \times qv \times f =$

Calculate Q_S, the heat loss through the base support of the tank:

Type of support (Concrete slab or earth foundation, legs, concrete saddles or uninsulated skirt)

Calculation of support heat loss

Q_S = Heat Loss of the base support x the quantity of base supports (as provided in H56887). (watts)

The next step is to calculate Q_A, the heat loss through the accessories (manholes, handholds, ladders, handrails) of the tank. See Tank Heating design guide (H56887), and calculate Q_A, the heat loss through the accessories:

Type of accessory

Calculation of accessory heat loss (watts)

Q_A = (Heat loss variable is provided in H56887). (watts)

Calculation of total heat loss

$Q_T = Q_V + Q_S + Q_A$

$Q_T = 0.9 \times (Q_V + Q_S + Q_A)$

nVent recommends a 20% safety factor for tank heat loss design.

Final design heat loss

$Q_F = Q_T \times 1.20$

Tank Design Worksheet

PRODUCT SELECTION

Tank heating applications can be quite varied. For this reason, nVent offers a range of technologies to optimize your tank and vessel heat-tracing system.

Numerous nVent products can be used to maintain temperatures of tanks. See Tank Heating design guide (H56887) for information on product selection. Pay particular attention to the maximum exposure temperature and the system limit temperature. The maximum exposure temperature is the highest temperature to which the heating cable will be exposed. Heating cables can be damaged by temperatures in excess of those the cables are designed to handle. The system limit temperature is the highest temperature to which the heating cables may expose the system. The tank or tank contents could be damaged by excessively high temperatures.

Once suitable products are selected based on temperatures, the decision is often based on economics. It is important to consider both product cost and the labor required to install the products.

Pad heater Q_p (Watts/unit)

Pads required = Q_F/Q_p

Heating cable $P_{\text{heating cable}}$ (watts/ft) at T_m (maintain temperature)

Note: See Section 6 to determine if P_{adj} should be used in place of $P_{\text{heating cable}}$

$P_{adj} = f_{adj} \times P_{\text{heating cable}}$

Feet of heating cable required = Q_F / P_{adj} (or $P_{\text{heating cable}}$ if $f_{adj} = 1.0$)

See the Tank Heating design guide (H56887) for information on installing the heating cable on the tank. If aluminum tape is used for self-regulating heating cable installation, or if the heating cable is to be installed on a plastic tank, be sure to use the above formula to account for the change in power output of the self-regulating heating cable. Values for f_{adj} can be found in the Tank Heating design guide (H56887), Table 2. Also see the Tank Heating design guide (H56887), Table 3 for the circuit length adjustment factors for self-regulating heating cables.

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TUBING BUNDLE DESIGN REQUEST FORM

Contact Information

Name		Date	
Company		Bundle needed on site by:	
Street Address			
City		State/Province	
Postal Code		Country	
Phone		Email	

Design Conditions

○ °C	○ Indoor	Min ambient temp:		Maintain temp:		Max exposure temp:	
○ °F	○ Outdoor	Max ambient temp:		Min allowable temp:		Max allowable temp:	

Note: If process fluid is flowing and heat must be added or removed to change temperature of process, consult your local representative. Assumes a wind of 40 kph (25 mph).

Process Tubing

Tubing length: ○ Meters ○ Feet ○ Continuous lengths (±0.5%) ○ Exact quantity (±0.5%) ○ Continuous lengths and exact quantity (± 0.5%)

Number of process tubes*: ○ 1 ○ 2

Process Tube #1					**Process Tube #2**				
Outside diameter					**Outside diameter**				
○ 1/8"	○ 1/4"	○ 3/8"	○ 1/2"	○ 3/4"	○ 1/8"	○ 1/4"	○ 3/8"	○ 1/2"	○ 3/4"
○ 6 mm	○ 8 mm	○ 10 mm	○ 12 mm		○ 6 mm	○ 8 mm	○ 10 mm	○ 12 mm	
Wall thickness					**Wall thickness**				
○ 0.030	○ 0.032	○ 0.035	○ 0.049	○ 0.062	○ 0.030	○ 0.032	○ 0.035	○ 0.049	○ 0.062
○ 1 mm	○ 1.5 mm				○ 1 mm	○ 1.5 mm			

Process tubing material of construction

○ Welded 316 SS ○ Seamless 316 SS ○ Copper ○ PFA Teflon ○ Seamless Monel 400

* For more than two process tubes, or custom configurations, please contact your nVent representative.

Heat Tracing

Method of heat tracing	○ Electric	Voltage		Area class		Division		Zone	
	○ Steam	Pressure		Bar		Temp		○ °C ○ °F

Steam trace tubing

Outside diameter					**Wall thickness**				
○ 1/8"	○ 1/4"	○ 3/8"	○ 1/2"	○ 3/4"	○ 0.030	○ 0.032	○ 0.035	○ 0.049	○ 0.062
○ 6 mm	○ 8 mm	○ 10 mm	○ 12 mm		○ 1 mm	○ 1.5 mm			

☐ None (PIO)

Accessories

☐ Silicone sealant	☐ Heat-shrinkable boots	☐ Power kits	☐ Splice kits
☐ Heat-shrinkable entry seal	☐ Jacket patch kits	☐ End kits	☐ Bundle bending tool

Notes:

GROUND-FAULT EQUIPMENT DEVICE SELECTION

OVERVIEW

nVent RAYCHEM heating cables are reliable and easy to install and maintain. However, if the heating cable is improperly installed or physically damaged to the point that water contacts the bus wires, sustained arcing or fire could result. If arcing does occur, the fault current may be too low to trip conventional circuit breakers. To protect against the risk of fire, use ground-fault protection on each heating cable circuit.

nVent, approvals agencies, and national electrical codes require ground-fault protection of equipment for all heating cable installations. A grounded metallic covering is also required and is supplied as a braid or outer sheath.

DESIGN OPTIONS

A Ground-Fault Equipment Protection Device (GFEPD) typically has a trip level of 30 mA. These 30-mA devices, which are intended to protect equipment from damage due to overheating or fire, are not to be confused with 5-mA ground-fault circuit interrupters (GFCIs), which provide personnel protection from electrical shock but may cause nuisance tripping of the heat-tracing circuit. All nVent RAYCHEM single-phase, self-regulating heating cables and tank heating cables, and RAYCHEM MI heating cables, require 30-mA GFEPDs. For all 3-phase heating cables, a 70-mA ground-fault device is recommended to minimize nuisance tripping due to long heating cable circuit lengths.

Ground-Fault Protection Methods

Methods of providing ground-fault protection include:

- 30-mA ground-fault circuit breakers.
- Controllers with ground-fault protection built in, such as the nVent RAYCHEM 910, 920, NGC-30 and NGC-40.
- Neilsen-Kuljian or CR Magnetics sensors with a shunt-trip breaker, for use when current or voltage exceeds the ratings of traditional 30-mA ground-fault trip circuit breakers.
- Neilsen-Kuljian or CR Magnetics sensors to monitor and provide an alarm for a ground fault but not shut off the circuit, meeting the exception to the NEC requirement in Article 427-22.

Ground-Fault Circuit Breakers

Manufacturers of 30-mA circuit breakers include Square D, Cutler Hammer (Westinghouse), General Electric, and Siemens. The breaker that is right for your application depends on the load current expected, the equipment voltage rating, and the panelboard in which the breaker is to be installed.

Table 1 lists some of the breakers available.

TABLE 1 GROUND-FAULT CIRCUIT BREAKER SELECTION TABLE

Bolt-On Style						
Manufacturer	**Square D**			**Cutler Hammer (Westinghouse)**		
Voltage	**120**	**208/240**[1]	**277**	**120**	[2]	**277**
15 Amps	QOB115EPD	QOB215EPD	EDB14015EPB	QBGFEP1015	QBGFEP2015	GBH1015
20 Amps	QOB120EPD	QOB220EPD	EDB14020EPB	QBGFEP1020	QBGFEP2020	GBH1020
30 Amps	QOB130EPD	QOB230EPD	EDB14030EPB	QBGFEP1030	QBGFEP2030	GBH1030
40 Amps	(3)	QOB240EPD	EDB14040EPB	NA	QBGFEP2040	GBH1040
50 Amps	(3)	QOB250EPD	EDB14050EPB	NA	QBGFEP2050	GBH1050
Panelboard	NQOD	NQOD	NA	POW-R-LINE 1	POW-R-LINE 1	NA

Plug-In Style						
Manufacturer	**Square D**			**Cutler Hammer (Westinghouse)**		
Voltage	**120**	**208/240[1]**	**277**	**120**	[1]	**277**
15 Amps	QO115EPD	QO215EPD	NA	QPGFEP1015	QPGFEP2015	NA
20 Amps	QO120EPD	QO220EPD	NA	QPGFEP1020	QPGFEP2020	NA
30 Amps	QO130EPD	QO230EPD	NA	QPGFEP1030	QPGFEP2030	NA
40 Amps	(3)	QO240EPD	NA	NA	QPGFEP2040	NA
50 Amps	(3)	QO250EPD	NA	NA	QPGFEP2050	NA
Panelboard	QO Load Center	QO Load Center	NA	POW-R-LINE 1	POW-R-LINE 1	NA
Padlocks[2]	QO1PA	GF12PA	NA	QLPB123PL	QLPB123PL	NA

Note: Bell alarm contacts may be ordered through your local electrical distributor by adding a “2100” suffix to the Square D part number or a “W1” suffix to the Westinghouse part number (example: QOB120EPD2100 is a 20 A, 120 V breaker with bell alarm contacts).

1. Two-pole ground-fault breakers require 120 volts to power the internal electronics. 240-volt delta systems without a 120-volt neutral reference will require an additional transformer to provide the reference.
2. Padlocks are required to comply with NEC article 427-55(a) if the circuit breaker is utilized as a disconnecting means.
3. Use 208/240 V EPD for these amperages.

NA–not available.

External Ground-Fault Sensors

An external Neilsen-Kuljian or CR Magnetics ground-fault sensor may be used for ground-fault monitoring and alarm, high current or high voltage applications, and /or applications that require various ground-fault trip levels.

A Neilsen-Kuljian or CR Magnetics ground-fault sensor may be used for:

- Ground-fault monitoring and alarm, per the exception to NEC Article 427-22.
- Applications where current or voltage exceeds the ratings of available ground-fault circuit breakers.
- Applications that require a variety of ground-fault trip levels, such as 70 mA for VL heating cables.

Both of these ground-fault sensors have a ground-fault trip level adjustable from 1 to 100 mA and can be connected to an alarm light or to the shunt-trip of a breaker. These sensors also have an associated red light to indicate a fault and may have an additional light to indicate the presence of 120 V power. Both sensors can be supplied with a built-in TEST function, which simulates the fault and confirms that the unit is operational.

CLASSIFICATION OF HAZARDOUS LOCATIONS

The following discussion provides a basic understanding of approval issues and how they relate to heat tracing.

For complete information on the use of electrical equipment in hazardous locations, refer to the most recent issue of the National Electrical Code or the Canadian Electrical Code.

nVent heating systems are approved and certified for use in nonhazardous and hazardous locations by many agencies, including FM Approvals, CSA Group, UL, PTB, Baseefa, DNV, ABS and INMETRO.

HOW ARE HAZARDOUS AREAS DEFINED?

According to the National Electrical Code, Article 500 and Section 18 of the Canadian Electrical Code, "Locations shall be classified depending on the properties of the flammable vapors, liquids, or gases, or combustible dusts or fibers that may be present and the likelihood that a flammable or combustible concentration or quantity is present."

Areas where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers or flyings are defined by the National Electrical Code (NEC) and the Canadian Electrical Code (CEC) as hazardous locations.

The class and division of an area are based on the type of hazard (Class) and the expected frequency of the hazard (Division).

Class

The class of a location defines the type of explosive danger that exists or may exist in the location. Table 1 explains how the classes are defined.

TABLE 1 HAZARDOUS LOCATION CLASSES

Class	Explosive danger
Class I	Flammable gases or vapors
Class II	Combustible dusts
Class III	Combustible fibers or flyings

Division

The division of a location defines the frequency that the hazard exists or may exist in a location.

TABLE 2 HAZARDOUS LOCATION DIVISIONS

Division 1 Areas where one or more of these conditions exist:

1. Ignitable concentrations of flammable gases or vapors can exist under normal operating conditions.
2. Ignitable concentrations of such gases or vapors may exist frequently because of repair, maintenance operations, or leakage.

3 Breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of the electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

Division 2 Areas where one or more of these conditions exist:

1. Volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment.
2. Ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment.
3. Areas are adjacent to a Class I, Division 1 location, and to which ignitible concentrations of gases or vapors might be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards are provided against ventilation failure.

NEC Group

The NEC Group of a hazard is based on specific characteristics of the explosive hazard present. Different sealing techniques are required depending on the molecular size of the hazardous materials and other criteria.

Flammable gases and vapors are placed into NEC Groups based on a determination of explosion pressures and maximum safe clearance between parts of a clamped joint under several conditions. See NEC Articles 500–505 for details. The various groups (A, B, C, and D for flammable gases and vapors, E, F, and G for combustible dusts) are described in Article 500 of the NEC.

The autoignition temperature and the NEC Group of a large number of explosive gases, vapors, and combustible dusts can be found in Article 500 of the NEC; also see Appendix: Hazardous Gases and Vapors.

The temperature identification number (often called T-rating) is based on the maximum operating temperature of the equipment.

From NEC Article 500

*Marking. Approved equipment shall be marked to show the class, group, and operating temperature or temperature range referenced to a 40°C ambient, or at the higher temperature if the equipment is rated and marked for an ambient temperature greater than 40°C. The temperature range, if provided, shall be indicated in identification numbers, as shown in Table 500.8(B).

Temperature identification numbers marked on equipment nameplates (often called T-rating) shall be in accordance with Table 500.8(B).

TABLE 3 TABLE 500.8 (B). IDENTIFICATION NUMBERS

Maximum temperature		
°C	°F	Identification number (T-rating)
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

For equipment to be used in a hazardous (classified) area, the equipment should be approved for both the class and division of the hazardous area and approved for the NEC Group of the hazard(s) present in the area. Also, the identification number of the equipment must be less than both the autoignition temperature of the hazard(s) present in the area and less than the maximum allowed in the area. (See NEC Article 500 reference Division 1 locations. Also, see NEC article 500.8(B), Exceptions 1–5, for exceptions to this rule.)

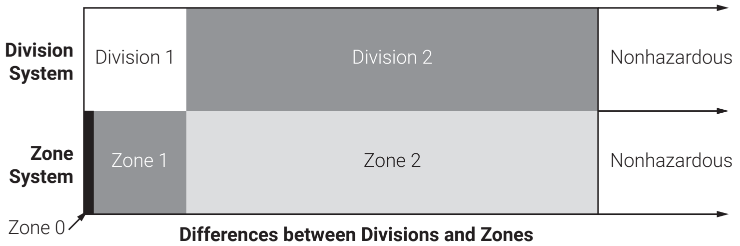
Examples

Acetaldehyde can be found in Table 2-1 of the NPFA 497. The data for acetaldehyde and numerous other fluids can also be found in Appendix: Hazardous Gases and Vapors. The NEC Group is Group C and the AIT (autoignition temperature) is 175°C. BTV-CR/CT, QTVR-CT, AND XTV-CT all have approvals for Class I, Division 2, NEC Group C. BTV-CR/CT (85°C) and QTVR-CT (135°C) have identification numbers (T-ratings) below 175°C (and below 80% of 175°C for CID1). Therefore, when used with the proper components, BTV-CR/CT or QTV-CT can be used in a Class I, Division 2 area where acetaldehyde may be present. The identification numbers for various XTV-CT products range from T3 to T2C, which is from 200°C to 230°C. Since these are all above the AIT of acetaldehyde (175°C), they should not be used in a hazardous area where acetaldehyde may be present in explosive quantities.

Benzene can be found in Table 2-1 of the NPFA 497 or Appendix: Hazardous Gases and Vapors. The NEC Group is Group D and the AIT is 498°C. Since BTV-CR/CT, QTVR-CT, and XTV-CT all have approvals for Class I, Division 2, NEC Group D and have temperature identification numbers well below 498°C, they can be used in a Division 2 area where benzene might be present. These standard products do not have approvals for Class I, Division 1 areas.

Zones

The IEC (International Electrotechnical Commission) uses the “zone” system for classifying locations where fire or explosion hazards may exist due to flammable gases, vapors, or liquids. The NEC adopted this approach in 1996 and expanded it in 1999 as an alternate to the Class and Division method previously discussed. It should be noted that the zone classification covers only flammable gases and vapors (Class I); it does not cover combustible dusts, fibers, or flyings (Classes II and III). Details on the use of the zone classification system as an alternative to the division classification system can be found in Article 505 of the NEC.



Differences between Divisions and Zones

Zone 2 is equivalent to Division 2. Division 1 is split between Zone 1 and Zone 0. Note that heating cables can never be placed in Zone 0 areas.

The use of the zone system requires that:

a. Supervision of Work. Classification of areas and selection of equipment and wiring methods shall be under the supervision of a qualified Registered Professional Engineer.

b. Dual Classification. In instances of areas within the same facility classified separately, Class I, Zone 2, locations shall be permitted to abut, but not overlap, Class I, Division 2 locations. Class I, Zone 0 or Zone 1 locations shall not abut Class I, Division 1 or Division 2 locations.

c. Reclassification Permitted. A Class I, Division 1 or Division 2 location shall be permitted to be reclassified as a Class I, Zone 0, Zone 1, or Zone 2 location provided all of the space that is classified because of a single flammable gas or vapor source is reclassified under the requirements of this article.

(Extracted from NEC Section 505.7 (C))

Therefore, the zone system approach will be most useful in new construction and significant upgrades.

HAZARDOUS GASES AND VAPORS

The following pages contain excerpts from the National Fire Protection Association (NFPA) publications **NFPA 497: Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas and NFPA 499: Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.** The list includes the ignition temperatures and group classifications for Class I gases. Class II dusts and Class III fibers and flyings are not listed.

Note that considerable skill and judgment must be applied when deciding to what degree an area contains hazardous concentrations of vapors, combustible dusts, or easily ignitable fibers and flyings. Many factors—such as temperature, barometric pressure, quantity of release, humidity, ventilation, and distance from the vapor source—must be considered. When information on every factor concerned is properly evaluated, a consistent classification of the selection and location of electrical equipment can be developed.

For the most current list of properties of flammable liquids, gases, and vapors, see the latest edition of **NFPA 497: Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.**

TABLE 1 GROUP CLASSIFICATION AND AUTOIGNITION TEMPERATURE (AIT) OF SELECTED FLAMMABLE GASES AND VAPORS

Material	Group	°F	°C
Acetaldehyde	C*	347	175
Acetic acid	D*	867	464
Acetic anhydride	D	600	316
Acetone	D*	869	465
Acetone cyanohydrin	D	1270	688
Acetonitrile	D	975	524
Acetylene	A*	581	305
Acrolein (inhibited)	B*	455	235
Acrylic acid	D	820	438
Acrylonitrile	D*	898	481
Allyl alcohol	C*	713	378
Allyl chloride	D	905	485
Ammonia	D*	928	498
n-Amyl acetate	D	680	360
Aniline	D	1139	615
Benzene	D*	928	498
Benzyl chloride	D	1085	585
1,3-Butadiene	B*	788	420
Butane	D*	550	288
1-Butanol	D*	650	343
2-Butanol	D*	761	405
n-Butyl acetate	D*	790	421
iso-Butyl acetate	D*	790	421
n-Butyl acrylate (inhibited)	D	559	293
Butylamine	D	594	312

* Material has been classified by test

TABLE 1 GROUP CLASSIFICATION AND AUTOIGNITION TEMPERATURE (AIT) OF SELECTED FLAMMABLE GASES AND VAPORS

Material	Group	°F	°C
Butylene	D	725	385
n-Butyraldehyde	C*	425	218
n-Butyric acid	D	830	443
Carbon monoxide	C*	1128	609
Chlorobenzene	D	1099	593
Cresol	D	1038–1110	559–599
Crotonaldehyde	C*	450	232
Cumene	D	795	424
Cyclohexane	D	473	245
Cyclohexene	D	471	244
Cyclohexanol	D	572	300
Cyclohexanone	D	473	245
Cyclopropane	D*	938	503
p-Cymene	D	817	436
n-Decanol	D	550	288
Decene	D	455	235
Diacetone alcohol	D	1118	603
o-Dichlorobenzene	D	1198	647
1.1-Dichloroethane	D	820	438
1.2-Dichloroethylene	D	860	460
Dicyclopentadiene	C	937	503
Diethyl benzene	D	743–842	395–450
Diethylene glycol monobutyl ether	C	442	228
Diethylene glycol monomethyl ether	C	465	241
Diethylamine	C*	594	312
Diethyl ether	C*	320	160
N-N-Dimethyl aniline	C	700	371
Di-isobutylene	D*	736	391
Di-isobutyl ketone	D	745	396
Di-isopropylamine	C	600	316
Dimethylamine	C	752	400
Dimethyl formamide	D	833	455
Dimethyl sulfate	D	370	188
1.4-Dioxane	C	356	180
Dipentene	D	458	237
Di-N-propylamine	C	570	299
Dodecene	D	491	255
Epichlorohydrin	C*	772	411
Ethane	D*	882	472
Ethanol	D*	685	363
Ethyl acetate	D*	800	427
Ethyl acrylate (inhibited)	D*	702	372
Ethylamine	D*	725	385
Ethyl benzene	D	810	432
Ethyl chloride	D	966	519
Ethylene	C*	842	450

* Material has been classified by test

TABLE 1 GROUP CLASSIFICATION AND AUTOIGNITION TEMPERATURE (AIT) OF SELECTED FLAMMABLE GASES AND VAPORS

Material	Group	°F	°C
Ethylene chlorohydrin	D	797	425
Ethylene glycol monobutyl ether	C	460	238
Ethylene glycol monobutyl ether acetate	C	645	340
Ethylenediamine	D*	725	385
Ethylene dichloride	D*	775	413
Ethylene glycol monoethyl ether	C	455	235
Ethylene glycol monoethyl ether acetate	C	715	379
Ethylene glycol monomethyl ether	D	545	285
Ethylenimine	C*	608	320
Ethylene oxide	B*	804	429
Ethyl formate	D	851	455
2-Ethylhexaldehyde	C	375	191
2-Ethyl hexanol	D	448	231
2-Ethyl hexyl acrylate	D	485	252
Ethyl mercaptan	C*	572	300
Formaldehyde (gas)	B	795	429
Formic acid (90%)	D	813	434
Fuel oils	D	410–765	210–407
Furfural	C	600	316
Furfuryl alcohol	C	915	490
Gasoline	D*	536–880	280–471
Heptane	D*	399	204
Heptene	D	500	260
Hexane	D*	437	225
2-Hexanone	D	795	424
Hexene	D	473	245
Hydrazine	C	74–518	23–270
Hydrogen	B*	968	520
Hydrogen cyanide	C*	1000	538
Hydrogen sulfide	C*	500	260
Isoamyl acetate	D	680	260
Isobutyl acrylate	D	800	427
Isobutyraldehyde	C	385	196
Isophorone	D	860	260
Isoprene	D*	428	220
Isopropyl acetate	D	860	460
Isoamyl alcohol	D	662	350
Isopropylamine	D	756	402
Isopropyl ether	D*	830	443
Iso-octyl aldehyde	C	387	197
Kerosene	D	410	210
Liquefied petroleum gas	D	761–842	405–450
Mesityl oxide	D*	652	344
Methane	D*	999	630
Methanol	D*	725	385
Methyl acetate	D	850	454

* Material has been classified by test

TABLE 1 GROUP CLASSIFICATION AND AUTOIGNITION TEMPERATURE (AIT) OF SELECTED FLAMMABLE GASES AND VAPORS

Material	Group	°F	°C
Methyl acrylate	D	875	468
Methylamine	D	806	430
Methyl n-amyl ketone	D	740	393
Methylcyclohexane	D	482	250
Methylcyclohexanol	D	565	296
Methyl ether	C*	662	350
Methyl ethyl ketone	D*	759	404
Methyl formal	C*	460	238
Methyl formate	D	840	449
Methyl isobutyl ketone	D*	840	449
Methyl isocyanate	D	994	534
Methyl methacrylate	D	792	422
2-Methyl-1-propanol	D*	780	416
2-Methyl-2-propanol	D*	892	478
alpha-Methyl styrene	D	1066	574
Monoethanolamine	D	770	410
Monoisopropanolamine	D	705	374
Monomethyl aniline	C	900	482
Monomethyl hydrazine	C	382	194
Morpholine	C*	590	310
Naphtha (coal tar)	D	531	277
Nitrobenzene	D	900	482
Nitroethane	C	778	414
Nitromethane	C	785	418
1-Nitropropane	C	789	421
2-Nitropropane	C*	802	428
Nonane	D	401	205
Octane	D*	403	206
Octene	D	446	230
Pentane	D*	470	243
1-Pentanol	D*	572	300
2-Pentanone	D	846	452
1-Pentene	D	527	275
Propane	D*	842	450
1-Propanol	D*	775	413
2-Propanol	D*	750	399
Propionaldehyde	C	405	207
Propionic acid	D	870	466
Propionic anhydride	D	545	285
n-Propyl acetate	D	842	450
Propylene	D*	851	455
Propylene dichloride	D*	1035	557
Propylene oxide	B*	840	449
n-Propyl ether	C	419	215
Propyl nitrate	B*	347	175
Pyridine	D*	900	482

* Material has been classified by test

TABLE 1 GROUP CLASSIFICATION AND AUTOIGNITION TEMPERATURE (AIT) OF SELECTED FLAMMABLE GASES AND VAPORS

Material	Group	°F	°C
Styrene	D*	914	490
Tetrahydrofuran	C*	610	321
Tetrahydronaphthalene	D	725	385
Toluene	D*	896	480
Turpentine	D	488	253
Unsymmetrical dimethyl hydrazine (UDMH)	C*	480	249
Valeraldehyde	C	432	222
Vinyl acetate	D*	756	402
Vinyl chloride	D*	882	472
Vinylidene chloride	D	1058	570
Vinyl toluene	ti	921	494
Xylenes	D*	867–984	464–529

* Material has been classified by test

APPROVAL FOR CLASS I, DIVISION 1 HAZARDOUS LOCATIONS IN USA FORM

The purpose of this form is to ensure that the heat-tracing system used in the Division 1 location is appropriate for that area classification. This form must accompany any order for CID1 materials.

THIS FORM MUST BE COMPLETELY FILLED OUT BEFORE THE DIVISION 1 HEATING CABLE AND CONNECTION KITS CAN BE SHIPPED TO THE CUSTOMER.

1. Purchase order number

2. Name of purchaser filling out this form

3. Company

Address

Phone

4. How many connection kits will you require?

5. Name and location of company where the Division 1 heating cable and connection kits will be installed.

Company

Address

Contact person

Phone

6. What is the T-classification of the area? (If none, fill out questions 7 and 8.)

7. What substance in the area is influencing the decision to use Division 1 equipment?

8. What is the autoignition temperature (AIT), expressed in °C, of the substance?

The maximum sheath temperature shall not exceed AIT (expressed in °C).
Note: This section must be filled out if no T-rating is available. See Hazardous Gases and Vapors document (H56896) for AIT temperatures for selected flammable gases and vapors.

9. Design data

Heating cable catalog number		Design safety factor	
Heating cable trace ratio		Maintain temperature	
Application: pipe, vessel		Normal operating temp.	
Size	Material ○ Steel ○ Plastic	Max. intermittent temp.	
Minimum ambient temp.		Insulation type	
Maximum ambient temp.		Thickness	Oversized ○ Yes ○ No
Installed	○ Indoors ○ Outdoors	Voltage	

10. The user has been notified that ground-fault equipment protection devices are required for all Division 1 applications.
All of the above information is believed to be correct.

Signature

Date

For Thermal Management use only. Attach this form to the Thermal Management purchase order.

Order number

Approved by

Date

(Customer Service Center)

nVent
RAYCHEM

REQUIRED INSTALLATION RECORD FOR CLASS I, DIVISION 1 HAZARDOUS LOCATIONS IN USA

To complete the approval process, this complete form must be returned to the nVent Customer Service Center, fax number (800) 527-5703.

Company Name

Purchase Order Number

Reference Drawing(s)

Circuit ID No.

Test value/remarks

Date

Initials

Area

Autoignition temperature (AIT)

Group classification

Heater circuit

Heater type

Supply voltage

Circuit length

Maximum pipe temperature

Heat temperature identification number (T-rating)

Components

Power connection

End seal

Tee connection

Splice

Ground-fault equipment protection

Make and model

Ground-fault equipment protection device trip level (mA)

Installation instructions

Correct connection kits per manufacturer’s specification

Seal fittings opened and inspected (properly poured)

Ground-leakage device tested

Insulation resistance testing

Minimum voltage requirements per IEEE 515 is 500 Vdc. nVent recommends 2500 Vdc for self-regulating cables.

Instrument used	
Calibration date	

As measured on the pipe before insulation is installed*

Insulation resistance between core and braid (Test A)	
Insulation resistance between braid and pipe (Test B)	

As measured after insulation is installed*

Insulation resistance between core and braid (Test A)	
Insulation resistance between braid and pipe (Test B)	

* Minimum insulation resistance per IEEE 515 is 20 M Ω. nVent recommends 1000 M Ω (for clean, dry self-regulating cables). Refer to the appropriate Installation and Maintenance manual for details.

Circuit Ready to Commission

Prepared by		Company		Date	
Approved by		Company		Date	

CLASS I, DIVISION 1 IN USA – FREQUENTLY ASKED QUESTIONS

APPLICATION

What is required to get CID1 approval?

- Application design information required for USA installations must be submitted to nVent for review and approval using the Approval for Class 1, Division 1 Hazardous Locations in USA form (H56897).
- The approved CID1 heating cable must not exceed the T-rating for the area, or the heating cable's maximum sheath temperature must not exceed 80% (as expressed in °C) of the autoignition temperature (AIT) for the hazardous materials in the area.
- Post-installation, the required CID1 Installation Record (Required Installation Record for Class I, Division 1 Hazardous Locations in USA form (H57426)) must be completed and sent to nVent Customer Service Center, where it will be kept on file.

Why is the field information form required?

This form is required as part of the approval based on the IEEE 515 Standard. It has two purposes:

1. It identifies the company and the contact person responsible for the hazardous area heat-tracing design.
2. It identifies either the T-rating for the area or the lowest AIT of the hazardous substances in the area. This information is used by nVent to verify that the heating cable meets the area requirements.

Note: The customer must identify the T-rating for the area. If this information is not available, then the lowest AIT for the area must be identified. This section must be filled out by the person designing the system and/or the person most familiar with the hazardous location. nVent cannot fill in this section because we cannot make any assumptions about the area being designed.

What if I don't know the AIT?

If the T-rating is not known, then identifying the lowest AIT in the area should be done by contacting the safety manager or project expert. Identifying the correct AIT is critical to ensure a safe design, and this information is required before nVent can process the order. nVent cannot make any assumptions about the area; therefore, this information must be obtained from the area expert.

What is the difference between the flash point and the AIT?

The flash point of a liquid is the minimum temperature at which the liquid gives off sufficient vapor to form an ignitable mixture with air near the surface of the liquid or within the test vessel used. "Ignitable mixture" means a mixture whose composition is within the flammable range (between the upper and lower limits), and thus is capable of propagating a flame away from the source of ignition. The AIT of a substance is the minimum temperature at which it will spontaneously ignite, without an external source of igntion.

As an example of the difference between the flash point temperature and the AIT, gasoline is listed in **NFPA 497: Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas** as having a flash point of –50°F (–45.5°C) and an AIT of 880°F (471°C). This means that gasoline will form sufficient vapors at temperatures above –50°F (–45.5°C) to burn when exposed to a flame. However, only if the temperature exceeds 880°F (471°C) can those vapors self-ignite (without being exposed to a flame).

If the heat tracing goes through a CID1 area but is terminated in a CID2 area , do you need to use CID1 area connection kits?

If both ends of the heating cable are terminated in a CID2 area, then industrial connection kits approved for use in C1D2 areas can be used with the approved CID1 heating cable.

What happens if the end user does not fill out the required CID1 Installation Record (Required Installation Record for Class I, Division 1 Hazardous Locations in USA Form (H57426)) after installing the product?

The customer will not have an approved system. This form must be filled out and returned to the nVent Customer Service Center to complete the approval process.

In North America, we are starting to hear about "zone" approvals. How do these approvals relate to CID1 applications?

The NEC declares that cables certified for use in CID1 areas may be used in Zone 1 areas, and cables certified for use in CID2 areas may be used in Zone 2 areas. However, cables with Zone 1 or Zone 2 approvals are not approved for CID1 or CID2 areas, respectively.

The reason for this difference is that CID1 approvals cover hazardous areas not included in Zone 1 areas, so Zone 1–approved products may not necessarily be tested for all CID1 areas.

What indicator light solution is available for CID1 areas?

The nVent RAYCHEM E-100-L is not approved for CID1 areas, and currently nVent does not offer an end-of-line indicator light for these areas.

INSTALLATION

In the Industrial Heat-Tracing Installation and Maintenance Manual for Self-Regulating and Power-Limiting Cable Systems (H57274), there is a section describing the minimum bend radius. Why is the minimum bend radius important?

It is important not to bend self-regulating heating cables less than one inch in the in-plane direction or less than half an inch in the out-of-plane direction to prevent bus wire damage.

Which products can be used on plastic pipes?

HBTV is the product that should be used on all types of standard plastic pipes. Typically, the maximum exposure temperature for PVC pipe (schedule 40) is 150°F (66°C). In some cases, plastic pipes can withstand higher temperatures, which would sometimes allow HQTV to be used. TraceCalc Pro design software can be used to see if a heating cable is appropriate for use on a particular pipe.

OPERATION AND MAINTENANCE

What is the warranty?

The standard nVent Industrial Heat Tracing limited warranty applies to nVent RAYCHEM self-regulating/power limiting and nVent RAYCHEM MI heating cables. A complete set of warranty documents can be found on our web site, nVent.com.

LOGISTICS

These products can be obtained by our channel partners who will obtain the field information and ensure that the inspection records are completed and returned to the nVent Customer Service Center. The representative stocking the product must verify the design requirements.

ENGINEERING SPECIFICATION FOR ELECTRICAL HEAT-TRACING SYSTEMS

Contents

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1 SCOPE

This specification covers the requirements of materials and support services for heat-tracing systems supplied by the vendor. Neither the supply of the materials related to the connection of the power supply nor the installation of the entire system is part of this specification.

2 CODES, APPROVALS AND STANDARDS

The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured and tested in accordance with the requirements stated in the applicable CSA, FM, IEEE and UL standards and US National and Canadian Electrical Codes.

3 ELECTRIC HEAT TRACE SYSTEM MATERIALS

3.1 Self-Regulating Heating Cables

All heat-tracing applications with continuous exposure (maintain) temperatures from 150°F (65°C) to 300°F (150°C) or intermittent exposure temperatures from 185°F (85°C) to 482°F (250°C) shall use self-regulating cables.

A. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

B. Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:

   1. Retention of at least 75 percent of nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
   2. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 60216-1.

C. A warranty against manufacturing defects for a period of 10 years shall be available.

D. All cables shall be capable of passing a 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).

3.1.1 Freeze-Protection Systems

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

D. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

TABLE 1 MINIMUM SELF-REGULATING INDICES

Heating cable	S.R. index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

E. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.

F. The heating cable shall be nVent RAYCHEM BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by nVent.

3.1.2 Process Temperature Maintenance with No Steam Exposure

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable has a temperature identification number (T-rating) of T4 (275°F or 135°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

D. The heating cable shall be nVent RAYCHEM QTVR-CT self-regulating heater, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by nVent.

3.1.3 Freeze Protection and Process Temperature Maintenance with Steam Exposure

A. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires, separated by a fluoropolymer spacer and helically wrapped with a self-regulating fluoropolymer fiber that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T2C (446°F or 230°C) or lower without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

D. The heating cable shall be nVent RAYCHEM XTV-CT or nVent RAYCHEM KTV-CT self-regulating heater, for continuous exposure (maintain) capability up to XTV: 250°F (121°C), KTV: 300°F (150°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam), as manufactured by nVent.

3.1.4 Systems for Division 1 Hazardous Locations

The following requirements shall apply in addition to the criteria specified in paragraph 3.1.1, 3.1.2, or 3.1.3.

A. The self-regulating heating cable shall be specifically FM Approved or CSA Certified for use in Division 1 locations.

B. A ground-fault protection device set at 30 mA, with a nominal 100 ms response time, shall be used to protect each circuit.

C. The temperature identification number (T-rating) of the cable used shall comply with FM and CSA requirements as applicable.

D. Connection methods used with the cable shall be compatible and approved as a part of the system manufactured and supplied by the heating cable vendor for use in the Division 1 location.

E. For plastic pipe and vessel applications, the heating cable shall be nVent RAYCHEM HBTV-CT or nVent RAYCHEM BTV-CT self-regulating heaters, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by nVent.

F. The heating cable shall be nVent RAYCHEM HQTV-CT or nVent RAYCHEM QTVR-CT self-regulating heaters, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by nVent.

G. The heating cable shall be nVent RAYCHEM HXTV-CT or nVent RAYCHEM XTV-CT self-regulating heaters, for continuous exposure (maintain) capability up to 250°F (121°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam), as manufactured by nVent.

3.1.5 Terminations for nonhazardous And hazardous class I, div 2 locations

A. All connection kits used to terminate heating cables, including power connectors, splices, tees, and connectors shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer.

B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four inches (100 mm) of thermal insulation.

C. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch, or hot work permit for installation.

E. Components shall be rated to a minimum installation temperature of –40°F (–40°C), minimum usage temperature of –75°F (–60°C), and maximum pipe temperature of 500°F (260°C).

F. The connection kit system shall be nVent RAYCHEM JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three BTV, QTVR, or XTV industrial parallel heating cables as manufactured by nVent.

3.2 POWER-LIMITING HEATING CABLES

Heat-tracing applications with continuous exposure (maintain) temperatures from 250°F (121°C) to 455°F (235°C) or power-off exposure temperatures from 420°F (216°C) to 500°F (260°C) shall use power-limiting cables. Continuous exposure (maintain) temperatures are based on wattage and voltage used; consult with vendor for specific cable temperature limits. Applications below 500°F (260°C) continuous exposure, power-off, shall consider power-limiting cables if more than one run of self-regulating heating cable is required.

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters can use fewer runs due to higher power output at higher temperatures.

A. Power-limiting heating cable shall use a metallic heating element that varies its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be a parallel-zoned heating cable with a positive temperature coefficient heating element spirally wound around a flexible glass fiber core. The cable shall be designed such that it can be crossed over itself one time and cut to length in the field.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Maximum heating cable sheath temperature, per either the FM or CSA method of calculation, shall be submitted with the bid or design for all Division 1 and Division 2 applications.

D. The power-limiting heating cable shall have 12 AWG copper bus wires.

E. A warranty against manufacturing defects for a period of 10 years shall be available.

F. All cables shall be capable of passing a 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).

G. The heating cable shall be nVent RAYCHEM VPL-CT power-limiting heater, with continuous exposure (maintain) capability of 300°F (150°C) to 455°F (235°C), depending on power output required, and intermittent exposure capability up to 500°F (260°C), as manufactured by nVent.

3.2.1 Terminations for nonhazardous And hazardous class I, div 2 locations

A. All connection kits used to terminate heating cables—including power connectors, splices, tees, and connectors—shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer.

B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four inches (100 mm) of thermal insulation.

C. Terminals shall be the spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch, or hot work permit for installation.

E. Components shall be rated to a minimum installation temperature of –40°F (–40°C), minimum usage temperature of –75°F (–60°C), and maximum pipe temperature of 500°F (260°C).

F. The connection kit system shall be JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three VPL industrial parallel heating cables as manufactured by nVent.

3.3 MINERAL INSULATED HEATING CABLE SYSTEMS

All heat-tracing applications with continuous exposure (maintain) temperatures above 300°F (150°C) to 455°F (230°C), depending on power output required, or intermittent exposure temperatures above 500°F (260°C) shall use factory-terminated, mineral insulated (MI) cables.

A. MI heating cable shall be magnesium oxide insulated, with copper or alloy conductors and an Alloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Alloy 825.

B. Each cable shall be factory-terminated to the required length, consisting of the lengths required for the pipe or equipment, plus an allowance for areas of additional heat loss such as valves, flanges, fittings, supports, and the like, plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long unless otherwise specified.

C. Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.

D. Each cable shall be shipped with the catalog number marked on the outside of the package, and a permanent metallic cable tag containing the heating cable length, wattage, voltage, and current draw. If the cable has been designed for a hazardous location, the tag shall also indicate the area classification and heat-tracing circuit number.

E. A warranty against manufacturing defects for a period of 10 years shall be available.

F. The heating cable shall be nVent RAYCHEM (Alloy 825), mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C), as manufactured by nVent.

3.4 ELECTRICAL TANK HEATING PADS

A. The tank wall, to which the panel is to be fixed, shall be prepared according to the panel manufacturer's instructions.

B. Panels shall be flexible so that they are easily fastened to the surface of the tank to be heated.

C. Panels shall be suitable for maintaining the tank wall temperature at the specified temperature continuously without degrading or changing output characteristics of the panel.

D. Resistance heating elements shall be between flexible insulating layers, with a continuous operating rating of 200°F (93°C) and a short-term withstand rating of 366°F (186°C), to insulate electrically and provide mechanical protection for the heating elements. Elements shall be constant resistance.

E. Panels shall have an integrated thermostat to be used for over-temperature protection, but an additional primary control thermostat must be used.

F. All heater circuits are required to be protected with a 30 mA ground-fault protection device (GFPD).

G. For metallic tanks, supplied watt density (at 240 volts) shall be 1.9 watts/sq inch with a T-rating of T2C.

H. For plastic tanks, supplied watt density (at 240 volts) shall be 0.6 watts/sq inch with a T-rating of T4A.

I. A stainless steel ground plain on the external surface of the panel shall be supplied to provide a ground path as required by the National Electrical Code section 427-22.

J. Vendor shall supply a stainless steel junction box. Cold leads shall be Teflon-coated 14 AWG copper leads contained within liquid-tight, flexible conduit for added protection.

K. Mounting instructions and all required materials for fastening panels to the tank wall are to be furnished. Means other than thermal insulation are to be provided to hold panels in position. In addition to the specified tank heater the following materials are required: nVent RAYCHEM RHS Installation Kit (P/N 844869-001), nVent RAYCHEM 910 controller or equivalent, BCK-35 clamp kit (P/N C77215-000) or equivalent, Thomas and Betts 5232 conduit fitting, and 5302 sealing ring or agency approved equivalent.

L. Nonhazardous and hazardous location approvals for Class I, Division 2 Groups B, C, D, Class II Division 1 and 2 Groups E, F, G and Class III shall exist on all heating elements.

M. Installation and operation instructions shall be provided in hard copy and available on a 24-hour accessible Internet site. Installation instructions shall be nVent RAYCHEM Tank Heater (H55207) instructions.

N. A Megger test at 2500 Vdc shall be performed during installation and once a year.

O. The panels shall be RAYCHEM RHS tank heaters as supplied by nVent.

3.5 LONGLINE SYSTEMS

A. Self-Regulating, Two-Wire Geometry, Freeze Protection (500–2000 feet). For freeze protection applications, without high temperature exposure, up to 2000 feet, a two-wire self-regulating heater is often the best choice.

   1. The heating cable shall consist of two 10 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. The cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without the use of thermostats.
   2. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be nVent RAYCHEM LBTV2-CT for lengths of 500–1125 feet and SLBTV-CT for lengths of 1125–2000 feet, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by nVent.

B. Self-Regulating, VL Geometry, Freeze Protection (1000–12,000 feet). For freeze protection applications, without steam exposure, above 2000 feet up to 12,000 feet a self-regulating freeze protection heater in a VL geometry is often the best choice.

   1. The heating cable shall consist of two 10 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core, plus three additional 10 AWG nickel-plated copper bus wires. The cable shall be able to be connected directly to a 3-phase, 4-wire, 480 Vac or 600 Vac source.
   2. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be nVent RAYCHEM VLBTV2-CT self-regulating heater, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), manufactured by nVent.

C. Self-Regulating, VL Geometry, Freeze Protection and Process Temperature Maintenance with Steam Exposure (1000–6000 feet). For process temperature maintenance and freeze protection with steam exposure, a self-regulating process temperature maintenance heater in a VL geometry is often the best choice.

   1. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires separated by a fluoropolymer spacer and helically wrapped with a self-regulating fluoropolymer fiber, plus three additional 14 AWG nickel-plated copper bus wires. The cable shall be able to be connected directly to a 3-phase, 4-wire, 480 Vac or 600 Vac source.
   2. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be nVent RAYCHEM VLKTV2-CT self-regulating heater, with continuous exposure capability up to 300°F (150°C) and intermittent exposure capability up to 420°F (215°C) or 250 psi steam as manufactured by nVent.

D. Constant-Wattage Series Resistance, Freeze Protection and Process Temperature Maintenance up to 482°F (250°C) with Steam Exposure (500–12,000 feet). For process temperature maintenance and freeze protection with steam exposure, a constant wattage series resistance heater is often the best choice, particularly when more than one run of self-regulating heater is needed.

   1. The heating cable shall be a series resistance constant wattage heater. It shall consist of one, two or three or three copper conductors or copper alloy conductors insulated with high temperature heavy-walled fluoropolymer.
   2. The heating cable shall have a tinned or nickel-plated copper braid to provide a ground path. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
   3. The heating cable shall be constant wattage nVent RAYCHEM SC, with continuous exposure capability up to 400°F (204°C), nVent RAYCHEM SC/H with continuous exposure capability up to 482 °F (250°C), or SC/F with continuous exposure capabilities up to 195°F (90°C) as manufactured by nVent.

E. Constant-Wattage, Mineral Insulated (MI), Series Resistance, Freeze Protection and Process Temperature Maintenance from 482°F (250°C) to 1022°F (550°C) with Steam Exposure 5,000-10,000 feet. A constant wattage Alloy 825 series resistance heater is often the best choice for high temperature, longline, and corrosion resistant applications.

   1. MI cable shall be magnesium oxide insulated, with copper or alloy conductors and an Alloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Alloy 825.
   2. Each cable shall be factory-terminated to the required length, consisting of the lengths required for the pipe or equipment, plus an allowance for areas of additional heat loss, such as valves, flanges, fittings, supports, and the like, plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long unless otherwise specified.

3. Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.
4. Each cable shall be shipped with the catalog number marked on the outside of the package, and a permanent metallic cable tag containing the heating cable length, wattage, voltage, and current draw. If the cable has been designed for a hazardous location, the tag shall also indicate the area classification and heat-tracing circuit number.
5. A warranty against manufacturing defects for a period of 10 years shall be available.
6. The heating cable shall be nVent RAYCHEM XMI (Alloy 825) MI mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C), as manufactured by nVent.

F. Skin-Effect Heat-Tracing Systems, Circuit Lengths up to 15 Miles, Freeze Protection and Process Temperature Maintenance up to 392°F (200°C), with or without Steam Exposure. For very long lines, process temperature maintenance and freeze protection, skin-effect tracing is required.

1. The heating system shall consist of an electrically insulated, temperature-resistant conductor with high-temperature, heavy-walled fluoropolymer insulation installed inside a heat tube and connected to the tube at the far end.
2. The heat tube shall be ferromagnetic and thermally coupled to the carrier pipe that is being traced.
3. The design must be completed by the system manufacturer. 4. The installation should be supervised by the system manufacturer.
5. The heat-tracing system shall be nVent RAYCHEM STS (Skin-Effect Heat-Tracing System) as manufactured by nVent.

3.6 HEAT-TRACE PANELS

3.6.1 Group Heat-Tracing Circuit Control

A. For freeze protection or group control process-temperature maintenance systems, distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30mA trip level).

B. The panels shall provide ground-fault alarm capabilities.

C. If more than one circuit is required, a main contactor shall be used.

D. The panels shall operate with ambient-sensing or proportional ambient-sensing controllers.

E. The panels shall be capable of remote temperature monitoring and alarming of individual heat-tracing circuits.

F. The panels shall be CID2 approved for hazardous locations with Z-purge.

G. The panels shall be capable of providing audible and visible alarms.

H. The panel shall be the nVent RAYCHEM HTPG heat-tracing panel as manufactured by nVent.

3.6.2 Individual Heat-Tracing Circuit Control

A. For individual control process temperature maintenance systems, distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30mA trip level).

B. The panels shall provide ground-fault alarm capabilities.

C. Circuits shall be switched by individual contactors operated by line-sensing controllers.

D. The panels shall be capable of remote temperature monitoring and alarming of individual heat-tracing circuits.

E. The panels shall be CID2 approved for hazardous locations with Z-purge.

F. The panels shall be capable of providing audible and visible alarms.

G. The panel shall be the nVent RAYCHEM HTPI heat-tracing panel as manufactured by nVent.

3.7 CONTROL AND MONITORING SYSTEMS

All control and monitoring systems shall be capable of communicating with a host PC for central programming, status review, and alarm annunciation. All systems shall include, but not be limited to, the following:

A. Alarm limits and setpoint temperatures shall be programmable from the central monitoring and control panel in °F and °C. The system shall include an alphanumeric display with multilanguage support and password protection or lockable cabinet to prevent unauthorized access to the system.

B. The system shall be switched by an external solid-state or mechanical relay with a minimum rating of 30 Amps.

C. The system shall be capable of assigning one or more RTDs to a circuit to monitor temperature. One RTD can be applied to control the heater circuit and a second RTD for another control point or to measure sheath temperature of a heater for high temperature cutout.

D. The system shall monitor temperature, voltage, and line current to the systems. (NGC-40 does not support voltage monitoring).

E. The system shall monitor ground-fault current and offer the option of alarm only or alarm and trip if the ground fault exceeds the selectable level.

3.7.1 MULTIPOINT CONTROL AND MONITORING SYSTEMS FOR SINGLE AND MULTI- CIRCUIT APPLICATIONS

GENERAL

A. The system shall have FM, UL, CSA, ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching device or using electromechanical relays and a Z-purge system.

B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, outdoor installation) as required by project specification.

C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. The entire switch rack shall be factory assembled, tested, and approved by FM, UL, CSA, ETL (or equivalent).

D. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs) for temperature sensing.

E. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

F. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional (PID) Control with configurable power limiting shall also be available.

G. The controllers shall support single and 3 or 4 wire 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

H. Ground-fault (GF) detection equipment approved to UL1053 shall be integral to the controller. The GF feature shall provide independent alarm and trip settings.

I. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

J. For controllers utilizing SSRs, a soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

K. The controller shall be capable of testing the heating circuit at a user defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

SYSTEM

A. The system shall be compatible with all types of heating cables and capable of performing the following functions:

   1. Controlling and monitoring pipe temperatures.
   2. Providing real-time temperature and alarm log readouts.
   3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.
   4. Providing remote alarm annunciation.
   5. Interfacing with personal computers and DCS systems.

B. The system shall support an optional touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if locating the user interface remotely from the panel is desired.

C. The UI shall not be used for basic heat trace control functions. Primary heat trace control shall be performed independently by the control modules.

D. The UI shall have three form-C alarm relays that may be configured to alarm by type.

E. The system shall be capable of updating UI operating software in the field.

F. The system shall support Modbus RTU/TCP communications protocols and be supplied complete with RS-232, RS-485 and Ethernet communications interface capability. Fiber-optic interfaces, and pre-packaged communications converters and repeaters shall be available as options.

G. Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.

H. The heat trace vendor shall offer Windows®- based supervisor software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a client-server architecture allowing multiple simultaneous users and workstations, and be capable of integrating all system data into a central database. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

SINGLE/DUAL CIRCUIT CONTROLLERS

A. The single and dual-point controllers shall allow up to two hardwired RTD inputs per circuit.

B. The controller shall monitor heater voltage and support high and low voltage alarming.

C. The system shall be the nVent RAYCHEM 910 or nVent RAYCHEM 920 heat-tracing control system, as manufactured by nVent.

MULTI-CIRCUIT PANELS

A. The multi-point panels shall have the option to include integral power distribution.

B. The multi-point panels shall be capable of using RTDs that are wired directly to the internal control or expansion modules. The system shall allow up to four RTD inputs to be assigned to any circuit within the control panel. Expansion of the number of RTDs shall not result in a loss of the number of available heating circuits in the panel.

C. The multi-point panels shall support external field mounted RTD multiplexing modules and allow the temperatures to be assigned to any circuit within the control panel. RTD multiplexing modules shall be capable of being installed at a distance of up to 1200m (4000ft) from the control panel without additional equipment.

D. The multi-point control modules shall provide dry contact alarm relays.

E. The controller shall have the option to monitor heater voltage and support high and low voltage alarming.

F. The system shall be the nVent RAYCHEM NGC-30 heat-tracing control system, as manufactured by nVent.

3.7.2 SINGLE POINT CONTROL AND MONITORING SYSTEMS FOR SINGLE CIRCUIT AND MULTI-CIRCUIT APPLICATIONS

GENERAL

A. The system shall have FM, UL, CSA, ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching device or using electromechanical relays and a Z-purge system.

B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, outdoor installation) as required by project specification.

C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. The entire switch rack shall be factory assembled, tested, and approved by FM, UL, CSA, ETL (or equivalent).

D. The control solution shall provide single, dedicated, independent control modules for each heat tracing circuit to deliver the highest level of heat management system reliability.

E. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs) for temperature sensing.

F. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

G. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional (PID) Control with adaptive power limiting shall also be available.

H. Each control module shall provide one digital input that may be configured for various functions such as forcing the controller output on or off.

I. The controllers shall support single and 3 or 4 wire 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

J. For controllers utilizing SSRs, Circuit Breaker Limiting and Switch Limiting features for protection of circuit breakers and SSR relay outputs shall be available.

K. Ground-fault (GF) detection equipment approved to UL1053 shall be integral to the controller. The GF feature shall provide independent alarm and trip settings.

L. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

M. For controllers utilizing SSRs, an adaptive soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

N. The controller shall be capable of testing the heating circuit at a user defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

SYSTEM

A. The system shall be compatible with all types of heating cables and capable of performing the following functions:

   1. Controlling and monitoring pipe temperatures.
   2. Providing real-time temperature and alarm log readouts.
   3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.
   4. Providing remote alarm annunciation.
   5. Interfacing with personal computers and DCS systems.

B. The system shall support an optional touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if locating the user interface remotely from the panel is desired.

C. The UI shall not be used for heat trace control. All heat trace control shall be performed independently by the control modules.

D. The system shall be capable of updating UI operating software and controller firmware in the field.

E. The system shall support Modbus RTU/TCP communications protocols and be supplied complete with RS-232, RS-485 and Ethernet communications interface capability. Fiber-optic interfaces, and pre-packaged communications converters and repeaters shall be available as options.

F. Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.

G. The heat trace vendor shall offer Windows®- based supervisor software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a client-server architecture allowing multiple simultaneous users and workstations, and be capable of integrating all system data into a central database. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

H. The system shall provide load shedding capabilities that may be initiated by external devices. Multiple load shedding zones shall be supported, allowing select groups of controllers to be put into load shedding mode.

I. The load shedding command shall be periodically broadcast on the network. The controller shall manage the load shedding mode and automatically revert to normal operation should the load shedding commands fail to be broadcast.

J. The Controllers shall provide a fail-safe load shedding mode to ensure that pipe temperatures do not drop below acceptable levels even during load shedding events.

SINGLE/DUAL CIRCUIT CONTROLLERS

A. The single and dual-point controllers shall allow up to two hardwired RTD inputs per circuit.

B. The controller shall monitor heater voltage and support high and low voltage alarming.

C. The system shall be the 910 or 920 heat-tracing control system, as manufactured by nVent.

MULTI-CIRCUIT PANELS

A. The multi-point panels shall consist of DIN rail mountable control and monitoring modules. Panels shall have the option to include integral power distribution.

B. The multi-point panels shall be capable of using RTDs that are wired directly to the internal control or expansion modules. The system shall allow up to eight RTD inputs to be assigned to any circuit within the control panel. Expansion of the number of RTDs shall not result in a loss of the number of available heating circuits in the panel.

C. The multi-point panels shall support external field mounted RTD multiplexing modules and allow the temperatures to be assigned to any circuit within the control panel. RTD multiplexing modules shall be capable of being installed at a distance of up to 1200m (4000ft) from the control panel without additional equipment.

D. The multi-point control modules shall provide dry contact relays. Alarming shall be software configurable on an individual circuit, group, or panel basis, rather than hard-wired.

E. For three phase circuits, the controllers shall monitor and report the current for each phase (L1, L2 and L3) individually. High and low line current alarm threshold set points shall be independently programmable for each phase.

F. The system shall be the nVent NGC-40 heat-tracing control system, as manufactured by nVent.

3.7.3 POWER LINE CARRIER COMMUNICATIONS (PLI) OPTION FOR NGC-30 CONTROL SYSTEMS (This specification is intended as an addendum to Section 3.7.1 which covers the NGC-30 Control System)

A. The system shall be capable of utilizing power line carrier (PLI) technology that uses the heating cable bus wires and power distribution wiring for communication, thus eliminating additional field instrument/sensor wiring.

B. The PLI system shall consist of a PLI modules located in the Control System panel which communicates with field mountable connectors as follows:

   1. nVent RAYCHEM Smart End Seal (SES) kits
   2. nVent RAYCHEM Smart Power Connection (SPC) kits

C. The NGC-30 system with PLI shall be fitted with electromechanical relays for heat-tracing circuit on/off control.

D. The NGC-30 system with PLI shall have FM, UL or CSA (or equivalent) approval for Class I, Division 2, Groups A, B, C, D when using electromechanical relays and a Z-purge system.

E. The PLI field mountable connectors shall have FM, UL or CSA (or equivalent) approval for Class I, Division 2, Groups A, B, C, D for use in hazardous locations.

F. Temperature transmitters shall monitor temperature at any point along the heat-tracing circuit, including teed-off heating segments and the end of the circuit and may provide the option for line continuity monitoring and reporting.

G. For temperature monitoring with the PLI technology, the system shall use resistance temperature detectors (RTDs) wired directly to the PLI temperature transmitters. The PLI temperature transmitters shall communicate to a PLI Module located in the NGC-30 panel over the power distribution wires and bus wires of the heater.

H. The Control system shall also support temperature monitoring in addition to the PLI system. The Control system and shall use resistance temperature detectors (RTDs) that are wired directly to the monitoring and control panel or to a remote module (RMM2) that communicates with the central monitoring and control system via RS-485 twisted pair wiring. The system shall allow these additional inputs to be assigned to any circuit within the control panel.

I. Electrical isolation between the plant environment and the system shall be provided by dedicated, shielded, heat-tracing isolation transformers and front end filters.

J. The system shall provide a touch screen User Interface Terminal, to display monitoring, fault and status information of the PLI system as well as configuration capability.

K. The PLI part of the system shall be compatible with the following types of heating cables:

    1. Self-Regulating heating cables
    2. VPL heating cables (using SPC kits only)
    3. SC heating cables
    4. MI heating cables (using SPC kits only)

L. The system shall be the NGC-30 heat tracing control & monitoring system with PLI option as manufactured by nVent.

3.7.4 SINGLE- OR DUAL- POINT CONTROL AND MONITORING DEVICES

A. The system shall be field-mounted and shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D when using a solid-state switching device.

B. The system shall provide the user with the option of line-sensing control with a user selectable dead band, ambient sensing, proportional ambient sensing, and power limiting control modes.

C. The system shall provide an isolated solid-state alarm relay or a dry contact relay for alarm annunciation back to a Distributed Control System (DCS).

D. Electrical code-approved ground-fault detection equipment shall be integral to the controller to simplify installation and reduce total cost.

E. Enclosure type shall be TYPE 4X fiberglass reinforced plastic (FRP) or stainless steel for corrosion resistance and protection from moisture.

F. The control and monitoring systems shall have a network-ready option to provide communication to a host PC running Windows®-based nVent RAYCHEM Supervisor software for central programming, status review, and alarm annunciation. nVent RAYCHEM Control and Monitoring Systems shall support the Modbus® RTU or ASCII communications protocol and be supplied complete with RS-232, RS-485 communications interface capability.

G. The system shall be the 910 or 920 heat-tracing control system, as manufactured by nVent.

3.8 THERMOSTATS AND CONTACTORS

A. Freeze protection systems shall operate using self-regulating control or with the nVent RAYCHEM AMC-1A or nVent RAYCHEM AMC-F5 thermostat and the nVent RAYCHEM E104-100A or nVent RAYCHEM E304-40A contactor in nonhazardous locations, and nVent RAYCHEM AMC-1H thermostat with nVent RAYCHEM E307-40A contactor in hazardous locations, as supplied by nVent.

B. Process temperature maintenance systems shall operate using self-regulating control or with nVent RAYCHEM AMC-1B thermostat and nVent RAYCHEM E104-100A or nVent RAYCHEM E304-40A contactor in nonhazardous locations and nVent RAYCHEM E507S-LS or nVent RAYCHEM RAYSTAT-EX-03-A thermostats and nVent RAYCHEM E307-40A contactor in hazardous locations, as supplied by nVent.

4 ENGINEERING

A. The vendor shall be given a line list from which to design and estimate a complete heat-tracing system. The bid package shall also include area layout and orthographic drawings.

B. The vendor shall provide a detailed design utilizing standard heat-tracing design software, such as nVent TraceCalc Pro design software or equal. At minimum, the design must provide the following:

1. Circuit identification number
2. Maintain temperature
3. Line size and insulation
4. Heat loss for pipe, valves, and supports
5. Amount and type of heating cable required
6. Spiral requirements
7. Heating cable service voltage
8. Heating cable power output at the maintain temperature
9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures
10. Circuit breaker and transformer sizing

C. The vendor shall provide heat-tracing isometric drawings at the buyer's request, using either hard copy or machine-readable CAD inputs.

5 TESTING

A. Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (MI) heater cables shall include but are not limited to the following:

1. Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer's standards.
   Insulation resistance shall be measured from heating device conductors to metallic braid, metallic sheath, or other equivalent electrically conductive material with a 500 Vdc test voltage. However, it is strongly recommended that higher test voltages be used—mineral insulated trace heaters should be tested at, but not exceed, 1000 Vdc, and polymeric insulated trace heaters should be tested at 2500 Vdc.
2. In the field, all heater cables shall be tested for insulation resistance. The following separate field megohmmeter readings shall be taken on each cable:
   a. When received at jobsite before installation
   b. After installation, but before insulation is applied
   c. After insulation has been installed
3. The readings obtained shall satisfy the minimum acceptable readings per IEEE Std 515-2011 otherwise the heater cable is not acceptable and shall be replaced.

It is strongly recommended that the manufacturer's minimum recommended IR values be observed as tabulated below:

Source	**Manufacturer**			**IEEE515-2011**
Cable Type	Self- Regulating/ Power- Limiting	Constant Wattage (Polymer)	Constant Wattage (MI)	All
IR Values (Megohms)	Recommended Minimum IR Value			Absolute Minimum Acceptable
On Receipt	1000	100	100	20
After Insulation	1000	100	20	20
After Insulation	1000	100	20	5
Start Up/ Commissioning	1000	100	10	5

Note: Insulation resistance readings should be recorded promptly at each of the different stages after the cable has been received, installed, insulated and commissioned.

4. Field megohmmeter tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.
5. Adverse weather conditions such as high humidity can influence measuring equipment/ test leads/ connections and appropriate steps should be taken to avoid false insulation resistance readings.

TYPE ENCLOSURE TYPES

DEFINITIONS PERTAINING TO NONHAZARDOUS LOCATIONS

Type 1 Enclosures	Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.
Type 2 Enclosures	Type 2 enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water.
Type 3 Enclosures	Type 3 enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and damage from external ice formation.
Type 3R Enclosures	Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, damage from external ice formation, and must have a drain hole.
Type 3S Enclosures	Type 3S enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and to provide for operation of external mechanisms when ice laden.
Type 4 Enclosures	Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.
Type 4X Enclosures	Type 4X enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.
Type 5 Enclosures	Type 5 enclosures are intended for indoor use primarily to provide a degree of protection against airborne dust, falling dirt, and dripping noncorrosive liquids.
Type 6 Enclosures	Type 6 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during temporary submersion at a limited depth, and damage from external ice formation.
Type 6P Enclosures	Type 6P enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth, and damage from external ice formation.
Type 12 Enclosures	Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.
Type 12K Enclosures	Type 12K enclosures with knockouts are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.
Type 13 Enclosures	Type 13 enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.

DEFINITIONS PERTAINING TO HAZARDOUS (CLASSIFIED) LOCATIONS

Type 7 En closures	Type 7 enclosures are intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the National Electrical Code.
Type 8 Enclosures	Type 8 enclosures are intended for indoor or outdoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the National Electrical Code.
Type 9 Enclosures	Type 9 enclosures are intended for indoor use in locations classified as Class II, Groups E, F, and G, as defined in the National Electrical Code*.
Type 10 Enclosures	Type 10 enclosures are constructed to meet the applicable requirements of the Mine Safety and Health Administration.

* Refer to NEMA Standards Publication No. 250 Enclosures for Electrical equipment (1000 Volts Maximum) or other third party certification standards for specific requirements for product construction, testing and performance such as Underwriters Laboratories, Inc., Standard UL 50 “Standards for Enclosures for Electrical Equipment,” and UL886 “Outlet Boxes and Fittings for use in Hazardous (Classified) Locations.”

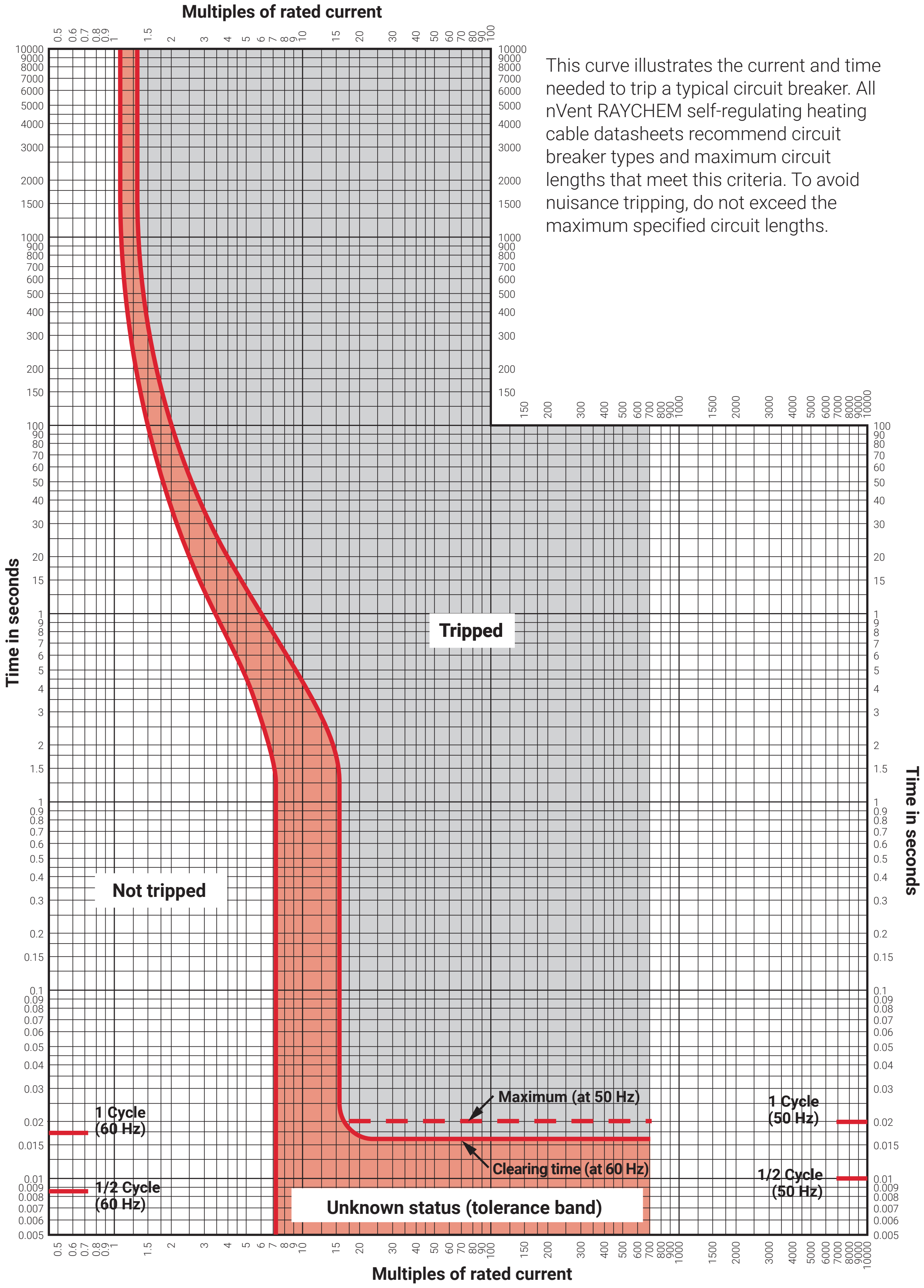
ENCLOSURE TYPES VS. IEC CLASSIFICATION DESIGNATION COMPARISON

Enclosure Type rating	IEC Enclosure (IP) Classification
1	IP 10
2	IP 11
3	IP 54
3R	IP 14
3S	IP 54
4 and 4X	IP 55
5	IP 52
6 and 6P	IP 67
12 and 12K	IP 52
13	IP 54
(one way conversion)	

Note: This table is for the reference only. (Direct conversion is not allowed) Both enclosure type rating test and IEC enclosure (IP) rating test have to be tested to achieve both rating.

TYPICAL CIRCUIT BREAKER TRIP CURVE

This curve illustrates the current and time needed to trip a typical circuit breaker. All nVent RAYCHEM self-regulating heating cable datasheets recommend circuit breaker types and maximum circuit lengths that meet this criteria. To avoid nuisance tripping, do not exceed the maximum specified circuit lengths.



Thermal-magnetic time/current characteristics curve (TYPE standard)

UNIT CONVERSION TABLES

TABLE 1 EQUIVALENCE OF MISCELLANEOUS UNITS

Lengths					
1 ft	= 0.3048 m	= 12 in	= 0.3333 yd		
1 m	= 3.28084 ft	= 39.37008 in			
1 mi	= 5,280 ft	= 1,760 yd	= 1,609.34 m	= 1.60934 km	= 320 rd
Areas					
1 ft^2	= 0.09290 m^2	= 144 in^2	= 0.11111 yd^2		
1 m^2	= 1550 in^2	= 10.7639 ft^2	= 1.19599 yd^2		
1 acre	= 43,560 ft^2	= 4,840 yd^2	= 0.40469 ha (hectare)	= 4046.87 m^2	= 0.001563 mi^2
1 mi^2	= 640 acres	= 3,097,600 yd^2	= 2,589,988 m^2	= 2.5899 km^2	= 258.99 ha
1 km^2	= 0.38610 mi^2	= 247.104 acre	= 100 ha		
Masses and weights					
1 lb	= 0.45359 kg = 0.000464 long ton	= 16 oz	= 14.5833 oz (troy)	= 0.0005	ton = 7000 grains
1 kg	= 2.2046 lb av = 0.001 m ton	= 2.6792 lb tr (troy)	= 35.274 oz av	= 15,432.4 grains	= 0.00110 ton
1 ton	= 2,000 lb	= 907.185 kg	= 32,000 oz	= 0.90722 m ton	
Volume and capacity					
1 ft^3	= 1728 in^3 = 6.229 Imp gal (Br)	= 0.03704 yd^3 = 0.80356 bu	= 0.028317 m^3	= 29.9221 qt (liq)	= 7.4806 gal (liq)
1 yd^3	= 46,656 in = 21.6962 bu (bushel)	= 27 ft^3	= 0.76456 m^3	= 807.896 qt (liq)	= 201.974 gal (liq)
1 gal (liq)	= 231 in^3	= 0.13368 ft^3	= 4 qt	= 0.83268 Imp gal	= 0.00378543 m^3
1 m^3	= 61,023 in^3 = 1.308 yd^3	= 35,314 ft^3	= 1056.7 qt (liq)	= 264.18 gal	= 28.38 bu

TABLE 2 CONVERSION FACTORS FOR THERMAL CONDUCTIVITY

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h·ft·°F	Btu-in/h·ft·°F	W/m·°C	W/cm·°C	cal/s·cm·°C	kcal/h·m·°C
Btu/h·ft·°F	1.0000	12.000	1.72958	0.017296	4.13378 x E-03	1.48816
Btu·in/h·ft^2·°F	0.0833	1.000	0.14413	1.441314 x E-03	3.44481 x E-04	0.124013
W/m°·C	0.57818	6.9381	1.000	0.001	2.39006 x E-03	0.860422
W/cm·°C	57.8175	693.810	100.000	1.000	0.23901	86.0422
cal/s·cm·°C	241.9090	2902.91	418.40	4.18400	1.000	360.000
kcal/h·m·°C	0.671971	8.06365	1.16222	0.011622	2.77778 x E-03	1.000

TABLE 3 CONVERSION FACTORS OF COEFFICIENTS OF HEAT TRANSFER

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h-ft2·°F	**W/m2·°C**	**W/cm2·°C**	**kcal/h·m·°C**	**cal/s·cm2·°C**
Btu/h·ft2·°F	1.0000	5.67446	5.67446 x E-04	4.88243	1.35623 x E-04
W/m2·°C	0.17623	1.000	1.0 x E-04	0.86042	2.3900 x E-03
W/cm2·°C	1762.28	1.0 x E+04	1.000	8604.20	0.2390
kcal/h·m2·°C	0.20482	1.16222	1.16222 x E-04	1.000	2.77778
cal/s·cm2·°C	7373.38	4.1840 x E-04	4.1840	3.6000	1.000

TABLE 4 CONVERSION FACTORS FOR ENERGY

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu	**J**	**kWh**	**kcal**	**ft·lbf**
Btu	1.0000	1054.350	2.92875 x E-04	0.251996	778.21
J	9.478 x E-04	1.0000	2.77778 x E-07	2.39006 x E-04	7.3756 x E-01
kWh	3414.43	3.6 x E+06	1.0000	860.420	2.6552 x E+06
kcal	3.9656	4184.0	1.16222 x E-03	1.0000	3086.54
hp·h	2547.16	2.6864 x E-06	0.7457	641.6	1.9808 x E-06
ft·lbf	1.28592 x E-03	1.355818	3.76616 x E-07	3.2405 x E-04	1.0000

TABLE 5 CONVERSION FACTORS FOR ENERGY IN RELATION TO TIME AND AREA

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h·ft^2	**Btu/h·m^2**	**W/ft^2**	**W/m^2**	**kcal/h·m^2**	**Btu/s·ft^2**
Btu/h·ft^2	1.0000	10.7639	0.29288	3.15248	2.71428	2.77778 x E-04
Btu/h·m^2	0.092903	1.0000	0.027209	0.29288	0.251996	2.58064 x E-05
W/ft^2	3.41443	36.7526	1.0000	10.76391	9.26142	9.48453 x E-04
W/m^2	0.31721	3.41442	0.092903	1.0000	0.86042	8.81138 x E-05
kcal/h·m^2	0.36867	3.96832	0.10797	1.16222	1.0000	1.02408 x E-04
Btu/s·ft^2	3600.0	38750.0	1054.35	11348.9	9764.85	1.0000

TABLE 6 MISCELLANEOUS CONVERSION EQUIVALENTS

	(lb/ft^3)	**(g/cm^3)**	**(kg/m^3)**	**(lb/gal)**
lb/ft^3	1.000	= 0.0160185	= 16.01846	= 0.133680
g/cm^3	62.428	= 1.000	= 1000.0	= 8.34538
kg/m^3	0.062428	= 0.001	= 1.000	= 0.008345
lb/gal	7.4805	= 0.11982	= 119.82	= 1.000
Enthalpy and energy per unit mass				
	(Btu/lb)	**(kcal/kg)**	**(J/g)**	**(w·h/kg)**
Btu/lb	1.000	= 0.555556	= 2.32444	= 0.645679
kcal/kg	1.799	= 1.000	= 4.184	= 1.16222
J/g	0.430210	= 0.239006	= 1.000	= 0.277778
w·h/kg	1.54876	= 0.860422	= 3.600	= 1.000
Specific heat and entropy				
	(Btu/lb·°R)	**(kcal/kg·°K)**	**(kJ/kg·°K)**	**(w·h/kg·°K)**
kcal/kg·°K	1.000	= 1.000	= 4.184	= 1.16222
kJ/kg·°K	0.239006	= 0.239006	= 1.000	= 0.277778
w·h/kg·°K	0.860422	= 0.860422	= 3.600	= 1.000

TABLE 7 TEMPERATURE CONVERSION

°F = (°C x 9/5) + 32		°C = (°F - 32) 5/9							
°F	**°C**	**°F**	**°C**	**°F**	**°C**	**°F**	**°C**	**°F**	**°C**
−40	−40	200	93	440	227	680	360	920	493
−35	−37	205	96	445	229	685	363	925	496
−30	−34	210	99	450	232	690	366	930	499
−25	−32	215	102	455	235	695	368	935	502
−20	−29	220	104	460	238	700	371	940	504
−15	−26	225	107	465	241	705	374	945	507
−10	−23	230	110	470	243	710	377	950	510
−5	−21	235	113	475	246	715	379	955	513
0	−18	240	116	480	249	720	382	960	516
5	−15	245	118	485	252	725	385	965	518
10	−12	250	121	490	254	730	388	970	521
15	−9	255	124	495	257	735	391	975	524
20	−7	260	127	500	260	740	393	980	527
25	−4	265	129	505	263	745	396	985	529
30	−1	270	132	510	266	750	399	990	532
35	2	275	135	515	268	755	402	995	535
40	4	280	138	520	271	760	404	1000	538
45	7	285	141	525	274	765	407	1005	541
50	10	290	143	530	277	770	410	1010	543
55	13	295	146	535	279	775	413	1015	546
60	16	300	149	540	282	780	416	1020	549
65	18	305	152	545	285	785	418	1025	552
70	21	310	154	550	288	790	421	1030	554
75	24	315	157	555	291	795	424	1035	557
80	27	320	160	560	293	800	427	1040	560
85	29	325	163	565	296	805	429	1045	563
90	32	330	166	570	299	810	432	1050	566
95	35	335	168	575	302	815	435	1055	568
100	38	340	171	580	304	820	438	1060	571
105	41	345	174	585	307	825	441	1065	574
110	43	350	177	590	310	830	443	1070	577
115	46	355	179	595	313	835	446	1075	579
120	49	360	182	600	316	840	449	1080	582
125	52	365	185	605	318	845	452	1085	585
130	54	370	188	610	321	850	454	1090	588
135	57	375	191	615	324	855	457	1095	591
140	60	380	193	620	327	860	460	1100	593
145	63	385	196	625	329	865	463	1105	596
150	66	390	199	630	332	870	466	1110	599
155	68	395	202	635	335	875	468	1115	602
160	71	400	204	640	338	880	471	1120	604
165	74	405	207	645	341	885	474	1125	607
170	77	410	210	650	343	890	477	1130	610
175	79	415	213	655	346	895	479	1135	613
180	82	420	216	660	349	900	482	1140	616
185	85	425	218	665	352	905	485	1145	618
190	88	430	221	670	354	910	488	1150	621
195	91	435	224	675	357	915	491	1155	624

GLOSSARY OF TERMS

ampacity	The current (in amperes) that a wire can carry without exceeding its temperature rating.
approved	Acceptable to the authority having jurisdiction (for enforcement of the National Electrical Code, for example).
ANSI	American National Standards Institute.
ASTM	American Society for Testing and Materials.
ATEX Directive 94/9/EC	A European product directive for hazardous locations designed to open up free trade across Europe, and mandatory for all electrical and mechanical equipment which may be used in potentially explosive atmospheres.
autoignition temperature (AIT)	The AIT is the minimum temperature at which a material can spontaneously ignite without an external source of ignition. This is different from the flash point of a liquid, which is the lowest temperature at which the liquid gives off sufficient vapor to form an ignitable mixture with air near the surface of the liquid or within the vessel used. The flash point of gasoline is -50°F and the AIT is 536°F.
autotherming	An operating characteristic of self-regulating heating cables that results in a substantial change of its electrical resistance over a small temperature increment—the autotherming temperature is the temperature at which this change occurs.
Auto-Trace	A historic trademark of the families of self-regulating heating cables manufactured by Thermal Management (formerly the Chemelex Division of nVent RAYCHEM).
braid	The wires woven around the heating cable that provide an electrical ground path.
branch-circuit	The electrical current path from an individual branch-circuit breaker (or fuse) to all connected heating cable circuits.
cable sets	A preterminated MI heating cable complete with a heated section and nonheated cold lead section.
CE	Marking to show compliance with all essential safety requirements of European Union directives.
CEC	Canadian Electrical Code.
circuit breaker	A device that opens and closes a circuit by nonautomatic means; it also opens the circuit automatically on a predetermined overcurrent (without damage to itself) when properly applied within its rating.
cladding	An outer jacket, usually metallic, encasing the thermal insulation.
classified locations	A location that is classified into a class, division, and group, or into a class, zone, and group, because a fire or explosion hazard may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.
cold lead	An electrically-insulated conductor that connects a heating cable–circuit conductor to the branch-circuit conductors; it does not produce any appreciable heat. Constant wattage heating cables require the use of cold leads.
combustible dusts	Any finely divided solid material of 20 microns or less in diameter (i.e., material passing through a U.S. No. 40 Standard Sieve) that presents a fire or explosion hazard when dispersed and ignites in air or other gaseous oxidizer.
combustible liquid	A liquid having a flash point at or above 100°F (37.8°C).
conduction	One of the three methods of heat transfer (the others: radiation and convection). The transfer of heat by molecular motion without the bulk movement of material. Conduction is the only way that heat can be transferred within a solid.
conductor	A long thin piece of metal used to carry current. An insulated conductor is a wire.

constant-wattage heating cable	Heating cables that have effectively the same power output over a large temperature range. Zone heating cables that use Nichrome® heating wires and most series-resistance heating cables are examples of constant-wattage heating cables.
contactor	A heavy-duty relay that controls electric power circuits.
continuity	The presence of a complete path for current flow.
continuous load	A load in which the maximum current is expected to continue for three hours or more.
controller	A device that regulates the state of a system by comparing a signal from a sensor with a predetermined value and adjusts its output to the predetermined value. Controllers used in electric heat-tracing systems normally include some form of monitoring and alarming. Thermostats typically include little or no monitoring. Temperature sensors used with controllers are usually electronic (thermocouple, RTD, thermistor). Temperature sensors used with thermostats can be mechanical (bulb and capillary, bimetallic) or electronic.
convection	One of the three methods of heat transfer (the others: conduction and radiation). The transfer of heat by the bulk motion of a fluid (liquid or gas). Convection is also the transfer of heat between a solid and a fluid.
corrosive environment	An area where chemically-aggressive gases or liquids are present either in the pipe or in the surrounding atmosphere.
CSA International	CSA International is a leading provider of product testing and certification services worldwide. They test products for compliance to national and international standards and issue certification marks for qualified products across North America and around the world.
deadband	The range through which a measured signal can vary without initiating a response by the controlling device.
deadleg	A segment of pipe that is designed to be in a permanent no-flow condition. This pipe section is often created for use as a control point for a larger system.
dielectric	A material with a large resistance to the flow of electricity; an insulator.
DTS	Distributed Temperature Sensing (DTS) is a method of monitoring temperature along the continuous length of a pipeline. It provides a temperature profile for the full length of the pipeline for better visibility of hot/cold spots than can be provided by widely spaced RTD's.
electric heat-tracing system	A system of electric heating cables, connection kits, and a power distribution system that may include cables, panelboards, and transformers whose purpose is to maintain a piping system at or above a given temperature. The system may also include a control system with sensors, alarms, and controllers. Electric heat-tracing systems are sometimes referred to as electric pipe heating of trace-heating systems.
electrical insulation (cable)	The part of the cable that consists of dielectric (see above) material.
electromechanical relay (EMR)	An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts into or out of contact with each other. (See Contactor)
equipment	A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as part of, or in connection with, an electrical installation.
explosion-proof	A method of protection for electrical equipment used in Class I hazardous locations. Explosion-proof apparatus is apparatus enclosed in a housing that is capable of withstanding an explosion of a specified gas or vapor that may occur within it, and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.
factory fabricated	A heating cable assembled by the manufacturer, including hot and cold end terminations and cold lead. Mineral insulated (MI) cable is generally factory fabricated. Self-regulating heating cables are generally not factory fabricated.
Fiber Optic Cables	Fiber Optic cables are traditionally used in telecommunications. However, they are being deployed as sensors for continuous temperature monitoring, leak detection and intrusion detection on pipelines in industrial applications. These fiber optic cables are specially armored for durability.
field assembled	Heating cable supplied in bulk; terminating kits to be assembled (terminated) by field personnel.
flash point	The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid, as specified by tests.
FM Approvals	FM Approvals offers worldwide quality management systems and certification and testing services of industrial and commercial products to national and international standards.

FM Approved	A product or system which has been evaluated by FM Approvals, and found to comply with a given standard or set of standards or has been evaluated for its use by utilizing accepted engineering practices and performance approaches.
fuse	An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse is a one-use device, unlike a circuit breaker, which can be reset and used many times.
ganging	The practice of combining multiple heating cables onto one branch circuit breaker.
grounded	Connected to earth or to some conducting body that serves in place of the earth.
ground fault	The passage of current from a circuit to earth-ground.
ground-fault circuit breaker	A device that protects equipment; it turns off a circuit within an established period of time when a current to ground exceeds some predetermined value (usually from 5 to 100 mA) which is less than that required to operate the overcurrent protective device of the supply circuit.
ground-fault circuit interrupter	A device intended for the protection of personnel; it turns off a circuit within an established period of time when a current to ground exceeds some predetermined value (usually 5 mA) which is less than that required to operate the overcurrent protective device of the supply circuit.
ground-fault protection of equipment	A system that protects equipment from damaging line-to-ground-fault currents by disconnecting all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage from a supply circuit overcurrent device.
hazardous locations	Same as a classified location. A location that is classified into a class, division, and group, or into a class, zone, and group, because a fire or explosion hazard may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings. For a more detailed description, refer to the National Electrical Code, Articles 500 through 503 in particular, as well as other related articles.
hazardous locations divisions	Divisions 1 and 2 as defined in the National Electrical Code describe the likelihood that a flammable or combustible mixture will be present in ignitable quantity.
hazardous locations groups	Groups A, B, C, D, E, F, and G in the National Electrical Code Article 500 classification system, and Groups IIA, IIB and IIC in the National Electrical Code Article 505 method of classification. For purposes of testing, approval, and area classification, various air mixtures (not oxygen-enriched) are grouped together because they have similar explosion characteristics.
heat loss	The rate of energy lost from a pipe, vessel, or equipment to the surrounding environment due to the difference in temperature between the pipe and the surrounding environment. The heat loss needs to be calculated because the heat tracing selected must be of sufficient power to replace the heat lost if the desired temperature is to be maintained.
heat sink	A part that conducts and dissipates heat away from the pipe or equipment. Heat sinks can be pipe supports, valve operators, etc.
heat transfer aids	Thermally-conductive materials, such as metallic foils or heat transfer cements, used to increase the heat transfer rates from the heating cables to the process piping or equipment.
heating cable circuit	A discrete length of heating cable that is directly wired to a single power connection kit at one end and terminated with an end seal kit. Intermediate branch heating cables (connected to the primary run of heating cable with a tee connection kit) are considered part of the heating cable circuit. Note that multiple-entry power connection kits will accommodate multiple heating cable circuits.
high-limit temperature	The maximum allowable heat-tracing system temperature of the heat-traced equipment. A marking that indicates the maximum temperature that a piece of equipment will reach based upon a 40°C (104°F) ambient temperature. The temperature marking is compared to the ignition temperature of explosive gases, vapors, dusts, or flyings that may be encountered in hazardous areas.
IECEx	IEC System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres.
IEEE	Institute of Electrical and Electronics Engineers is the world's largest professional association for the advancement of innovation and technological excellence.
IEx - Institute of Certification	IEx is a Brazilian company with international renowned experts in electrical equipment for explosive atmospheres. IEx is accredited by INMETRO, National Institute of Metrology, Standardization and Industrial Quality, for hazardous locations products.
isometric	An engineering drawing: a three dimensional view of the object or system.
jacket	A thermoplastic or thermosetting plastic covering, sometimes fabric-reinforced, applied over the insulation, core, metallic sheath, or armor of a cable.

Joule effect	The heating effect produced by the flow of current through resistance.
lagging	See cladding.
listed	In accordance with the National Electrical Code and other NFPA standards this means equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or material, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.
maintain temperature	Specified temperature of the fluid or process material that the heat tracing is designed to hold at equilibrium under specified design conditions, normally at minimum ambient temperature.
maximum ambient temperature	Highest expected environmental temperature surrounding the heat-traced object.
maximum contact temperature	The maximum withstand temperature of the heat traced plastic pipe. The temperature depends on its pressure rating and material.
maximum equilibrium temperature	The highest equilibrium pipe temperature that occurs when the heating cable is continuously energized at the maximum ambient temperature (defined as runaway pipe temperature by IEEE 515).
maximum intermittent exposure temperature	The highest temperature to which the heating cable may be exposed intermittently.
(power on or off)	Defined as high-temperature excursions of not more than 48 hours in duration, with total cumulative exposure of less than 1000 hours. Intermittent high-temperature exposure may occur during process upset conditions or steam-cleaning operations.
maximum maintain temperature	The highest temperature at which the heating cable may be operated continuously (power on).
maximum operating temperature	The maximum temperature of the process fluid during normal continuous operation. This temperature may be the same as the maintain temperature, but it is sometimes substantially higher. This is assumed to be the highest temperature to which the heating cable will be continuously exposed.
minimum ambient temperature	The lowest expected ambient temperature at the design location. The effect of wind is covered in the design. The wind chill factor should not be used.
minimum operating temperature	The lowest process-operating temperature of the fluid during flow conditions. This temperature is frequently the same as the design maintain temperature.
NEC	National Electrical Code.
negative temperature coefficient	A device or material whose resistance decreases with an increase in temperature and increases with a decrease in temperature. A thermistor generally has a negative temperature coefficient.
NEMA	National Electric Manufacturers Association.
NFPA	National Fire Protection Association is an international nonprofit organization established in 1896. The company's mission is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training and education.
noncorrosive environment	An area where chemically-aggressive gases, vapors, or fluids are not present.
orthographic	An engineering drawing; the plan, section, and elevation views of the object.
outdoor location	The installation is subjected to environmental extremes, including exposure to a high wind velocity (assumed to be 20 mph [32 km/h] for an insulated, heat-traced pipe).
overcurrent	Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault. A current in excess of rating may be accommodated by certain conductors for a given set of conditions. Hence, the rules for overcurrent protection are specific to particular situations.
overcurrent protective device	An in-line component of an electric circuit used to cause and maintain the interruption of current flow to the protected device when the protected device is subjected to an overcurrent condition (e.g., circuit breaker, fuse).
overload	Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity when, if it persists for a sufficient length of time, it would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.
oversize insulation	A term applied to thermal insulation when the thermal insulation inner diameter must be larger than the nominal outer diameter of a particular pipe in order to accommodate the heating cable.
P & ID	Piping and instrumentation diagram.

panelboard	A single panel or group of panel units assembled in a single panel that includes buses, and automatic overcurrent devices. A panelboard may or may not have switches for the control of light, heat, or power circuits. Designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.
parallel heating cable	A heating cable with heating elements that are electrically connected in parallel, either continuously or in zones, such that watt density per linear length is approximately equal along the length of the heating cable (allowing for the drop in voltage down the length of the heating cable).
pipe schedule	An index that specifies the nominal wall thickness as a function of pipe size.
pipe size	The nominal diameter of the pipe. For tubing, the size and outside diameter are the same.
pipe support	A device for supporting a section of pipe.
pitch	The degree of slope or the distance between two points of a spiraled heating cable.
PLI	(Power Line carrier Interface) A set of components that provide temperature-monitoring capability for heat-tracing control & monitoring systems by communicating the temperature data to the control system using the heat tracing and power distribution wiring thus eliminating the need for RTD wiring.
plot plan	A representation of the layout of a particular facility or area. It typically shows the position of roads, buildings and other constructions inside an industrial plant with their coordinate lines.
positive temperature coefficient (PTC)	A characteristic of a device or material whose resistance increases with an increase in temperature and decreases with a decrease in temperature. Self-regulating heating cables have positive temperature coefficients and are often referred to as PTC heating cables.
power-limiting heating cable	A type of heating cable that shows PTC behavior based on the properties of a metallic heating element. The PTC behavior exhibited is much less (a smaller change in resistance in response to a change in temperature) than that shown by self-regulating heating cables.
process control	These terms are generally used to denote any heat-tracing application other than
(also process-temperature control)	freeze protection of water lines.
process operating temperature	The maximum temperature of the process fluid during normal continuous operation. This temperature may be the same as the maintain temperature, but it is sometimes substantially higher. This is assumed to be the highest temperature to which the heating cable will be continuously exposed.
radiation	One of the three methods of heat transfer (the others: conduction and convection). The transfer of heat by the propagation of energy waves. When dealing with insulated pipes and vessels the effect of radiation is usually insignificant.
rated output	The expected minimum power output of a heating cable for a given set of conditions. These conditions may include applied voltage, pipe or surface temperature, and total length.
rated voltage	The voltage to which operating and performance characteristics of heating cables are referenced.
redundant or redundancy	The introduction of auxiliary elements and components to a system to perform the same function as other elements in the system for the purpose of improving reliability. Redundant electric heat-tracing systems consist of duplicate independent heating cables and controllers, each with its own sensor supplied from separate power systems, all independent of each other but all applied to the same mechanical piping, valves, tanks, etc.
routine test	A test carried out by the manufacturer of the heating cable during production.
RMM2	Remote Monitoring Module which aggregates RTD temperature data in the field and sends it over one wire pair to the control & monitoring panel. This allows reduction of RTD wiring runs in the field while ensuring all temperature data is provided to the heat tracing control & monitoring system.
self-regulating	The inherent capability of polymer-core heating cables to inversely vary their power output in response to an increase or decrease in the actual temperature in the immediate vicinity of the heating cable.
sensor, sensing element	The first system element that responds quantitatively and performs the initial measurement. In electrical heat-tracing systems, sensors respond to the temperature of the system and may be directly connected to controllers. Sensors can be mechanical (bulb and bellows, bimetallic) or electrical (thermocouple, RTD, thermistor).

series heating cable	A heating cable using a high resistance wire in order to create heat via electrical resistance. These cables provide a constant heat output and cannot be overlapped.
SES	Smart End Seal transmitter that enables monitoring signals to transmit through heating cable bus wires and power cables. No additional field wire is necessary. Part of the Power Line Carrier Interface (PLI) option on certain nVent RAYCHEM control & monitoring systems.
sheath	The outermost continuous covering for the cable.
sheath temperature	The temperature of the outermost heating cable jacket covering that may be exposed to the surrounding atmosphere.
short circuit	A fault consisting of a lower-resistance connection across a voltage source, which normally results in an excessive current. It should cause the overcurrent device (circuit breaker or fuse) to open.
silicon-controlled rectifier (SCR)	A four-layer semiconductive device that is used as an electrical switch in ac and dc circuits. An activation signal is required to turn the SCR on or off.
Skin Effect	The phenomena which results from AC Current traveling through a wire located inside a ferromagnetic metal tube in which the return current flowing in the metal tube limits the current flow to the inside surface of the metal tube. No current or voltage potential exists on the outside of the tube.
solid-state relay (SSR)	A solid-state switching device that completes or interrupts a circuit electrically. An SSR has no moving parts.
SPC	Smart Power Connector is part of the Power Line Carrier Interface (PLI) option which allows MI and VPL technology heating cables to be used with the PLI option on certain control & monitoring systems. The SPC takes the place of the power connection kit.
start-up current	The initial current drawn by a heating cable when it is energized at the start-up temperature.
start-up temperature	The lowest temperature expected at a time when the heat-tracing cable will be switched on. This can be an important design consideration for self-regulating cables because the start-up current depends on the start-up temperature.
STS	nVent RAYCHEM Skin-effect heat Tracing System (STS) is a pipe heating technology designed for long pipeline applications. It is capable of providing high heating power to over 25Km of pipeline between power points.
system limit temperature	The highest temperature that the heat-tracing system is allowed to impose on the rest of the system. For example, a plastic pipe system will have a relatively low system limit temperature to protect the plastic pipe. A temperature-sensitive fluid will have a system limit temperature to protect the fluid from high temperatures from the heating cable.
thermal insulation	Material that is designed to have a low thermal conductivity. Thermal insulation is placed on the outside of pipes and vessels to reduce the rate of heat loss.
thermistor	A temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance in response to a small change in temperature. Thermistors usually have negative temperature coefficients.
thermocouple	A temperature-measuring device consisting of two wires of dissimilar metals. The voltage difference across the wires can be related to the difference in the temperature of the two junctions.
thermostat	A device that senses temperature and activates a relay to control the flow of current to a downstream device.
Touch 1500	A state-of-the-art user interface using a 15-inch (381 mm) color display with touch screen for the nVent RAYCHEM NGC-40 system.
TraceCalc Pro	Thermal Management' heat-tracing system design software. Performs thermal calculations, selects products, and generates the required Bill of Materials based upon the input design parameters.
turnkey installation	Complete, cost-effective installation using front-line, direct-hire labor. Includes complete documentation of the system.
type test	A test or series of tests carried out on equipment; representative of a type, to determine compliance of the design, construction, and manufacturing methods within specified requirements.
UIT2	User Interface Terminal. This is the touch screen display used for local control and monitoring of nVent RAYCHEM NGC-30 controllers.
UL	Underwriters' Laboratories is an independent product safety certification organization that tests products and writes standards for the safety of commercial and industrial products.

V.A.S.T.	Value-added steam tracing
volatile flammable liquid	A flammable liquid having a flash point below 38°C (100°F), or a flammable liquid whose temperature is above its flash point, or a combustible liquid having a vapor pressure exceeding 40 psia at 38°C (100°F) whose temperature is above its flash point.
watt-density	Thermal output of heating cable in watts per unit area.
weather barrier	A material or materials, which, when installed on the outer surface of thermal insulation, protects the insulation from the weather, such as rain, snow, sleet, wind, solar radiation, or atmospheric contamination and physical damage.
zone heating cable	A parallel resistance heating cable which uses a resistive element between the bus wires to act as a heater. The resistive element makes contact with alternate bus wires at a distance called the zone length.

North America

Tel +1.800.545.6258
Fax +1.800.527.5703
thermal.info@nvent.com

Latin America

Tel +1.713.868.4800
Fax +1.713.868.2333
thermal.info@nvent.com

Europe, Middle East, Africa

Tel +32.16.213.511
Fax +32.16.213.604
thermal.info@nvent.com

Asia Pacific

Tel +86.21.2412.1688
Fax +86.21.5426.3167
cn.thermal.info@nvent.com

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