



## CONNECT AND PROTECT

### HWAT HOT WATER TEMPERATURE MAINTENANCE SYSTEM

A single pipe solution for improved water safety,  
energy efficient design and cost savings

  
nvent

**RAYCHEM**



# Make the Right Choice in Hot Water Supply Systems

Delivering hot water is the industry's greatest challenge. Customers increasingly demand safe and comfortable hot water delivery solutions that are also cost effective and easy to design.

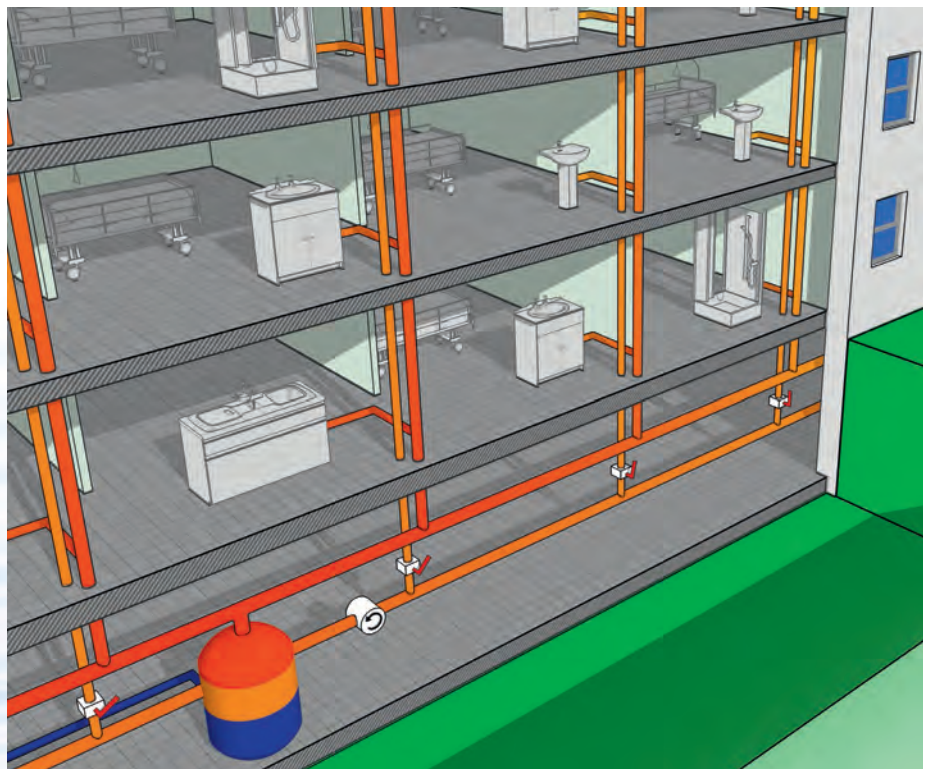
Water safety and the efficient use of water and energy resources has become increasingly important.

While delivering hot water without wasting water or power is a requirement of any modern hot water system, the system must also be easy to design, install and operate economically.

The nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) single pipe solution delivers these vital requirements.

## THE CONVENTIONAL SOLUTION: THE RECIRCULATION SYSTEM

- Heat losses from the hot water distribution pipes are compensated for by increased water temperature at the water heater.
- A pump circulates hot water continuously throughout the pipe network and returns unused water back to the heater.
- The hot water in the pipes nearest to point of use are typically not part of the circulation system and will gradually cool down during periods of non-use, resulting in water that is wasted while waiting for hot water to arrive.



## Requirements for Hot Water Systems



QUALITY & COMFORT



ECONOMICAL DESIGN

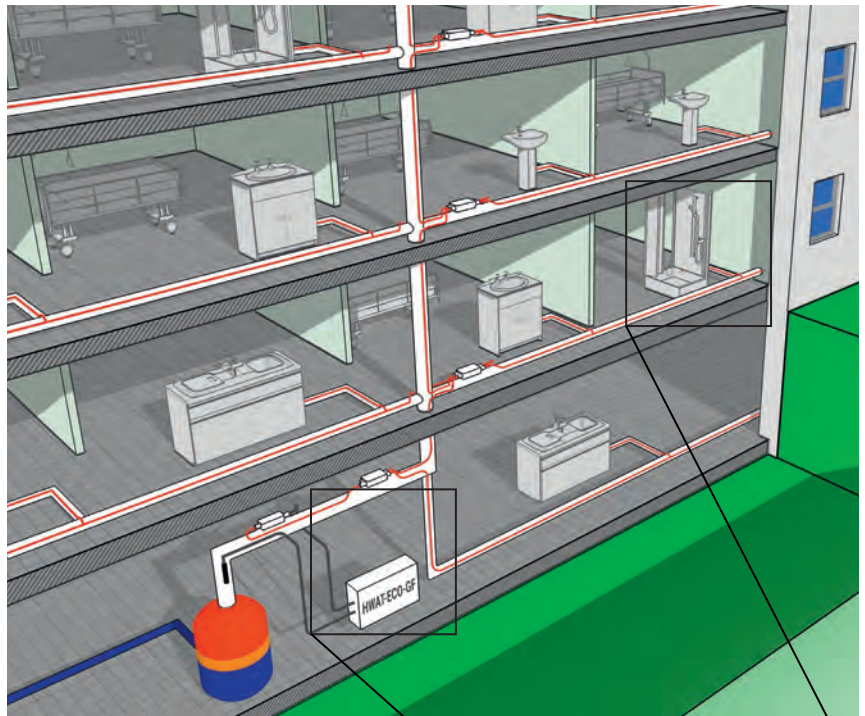


WATER & ENERGY SAVINGS

# Make the Right Choice in Hot Water Supply Systems

## THE ALTERNATIVE: THE HWAT SINGLE PIPE SYSTEM - A SIMPLY BETTER SOLUTION!

- HWAT heating cable is attached to a single hot water pipe beneath the insulation which keeps hot water at the specified temperature all the way to each point of use.
- Easy to program controllers monitor the boiler and pipe temperature and power the HWAT cable only as needed to maintain the desired hot water temperature.
- Maintaining hot water temperature to point of use improves water quality and user's comfort and satisfaction.
- HWAT systems are simple to design and install. Eliminating traditional recirculating system's return lines, pumps, and valves simplifies designs, decreases design time, and saves valuable space in buildings.
- HWAT systems have demonstrated savings in both energy and water consumption.



## HOW DOES IT WORK?

### The key components of the smart HWAT hot water temperature maintenance system:



#### The HWAT heating cable compensates for heat lost

The self-regulating heating cable compensates for heat lost when hot water is not flowing, keeping hot water at the specified temperature.



#### Insulation reduces the heat loss

Pipes must be insulated with specified thermal insulation to maintain the desired pipe temperatures.

Proper thermal insulation means:

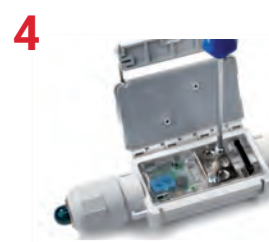
- Lower heat losses
- Lower operating costs

**All hot water supply systems require insulation whether recirculation or single pipe systems!**



#### Smart controllers for safe and economical operation

Easy to program controllers optimize system performance. The nVent RAYCHEM HWAT-ECO-GF controller contains pre-installed programs for different building types with options to fine tune programming for each building's unique requirements.



#### Easy Installation

Electrical connections are fast and easy with the nVent RAYCHEM RayClic connection system.



# Water Quality & Comfort

## HWAT SYSTEMS IMPROVE WATER QUALITY

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Studies show that legionella bacteria grows in numbers in water with temperatures between 77-115 °F (25-46 °C). HWAT temperature control systems can effectively maintain the temperatures required for your building services Legionella risk management program. See ASHRAE 188-2018 and CIBSE TM13: 2013 for additional information for the proper design, installation, operation, maintenance and management of your building water systems to minimize the risk of Legionella Disease.

Self-regulating HWAT heating cable is easy to install on all supply piping to point of use ensuring that instant hot water is available at every tap.



## HWAT IMPROVES USER COMFORT AND SATISFACTION

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By maintaining specified temperatures close to point of use, people no longer need to wait for hot water to arrive while watching precious water go needlessly down the drain. This improves satisfaction and hygiene while saving money and resources.



**WARNING:** Water temperature above 130°F (55°C) presents a significant risk of personal injury and/or death and requires that scald protection measures be implemented for safe use.

# Economical by Design!

## **FLEXIBILITY**

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### **Flexible and space-saving hot water delivery systems**

- The space needed for pipes is reduced, because no return pipes are needed. Risers, shafts and other openings can be reduced freeing space for other use.
- Existing building may be renovated or have extra stories or other spaces added. With the HWAT system, these new sections can be connected to the existing hot water temperature maintenance system easily, rapidly and economically.
- With smart single pipe solutions, it becomes easier to monitor energy and water consumption at each unit or area enabling invoicing by use and encouraging conservation.

## **LOW INVESTMENT COSTS**

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### **The system requires fewer components and simplifies installation**

- There are no pumps, control valves or double water meters to install, and the HWAT cable is easily attached directly to the hot water pipe under the thermal insulation.
- Time-consuming installations of return pipes is eliminated.
- Smart controls and RayClic connections further reduce time needed to program and install.



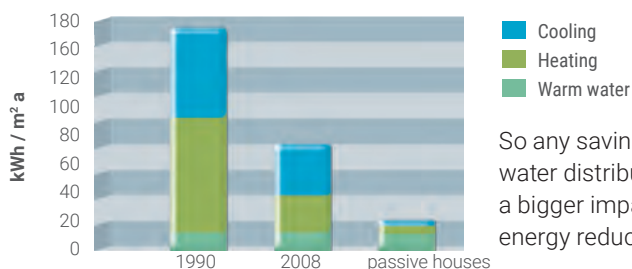


# Economical: Saving Energy & Money

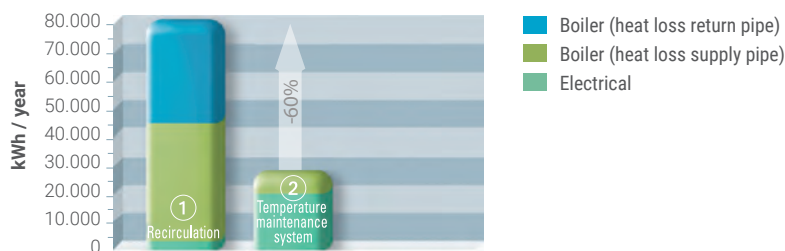
## MAXIMIZE BUILDING EFFICIENCY AND VALUE

HWAT systems improve building efficiency reducing total operating costs by as much as 16%. HWAT systems can also reduce water and energy waste.

The larger the building, the greater the savings. For instance, HWAT systems eliminate the need for recirculation plumbing and boilers every 10 floors in a high-rise building. Coupled with better temperature maintenance from less heat loss, self-regulating systems can also save an average of 5-6% in energy costs and reduce water waste in even a moderately-sized apartment by over 357,000 gal/year.



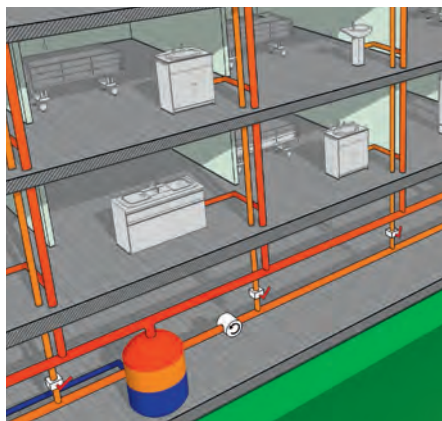
So any savings on the warm water distribution will have a bigger impact on the total energy reduction of the building.



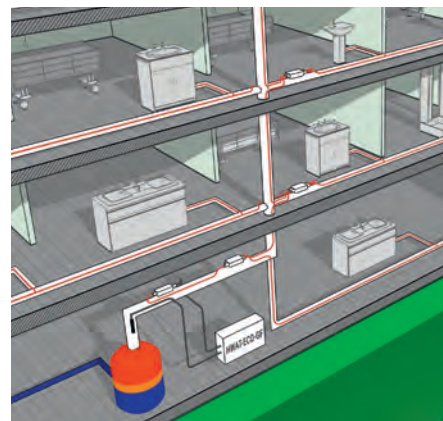
## HWAT - LEED POINT ELIGIBLE

The USGBC has proven that HWAT systems lower energy use. As a result, building owners may receive LEED credit points - an important distinction for many building owners. HWAT systems contribute 1 to 3 LEED points to Reduced Consumption of Source Energy, and 1-point credit for Innovation and Design. This is significant, particularly in regions where energy costs and consumption are high. LEED has proven to be a critical component in maximizing a building's future income potential, since the higher the LEED rating for a building, the higher the building's value!

Quite simply, the less energy consumption, water waste, and amount of materials needed to construct a building, the better the impact on embedded carbon reduction. HWAT systems deliver on all counts.



Traditional Recirculation System



Single-Pipe-System

# Ecological: Saving Water

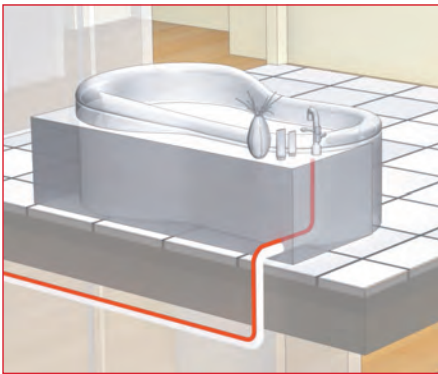
## SAVE WATER!

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There's no questioning the vast impact that warm water supply has on the environment.

5.5% of our total energy needs is consumed by hot water generation and this will increase during the coming years.

In addition to energy, buildings consume a significant amount of water. With these environmental impacts, hot water distribution systems are becoming increasingly considered for consumption-saving initiatives.



The HWAT single pipe system solution provides safer and more efficient hot water to each point of use that has a big impact on the environment and user's water and energy costs.

### Reduced Water Waste Example

Moderate income apt., 600 units, 2 tenants per apartment

- 2 showers/day, waste 0.4 gal per shower
- 2 washes/shaves/day, waste 0.42 gal per event

Total waste: 357,700 gal/year = 1,354,000 0.5L bottles





# What Our Customers Say

## RESIDENTIAL COMMUNITIES IN MAJOR CITIES ARE CHOOSING HWAT SYSTEMS FOR THEIR PROPERTIES

While the needs of each property varies, HWAT systems have demonstrated the ability to save money and increase energy-efficiency in high-rises and sustainability-focused communities..

Bruce Jaffe, a principal at MG Engineering, rethought the standard potable domestic hot water generation and distribution by utilizing electric temperature maintenance hot water heat trace cable in lieu of the industry standby recirculation pump method for plumbing code compliance.

MG Engineering's innovative designs result in cost-efficient construction and reduced mechanical shaft requirements, mechanical and electrical room space, building fuel use and greenhouse gas emissions, and water waste—all while supplying instant hot water for building tenants.

According to Mr. Jaffe, electric temperature maintenance cable systems decouple the zone pressure from the water heater pressure. "This permits us to create a master hot water plant, which minimizes overall space and BTU requirements. The system is simplified by eliminating equipment and its associated installation requirements," he concluded.

Source: Electrification Improves High-Rise Hot Water Design, NEMA Magazine, January 2018, <https://blog.nema.org/2018/01/06/electrification-improves-high-rise-hot-water-design/>

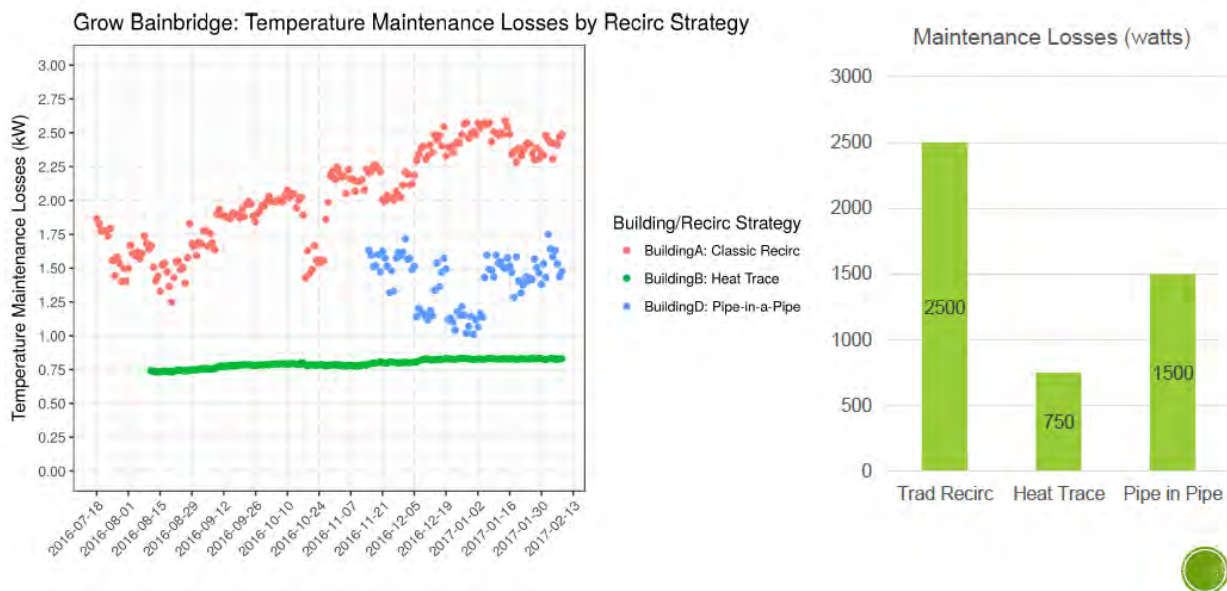


## SUSTAINABILITY AND HEALTHY LIVING COMMUNITY

Grow Community is a new urban neighborhood on Bainbridge Island, just outside of Seattle. The homes are entirely solar-powered and designed with energy-efficiency at heart. In 2017, the energy performance of 3 different hot water maintenance systems in 3 similar 12 unit multi-family buildings were compared.

### Key Findings:

1. Adjusted for occupancy loads, the HWAT heat-traced single pipe building reduced energy lost to maintain hot water temperatures by 70% versus the traditional recirculation building.
2. Adjusted for actual hot water used, the HWAT heat-traced single pipe building reduced energy consumed to maintain hot water temperatures by 25% versus the traditional recirculation building.



Source: 2017 Case Study, grow community, Bainbridge Island Washington State 2017, written by Shawn Oram, PE at Ecotope.



# Have Your Next Project Calculated & Compared

## INVENT PROVIDES FREE CALCULATIONS TO BENCHMARK ENERGY CONSUMPTION AND LIFETIME COSTS

The SaveWatt calculation and design software compares the effectiveness of a hot water temperature maintenance system with that of a circulation system.

### Comparison of:

- Investment costs
- Energy consumption
- Operating costs
- Amortisation (lifetime cost)

The program contains modules with which the optimum temperature settings can be calculated. The software also creates a bill of materials for the project.

## SAVEWATT CALCULATION AND DESIGN SOFTWARE: COMPARISON BETWEEN A SINGLE PIPE SYSTEM AND RECIRCULATION

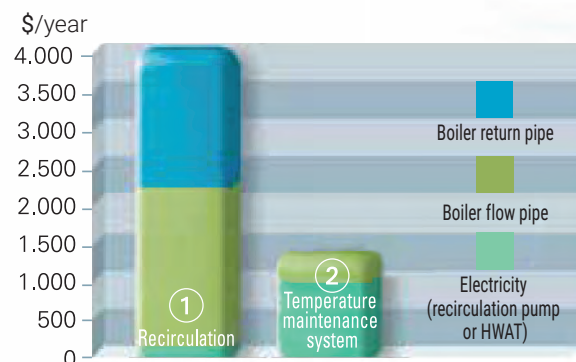
Example, illustrating potential savings versus a hospital equipped with recirculation (with 370m of flow pipe).

### 1. Investment costs



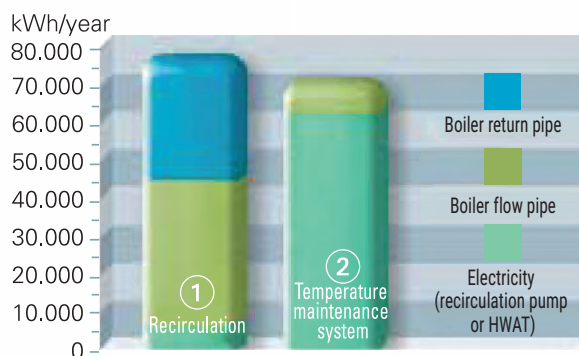
Investment costs:  
13% less than in a circulation system

### 3. Operating costs



Operating costs:  
10% lower operating costs

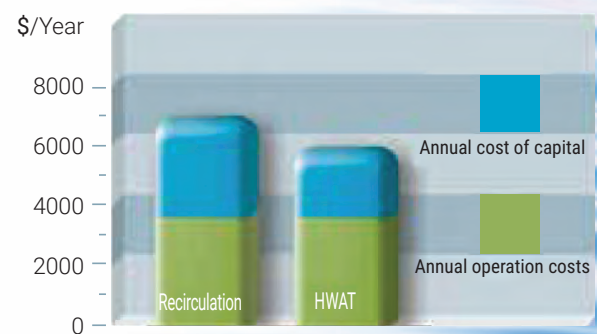
### 2. Energy demand



Only 36% energy demand

### 4. Depreciation

(period of use 20 years, rate of interest 5%)



Depreciation: 10% saving of the capital and operating costs per annum

# Hot Water Temperature Maintenance System

## **ECONOMICAL & ECOLOGICAL FROM THE GROUND UP!**

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### **1. Efficient use of water**

No water wastage caused by waiting for cold water to clear and hot water to arrive

### **2. A more hygienic and comfortable solution**

- Can be an effective part of your building services legionella risk management program
- No more waiting for hot water to arrive improves hygiene and user satisfaction

### **3. An energy-friendly and cost saving system**

- HWAT can save as much as 60% on power when compared to a comparable recirculation system
- No return pipe, so lower heat loss from only one pipe
- USGBC Approved – LEED points eligible

### **4. A reliable and low maintenance solution**

- No recirculation pump – no parts to wear out
- Fewer pipes, no control valves or pumps
- No hydraulic compensation with occupancy changes
- Up to 40 year expected life and 10-year warranty on heating cables





**HOT WATER TEMPERATURE  
MAINTENANCE PRODUCT  
SELECTION AND DESIGN GUIDE**





**RAYCHEM**

The nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) is a hot water temperature maintenance system that provides immediate hot water without the use of a water recirculation system. This product selection and design guide provides all the information necessary to select and design an HWAT system. For information regarding other products and applications, contact nVent at (800) 545-6258. Also, visit our web site at nVent.com.

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# HOT WATER TEMPERATURE MAINTENANCE – HWAT SYSTEM



This step-by-step design guide provides the tools necessary to design a nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT). For additional information, contact your nVent representative or call (800) 545-6258. Also, visit our web site at nVentthermal.com.

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## INTRODUCTION

The HWAT system is a hot water temperature maintenance system that utilizes an electronic controller, self-regulating electric heating cables, and an easy-to-install set of connection kits to provide commercial buildings with immediate hot water at the tap without the use of a water recirculation system.

Recirculation systems require the water heater temperature to be at least five degrees above the maintain temperature to compensate for the heat that is lost in the recirculation loop. With HWAT systems, the water in the supply pipe is maintained at a constant temperature along the entire length of the supply pipe so heating the water above the maintain temperature is not required. Recirculation systems also require return lines, pumps, and balancing valves, all of which are all unnecessary with HWAT.

A key component of the HWAT system is the controller. In addition to providing flexible temperature control, the controllers provide energy savings; a heat-up cycle that increases the water temperature in stagnant pipes; Building Management System (BMS) interface; alarm relay to signal power, temperature, or communication problems; a water heater sensor function; and nine predefined programs that can be customized by the user.

## Typical Applications

The HWAT system is designed to be installed and operated in commercial buildings. Table 1 shows typical HWAT applications, desired maintain temperatures when nVent RAYCHEM HWAT-R2 heating cable is used in conjunction with the nVent RAYCHEM HWAT-ECO-GF or ACS-30 controllers.

**TABLE 1 TYPICAL HWAT APPLICATIONS**

Application	Desired maintain temperature
Hospitals, nursing homes	105°F (40°C)
Schools, prisons, some hospitals	115°F (45°C)
Offices, hotels, apartments	125°F (50°C)
Kitchens, laundries	140°F (60°C)

This design guide covers standard HWAT applications which must meet the following conditions:

- Installed on copper or rigid plastic pipes
- Insulated in accordance with the insulation schedule shown in Table 6
- Powered at 208 - 277 V using the ACS-30 or HWAT-ECO-GF controller
- Operated indoors where the ambient temperature is relatively constant and between 60°F (15°C) and 80°F (27°C)

If your application does not meet the above conditions, contact your nVent representative for custom design assistance.

## Approvals and Code Compliance

The HWAT system components are UL Listed, CSA Certified, and/or FM Approved in nonhazardous locations.



Pipe Heating Cable

HWAT-R2 heating cable and RayClic connection kits, are UL Listed, CSA certified and FM approved for use in non-hazardous locations. The HWAT-ECO-GF controller is c-UL-us Listed and the ACS-30 controller is c-CSA-us certified (ACS-UIT) and c-UL-us Listed (ACS-PCM2-5) to US and Canadian standards for use in non-hazardous locations. Refer to the specific product data sheets for details.

The HWAT system is designed in accordance with the following international and national codes:

- International Plumbing Code
- International Building Code
- International Energy Conservation Code
- National Standard Plumbing Code
- National Electrical Code
- Canadian Electrical Code
- ANSI/ASHRAE Standard 188-2018 - Legionellosis: Risk Management for Building Water Systems
- CIBSE TM13-2013 Minimising the Risk of Legionnaires Disease

Additionally, our HWAT solution has numerous state and local code approvals. Contact your nVent representative for further information. Due to its potential to reduce energy usage and greenhouse gas emissions, HWAT solutions are eligible for LEED points.

## Safety Guidelines

The safety and reliability of any heat-tracing system depends on the quality of the products selected and on proper design, installation, and maintenance. Incorrect design, handling, installation, or maintenance of any of the system components can cause underheating or overheating of the pipe or damage to the heating cable system and may result in system failure, electric shock, or fire. The guidelines and instructions contained in this guide are important. Follow them carefully to minimize these risks and to ensure that the HWAT system performs reliably.

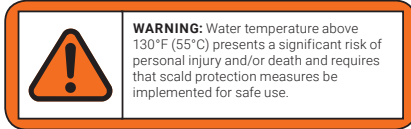
Pay special attention to safety warnings identified as  **WARNING.**



## 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 nVent requirements, 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 breakers. The HWAT-ECO-GF and ACS-30 controllers meet the electrical code requirements for ground-fault equipment protection.

## Scald Protection



HWAT systems present an increased risk of scalding due to the high water temperature. Pay special attention to the scald warning to the left.

## Design Requirements

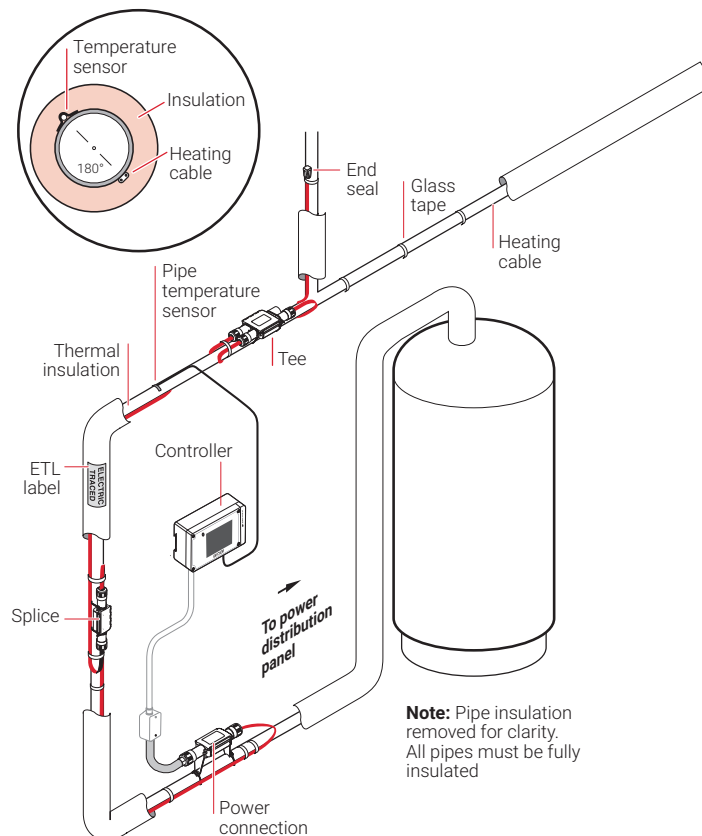
To comply with warranty requirements, the design and installation of the HWAT system must be in accordance with this guide and the additional documents listed below:

- HWAT-ECO-GF Installation and Operations Manual (H60223)
- HWAT System Installation and Operations Manual (H57548)
- Rayclic Connection Kit Installation Instructions (H55388 and H55092)

Installation documents are shipped with the respective products and are also available via the nVent web site at [nVentthermal.com](http://nVentthermal.com)

## SYSTEM OVERVIEW

A complete HWAT system includes one or more HWAT-ECO-GF or ACS-30 electronic controllers, HWAT-R2 heating cable, and nVent RAYCHEM RayClic connection kits. Fig. 1 illustrates a typical HWAT system. The key components of the system will be described in this section.



**Fig. 1 Typical HWAT heating cable system**

## HWAT Electronic Controllers

The HWAT-ECO-GF electronic controller is designed for use with a single circuit of HWAT-R2 self-regulating heating cable. For large hot water systems the ACS-30 distributed controller is available, refer to the ACS-30 data sheet (H58261) for more information. The HWAT-ECO-GF provides a variety of features and control options, listed below, for your hot water temperature maintenance system.

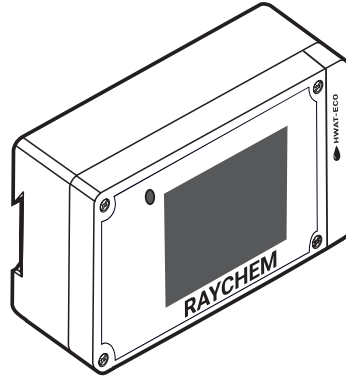


Fig. 2 HWAT-ECO-GF controller

- **Equipment rated ground-fault protection built-in**
- **Intuitive set-up and programming, includes a 5" inch color touch screen**
- **Flexible temperature control of hot water temperature maintenance systems**
- **Energy savings through an integrated function that lowers the maintain temperature during hours of low water consumption**
- **Heat-up cycle function that increases the water temperature of the hot water in the pipes**
- **Alarm relay to signal power, temperature or communication problems**
- **Hot water storage and pipe temperature monitoring with high and low temperature alarms and automatic system shut down**
- **Seven pre-defined building timer programs that can be customized by the user**
- **Program in advance in power-off mode by using external power bank/charger and USB connection**

## HWAT Heating Cables

HWAT-R2 self-regulating heating cables is installed on hot water supply pipes underneath standard pipe insulation. The heating cable adjusts its power output to reduce the effect of ambient temperature swings. The HWAT system provides continuous hot water temperature maintenance while eliminating the need for a recirculation system.

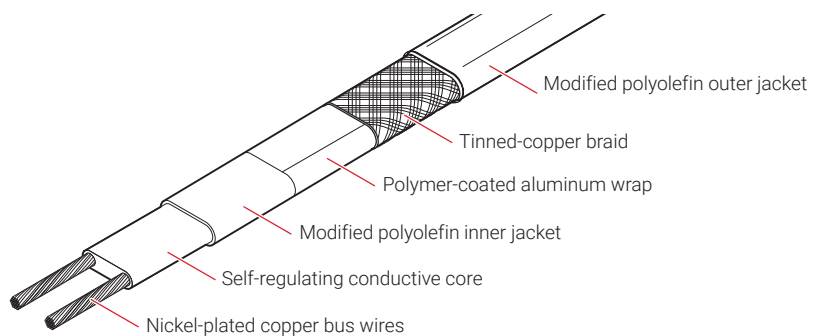


Fig. 3 HWAT-R2 heating cable

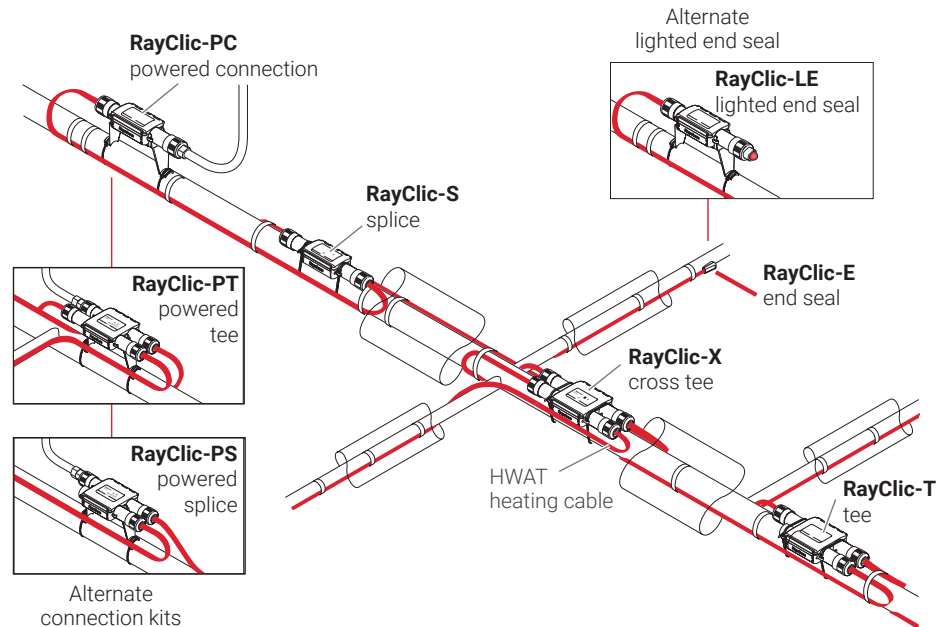


HWAT heating cables provide the following features:

- Adjust power output to reduce the variations in water temperature
- Can be cut to length, spliced, teed, and terminated in the field
- Designed for use with the HWAT-ECO-GF or ACS-30 controller

### RayClic Connection Kits

The RayClic connection system is a simple, fast, and reliable set of connection kits developed for use with HWAT self-regulating heating cables. RayClic connection kits reduce installation time, lowering the total installed cost of the HWAT system.



**Fig. 4 RayClic connection kits**

### DESIGN GUIDELINES

This section describes the seven steps necessary to design an HWAT system:

- 1 Select the heating cable
- 2 Lay out the heating cable
- 3 Select connection kits and accessories
- 4 Finalize circuit length
- 5 Select control configurations
- 6 Select thermal insulation
- 7 Complete Bill of Materials

To assist you with the design, we will carry two design examples through this process. The example details are listed below each step in red.

#### Example 1

An elementary school where 115°F (46°C) is the desired maintain temperature and no heat-up cycle is required. Piping layout shows approximately 300 ft of pipe with two branches at the same location.

#### Example 2

A medium security prison where 115°F (46°C) is the desired maintain temperature and a 140°F (60°C) heat-up cycle is required. Piping layout shows approximately 700 ft of pipe with two branches at different locations.

## Before You Begin

Before you begin designing your HWAT system, gather this necessary information:

- Desired maintain temperature
- Indoor ambient temperature
- Supply voltage
- Piping layout
- Total pipe length
- Pipe diameters

HWAT System Design
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

### Step 1 Select heating cable

Use Table 2 to select the appropriate system temperature setting. For more information on heat-up cycles, refer to HWAT-ECO-GF "Installation Manual" H60160; or ACS-30 Programming Guide (H58692). HWAT-R2 heating cable will be used regardless of the controller you choose.

Record the following information:

- Desired maintain temperature (°F/°C) \_\_\_\_\_
- Indoor ambient temperature (°F/°C) \_\_\_\_\_
- Supply voltage (V) \_\_\_\_\_
- Heat-up cycle (Yes/No) \_\_\_\_\_
- Temperature (°F/°C) \_\_\_\_\_

#### Example: Heating Cable Selection

Desired maintain temperature  
Ambient temperature  
Supply voltage  
Heat-up cycle required  
Heat-up cycle temperature

#### Example 1

115°F (46°C)  
70°F (21°C)  
208 Vac  
No  
n/a

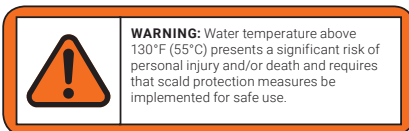
#### Example 2

115°F (46°C)  
70°F (21°C)  
208 Vac  
Yes  
140°F (60°C)

**TABLE 2 HWAT SYSTEM TEMPERATURE RANGE**

HWAT-R2	HWAT-ECO-GF	ACS-30
Minimum maintain temperature	105°F (40°C)	100°F (38°C)
Maximum maintain temperature	140°F (60°C)	150°F (66°C)
Heat-up cycle*	>140°F (60°C)	>150°F (66°C)

\* For additional information on heat-up cycles, refer to "Expanded HWAT-ECO-GF Electronic Controller Capabilities."



#### Heating Cable Selection

Heating cable selected

#### Example

HWAT-R2



HWAT System Design
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

## Step 2 Lay out the heating cable

The piping layout of your building may require more than one HWAT circuit. To determine the number of circuits, group your piping by maintain temperature and location, a step that may require you to consult the plumbing and/or electrical engineer. Calculate the total length of pipe in each group, allowing one foot of heating cable for each foot of pipe. The length of heating cable in each group must not exceed the circuit lengths listed in Table 3.

In Step 4, you will calculate the additional cable required to install the connection kits. This will increase the total length of heating cable and may require the need for additional circuits.

**TABLE 3 MAXIMUM CIRCUIT LENGTHS**

Circuit breaker size (Amps)	Circuit Lengths	
	HWAT-R2 ft (m)	
15	250	(75)
20	330	(100)
30	500	(150)

**Note:** Assumes a minimum water temperature of 50°F (10°C) at startup

**Example: Lay out circuits**

HWAT heating cable selected  
 Length of pipe  
 Number of circuits  
 Circuit breaker size

**Example**

HWAT-R2  
 700 ft  
 2  
 30 Amp

HWAT System Design
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

### Step 3 Select connection kits and accessories

HWAT systems are approved and warranted only as a complete system. The appropriate RayClic connection kits must be used. Use Table 4 to select the connection kits and accessories necessary for your HWAT system. Refer to the RayClic Connection System data sheet (H57545) in the Technical Data section for more information on the products.

The appropriate numbers of end seals are included with each connection kit.

**TABLE 4 RAYCLIC CONNECTION KITS AND ACCESSORIES**

Catalog number	Description	Quantity required	No. of end seals included
RayClic-PC	Power connection kit	One -PC, -PS, -PT required per circuit	1
RayClic-PS	Powered splice kit	One -PC, -PS, -PT required per circuit	2
RayClic-PT	Powered tee kit	One -PC, -PS, -PT required per circuit	3
RayClic-S	Splice kit	As required*	0
RayClic-X	Cross kit	As required	2
RayClic-T	Tee kit	As required	1
RayClic-E	End seal kit	As required for spares	1
GT-66	Glass tape	1 roll per 50 ft of pipe	n/a
ETL	Electric traced tape	1 label per 10 ft of pipe	n/a

\* To minimize cable waste, nVent recommends that one RayClic-S be ordered for every 500 feet of cable.

**Example: Select connection kits and accessories**

Piping layout determined that the following connection kits and accessories are required.

**Example**

- 2 RayClic-PC
- 2 RayClic-T
- 14 GT-66
- 70 ETL

HWAT System Design
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

### Step 4 Finalize circuit length

Additional cable is required for future access at each connection kit. Add the additional cable, as detailed in Table 5, to the estimated circuit lengths from Step 2. Confirm that the maximum lengths shown in Table 3 have not been exceeded. If your circuit lengths are greater than those shown, reconfigure your heating cable layout to allow for additional circuits.

**TABLE 5 ADDITIONAL CABLE REQUIRED FOR EACH CONNECTION KIT**

Connection kit name	No. of cable connections/kit	Cable length/ connection ft (m)		Total cable length (service loop) ft (m)	
RayClic-PC	1	2.0	(0.6)	2.0	(0.6)
RayClic-S	2	1.0	(0.3)	2.0	(0.6)
RayClic-T	3	1.0	(0.3)	3.0	(0.9)
RayClic-X	4	1.0	(0.3)	4.0	(1.2)
RayClic-PS	2	1.5	(0.5)	3.0	(0.9)
RayClic-PT	3	1.3	(0.4)	4.0	(1.2)
RayClic-E	1	n/a		n/a	

<b>Example: Finalize circuit length</b>	<b>Example</b>	
	<b>Circuit 1*</b>	<b>Circuit 2*</b>
<b>Length of heating cable per circuit</b>	<b>350 ft</b>	<b>350 ft</b>
<b>Additional cable required</b>		
<b>RayClic-PC</b>	<b>2 ft</b>	<b>2 ft</b>
<b>RayClic-T</b>	<b>3 ft</b>	<b>3 ft</b>
<b>RayClic-X</b>	<b>n/a</b>	<b>n/a</b>
<b>Total length of heating cable required</b>	<b>355 ft</b>	<b>355 ft</b>

**\* In this example, the circuits were evenly divided. Equal circuit lengths are not required.**

<b>HWAT System Design</b>
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

**Step 5 Select control configuration**

For single circuit applications, choose the HWAT-ECO-GF controller.  
For multi-circuit applications, choose the ACS-30 controller.

<b>Example: Select control method</b>	<b>Example 1</b>	<b>Example 2</b>
Type	Individual circuit	Multi-circuit
Number of circuits	1	up to 260
Controller	HWAT-ECO-GF	ACS-30

<b>HWAT System Design</b>
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

**Step 6 Select Insulation**

Select the size of thermal insulation from Table 6. You will need to know the length and diameter of each pipe used in your application.

For pipes 1 1/4 inches and smaller, use insulation that is oversized by 1/4 inch to allow room for insulating over the heating cables. Table 6 specifies IPS (Iron Pipe Size) insulation, which has a greater inner diameter than CTS (Copper Tube Size) insulation.



For pipes 3 inches and larger, the thickness of insulation can either be equal to the pipe diameter with a single heating cable or 1/3 the pipe diameter with two heating cables. For example, a 6 inch pipe with 6 inches of insulation and one run of heating cable is equivalent to a 6 inch pipe with 2 inches of insulation and two runs of heating cable.

**TABLE 6 FIBERGLASS INSULATION SELECTION**

Copper pipe size (in)	IPS insulation size (in)	Insulation thickness (in)
1/2	3/4	1/2
3/4	1	1
1	1 1/4	1
1 1/4	1 1/2	1 1/2
1 1/2	1 1/2	1 1/2
2	2	2
2 1/2	2 1/2	2 1/2
3	3	3

**Note:** For pipes 3 inches and larger, the thickness of insulation can be equal to the pipe diameter with one run of heating cable or 1/3 the pipe diameter with two runs of heating cable.

**Example: Select Insulation**

	Copper pipe size (in)	IPS insulation size (in)	Insulation thickness (in)
<b>Example 1</b>	3/4	1	1
	1	1 1/4	1
	1 1/2	1 1/2	1 1/2
<b>Example 2</b>	1	1 1/4	1
	2	2	2
	2 1/2	2 1/2	2 1/2

HWAT System Design
1. Select heating cable
2. Lay out the heating cable
3. Select connection kits and accessories
4. Finalize circuit length
5. Select control configuration
6. Select insulation
7. Complete Bill of Materials

**Step 7 Complete Bill of Materials**

You are now ready to compile a Bill of Materials. Using the design results, detail each item as shown in Table 7 below. Fig. 5 illustrates a complete typical HWAT system.

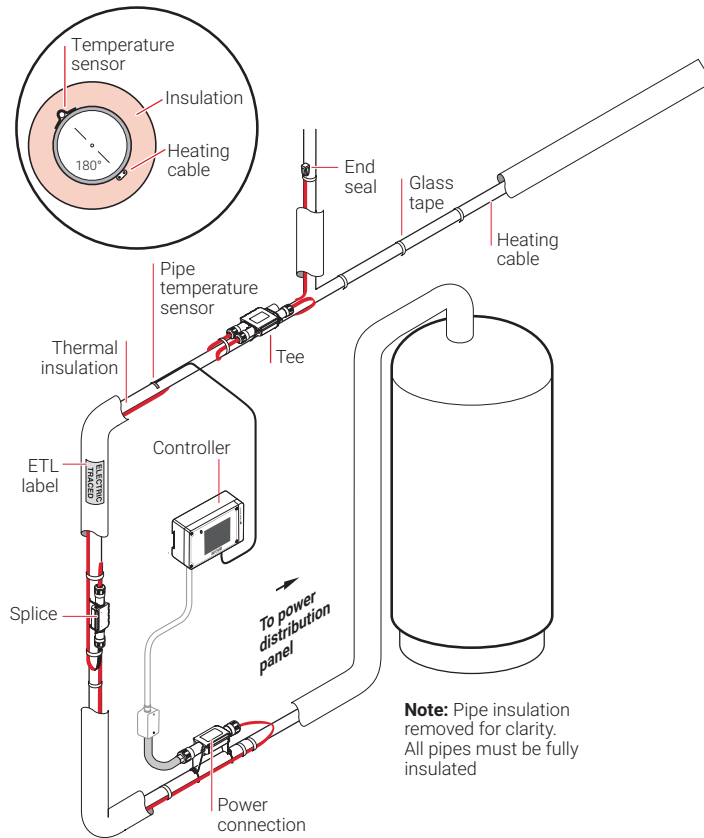


Fig. 5 Typical HWAT heating cable system

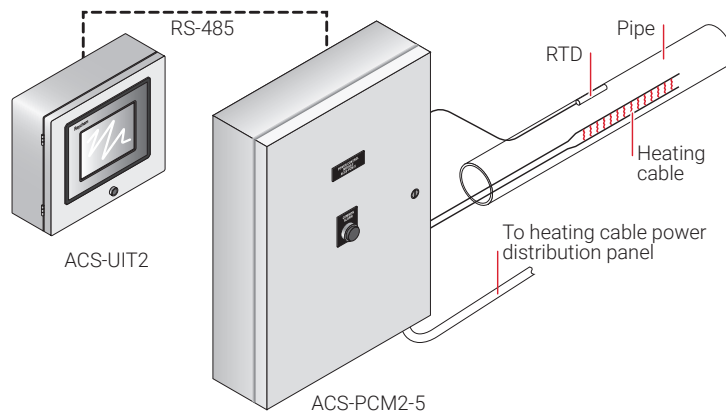


Fig. 6 Typical configuration for the ACS-30 system

TABLE 7 BILL OF MATERIALS (EXAMPLE)

Description	Catalog number	Quantity
HWAT heating cable	HWAT-R2	706 ft
Power connection kit	RayClic-PC	2
Tee connection kit	RayClic-T	2
Controller	HWAT-ECO-GF	2
Attachment tape	GT-66	12 rolls
Labels	ETL	70

## INSULATION SCHEDULE OF NON-STATIC SUPPLY PIPING

### APPLICATION DESIGN NOTE

One requirement for a successful hot water temperature maintenance system is to use the correct insulation type and thickness. The standard fiberglass insulation thickness schedule from the HWAT Product Selection and Design Guide (H57538) is shown in Table below. This schedule provides constant heat loss for all pipe sizes and results in uniform temperature maintenance with the nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT). If different thicknesses are used, pipe temperatures will vary.

**TABLE 1 INSULATION SCHEDULE**

Copper pipe size (in)	IPS insulation size (in)	Insulation thickness (in)
1/2	3/4	1/2
3/4	1	1
1	1 1/4	1
1 1/4	1 1/2	1 1/2
1 1/2	1 1/2	1 1/2
2	2	2
2 1/2	2 1/2	2 1/2
3	3	3

### Note

For pipes 3 inches and larger, the thickness of insulation can be equal to the pipe diameter with one run of heating cable or 1/3 the pipe diameter with two runs of heating cable.

For supply mains greater than 2 inches in diameter, the insulation schedule in Table 1 may present some difficulty due to the space required to accommodate the insulation. If this is a problem, reduce the insulation thickness to 1/3 of that specified and install two runs of nVent RAYCHEM HWAT heating cable.

The reason the insulation thickness is so critical for HWAT systems is that the pipes are assumed to be static for long periods of time. Using the specified insulation size and thickness ensures the pipes will be at the correct and uniform temperature. However, large diameter pipes are not likely to remain static for prolonged periods of time in large installations such as hospitals and hotels. In these pipes hot water is frequently added to the pipe system replacing the cold water and reducing the effective heat loss of the pipes.

For these situations an alternative insulation schedule has been created for HWAT systems on copper pipes 2 1/2 inches or larger with constant but low flow. The mains can be insulated with only 2 inches of fiberglass thermal insulation and use a single run of HWAT heating cable if the minimum flow is maintained. Fig. 1 shows the flow rate required to have less than 1°F temperature drop for every 50 feet of supply pipe.



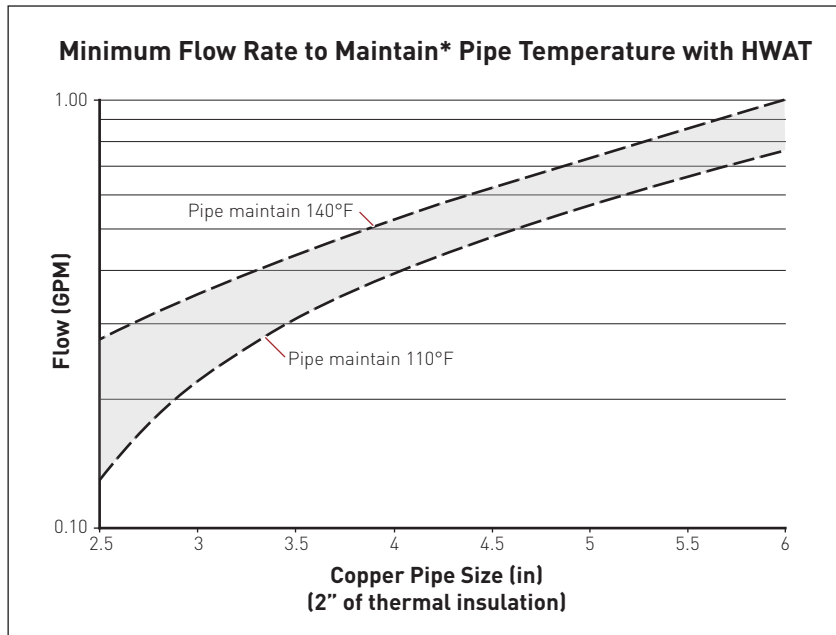


Fig.1 Flow rate required to maintain\* pipe temperature with a single run of HWAT heating cable

\* Less than 1°F temperature drop for every 50 feet of supply pipe

Using this approach, HWAT systems can maintain uniform pipe temperatures throughout the system with thinner insulation on the main supply pipe and standard insulation on the branch pipes.

Install in accordance with the HWAT System Installation and Operation Manual (H57548) and the HWAT-ECO-GF Installation and Maintenance Manual (H60223).

Approvals and performance are based on using nVent Thermal Management approved connection kits and accessories, do not substitute parts.

## RECIRCULATION AND HWAT DESIGN



### APPLICATION DESIGN NOTE

In high rise residential construction, it is fairly common for the plumbing engineer to recirculate the hot water main, but not the branch piping. This is done to minimize the wait for hot water at the point of use. The water in the main stays hot, but because the hot water line serving the condominium is typically not recirculated, the water temperature in the branch piping goes to ambient when there is no hot water flow.

These horizontal distribution lines are difficult to recirculate because of pressure and balancing in the high rise building. Furthermore, the risers don't always line up vertically because the floor plan of each unit may be different. Home owners are therefore required to run showers or sinks for long periods of time to draw new hot water into the unit, which is a significant waste of water.

The nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) offers a solution utilizing self-regulating heating cables and the nVent RAYCHEM HWAT-ECO-GF or ACS-30 electronic controller, in conjunction with the recirculation system. This combination of recirculated hot water mains and the HWAT system for the horizontal piping is the best of both worlds. The engineer can simply heat trace the horizontal hot water lines within the condominium to provide the owner with instant hot water. Different floor plans are also not a problem because the HWAT heating cable simply attaches to the hot water piping regardless of the configuration.

The drawing in Fig. 1 shows a typical hot water riser with recirculation and heat traced horizontal hot water lines feeding the condominiums. The HWAT system is installed following the design guidelines in the HWAT System Installation and Operation Manual (H57548).

Multiple horizontal runs can be controlled as long as the HWAT heating cable maximum circuit length is not exceeded, the same cable is on each run and the ambient conditions are the same for each pipe. The system shown in Figure 1 includes eight circuits of nVent RAYCHEM HWAT-R2 heating cable each 50 feet long, which can be wired in parallel to a junction box and controlled by a single HWAT-ECO-GF controller.

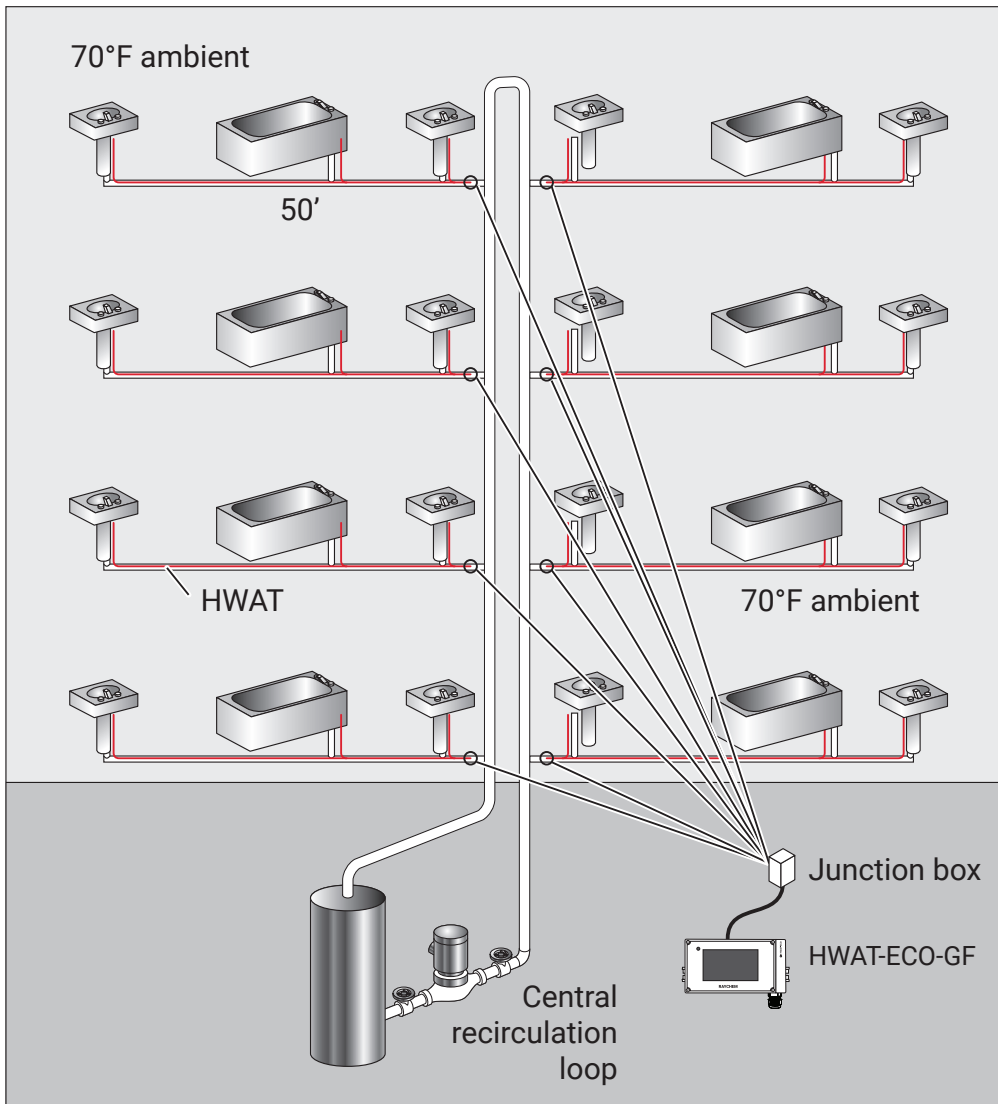


Fig. 1 Generic hybrid HWAT system

- Heating Cable** HWAT-R2
- Circuit Length** Total heating cable must be less than the maximum circuit length.
- Insulation** Install in accordance with the Installation and Operating Manual to maintain uniform pipe temperatures.
- Ambient** Pipes must be in uniform ambient conditions.

Install the system in accordance with the HWAT System Installation and Operation Manual (H57548) and the HWAT-ECO-GF Installation and Maintenance Manual (H60223).

Approvals and performance are based on using nVent approved connection kits and accessories, do not substitute parts.



## HEATING ON RIGID PLASTIC PIPES



### APPLICATION DESIGN NOTE

The nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) incorporates nVent RAYCHEM HWAT-R2 heating cable, the nVent RAYCHEM HWAT-ECO-GF or ACS-30 controller, or the ACS-30 multi-point controller. These controllers can adjust the power output of the HWAT heating cables to compensate for the poor heat transfer of plastic pipes, and maintain the correct water temperature.

Due to the increasing cost of copper, and in regions where pipe corrosion is a concern, plastic pipes are becoming more common in hot water distributions systems. Plastic pipes approved for use with HWAT heating cables include CPVC, rigid PEX and PEX tubing (fixed in place and supported no greater than every 32 inches along its length). HWAT systems should not be installed on un-supported PEX or nylon tubing due to the fact that frequent flexing could reduce the power output of the cable.

Use the following guidelines to install and operate HWAT heating cable on approved plastic pipe:

1. Secure the HWAT heating cables to the plastic pipe with aluminum tape continuously along its length, as shown in Fig. 1.

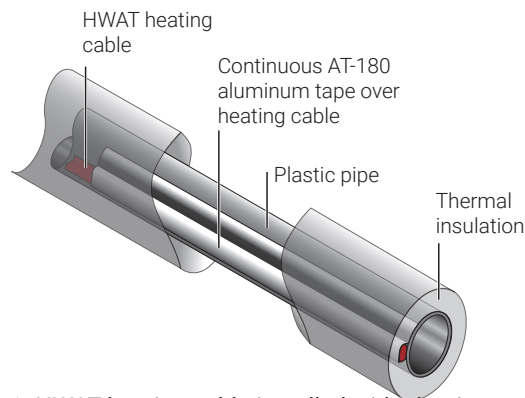


Fig1. HWAT heating cable installed with aluminum tape

2. To maintain desired water temperature on approved plastic pipes, adjust the temperature controllers as follows:

**a. HWAT-ECO-GF:**

Set the "Power Correction Factor" in the HWAT-ECO-GF menu to the values shown in Table 1.

### PLASTIC PIPE POWER CORRECTION FACTORS

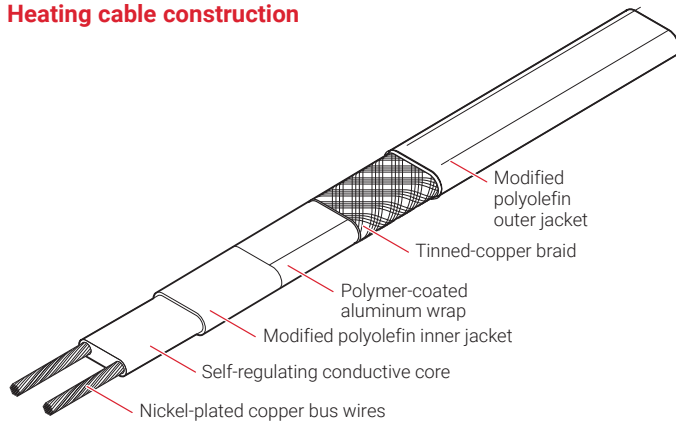
Heating Cable	Power Correction Factor
HWAT-R2	1.25

**b. ACS-30 controller:**

Select "Plastic Pipe" in the HWAT circuit set up menu. This setting automatically applies the same "Power Correction Factors" shown in Table 1.

## SELF-REGULATING HEATING CABLE FOR HOT WATER TEMPERATURE MAINTENANCE

### Heating cable construction



### PRODUCT OVERVIEW

nVent RAYCHEM HWAT self-regulating heating cables are installed on hot water supply pipes underneath standard pipe insulation. The heating cable adjusts its power output to compensate for variations in water temperature and ambient temperature. The heating cable replaces supply-pipe heat losses at the point where the heat loss occurs, thereby providing continuous, energy-efficient, hot water temperature maintenance and eliminating the need for a recirculation system.

#### Simplified design

Single-pipe nVent RAYCHEM Hot Water Temperature Maintenance Systems (HWAT) eliminate the need for designing complex recirculation systems, with their pumps, piping networks, and complicated flow balancing. Special cases, such as retrofits and multiple pressure zones, are simple to design.

#### Low installed cost

Installation of the HWAT system is simple. The heating cable can be cut to length, spliced, tee-branched, and terminated at the job site, reducing installation costs. Fewer plumbing components are needed; recirculation piping, pumps, and balancing valves are all eliminated.

#### Low operating cost

The HWAT system continuously maintains hot water temperature at every point along the supply pipe. Unlike conventional recirculation systems, HWAT systems do not require the overheating of supply water to allow for cooling. The HWAT system reduces the energy requirements of typical hot water systems with reduced heat loss from supply piping, no heat loss from recirculation piping, and no pump to run.

#### HWAT-ECO-GF and ACS-30 controllers

The nVent RAYCHEM HWAT-ECO-GF electronic controller is designed for operation with nVent RAYCHEM HWAT-R2 heating cable only. The HWAT-ECO-GF provides flexible temperature control, energy savings, heat-up cycle function, BMS interface, and nine predefined programs that can be customized by the user. The nVent RAYCHEM ACS-30 controller also incorporates the features of the HWAT-ECO-GF for large systems and multiple application control. The ACS-30 only supports HWAT-R2 heating cable for hot water temperature maintenance applications.



**SPECIFICATIONS**

Jacket	Modified polyolefin
Braid	Tinned copper
Bus wires	16 AWG nickel-plated copper
Supply voltage	208–277 V (277 V only when used with the ACS-30 Control System)
Minimum bend radius	0.5 in (12 mm)

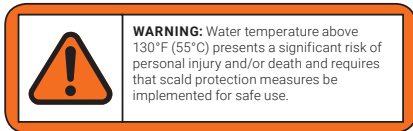
**PRODUCT CHARACTERISTICS (NOMINAL)**

Catalog number	<b>HWAT-R2</b>
Jacket color	Red
Maintain temperature range*	105°F (40°C) to 140°F (60°C)
Weight	230 lbs/1000 ft (0.35 kg/m)
Dimensions	
Width	0.72 in (18 mm)
Thickness	0.38 in (10 mm)

\* When designed in accordance with the HWAT System Product Selection and Design Guide

**SCALD PROTECTION**

HWAT systems present an increased risk of scalding due to the high water temperature. Pay special attention to the scald warning below:



**DESIGN AND INSTALLATION**

For proper design and installation, use the Design section of the HWAT System Product Selection and Design Guide (H57538) and the HWAT System Installation and Operations Manual (H57548).

**MAXIMUM CIRCUIT LENGTH FT (M)**

Breaker size	HWAT-R2 @208 V
30 A	500 (150)
20 A	330 (100)
15 A	250 (75)

**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 nVent requirements, agency certifications, and national electrical codes, 30-mA ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

**APPROVALS**



Pipe Heating Cable

HWAT heating cables are UL Listed, CSA Certified, and FM Approved when used with the appropriate agency-approved nVent RAYCHEM components and accessories



## DESIGN EXAMPLES FOR HOT WATER TEMPERATURE MAINTENANCE APPLICATIONS

### SCHOOL

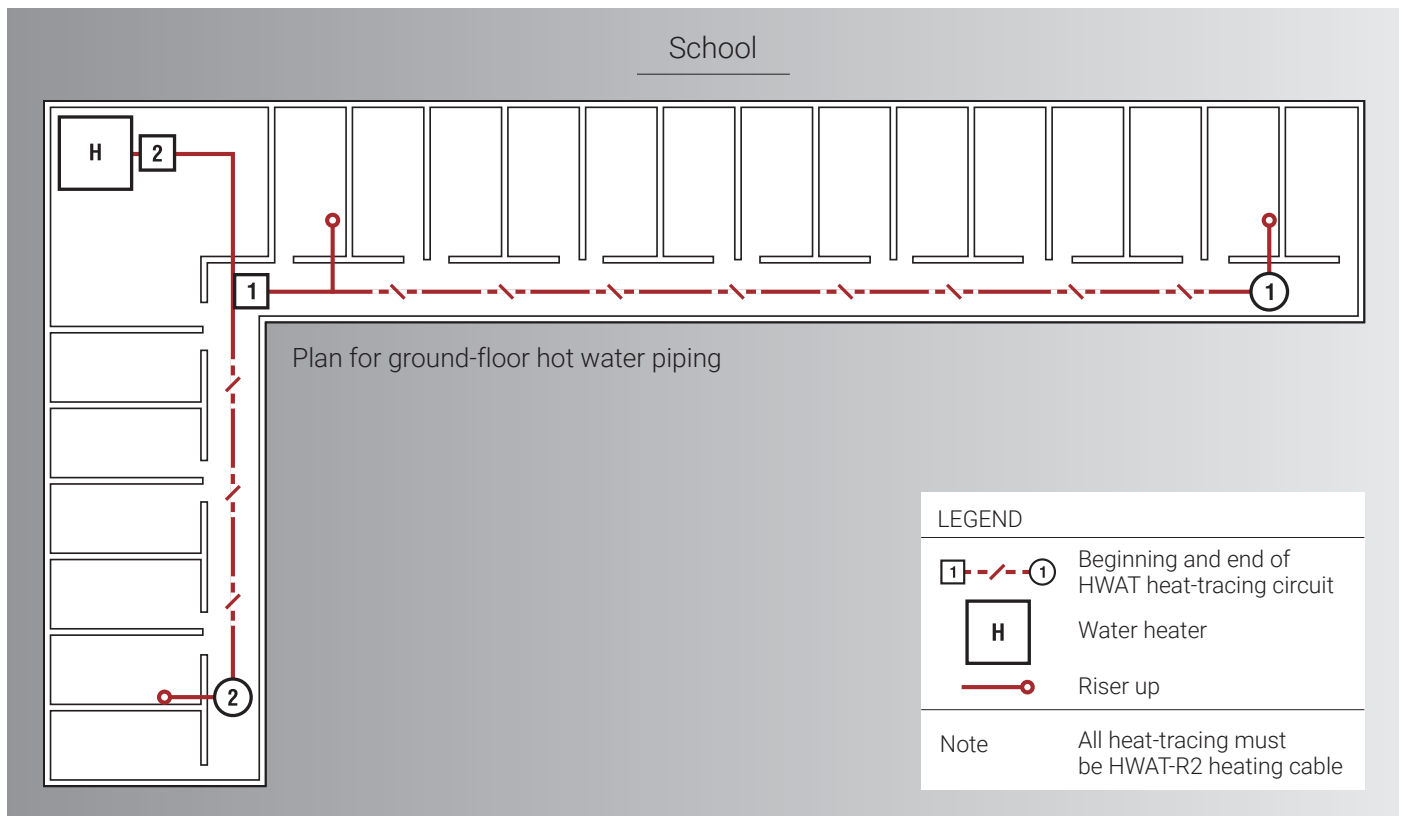
The plumbing engineer was laying out the piping for the domestic hot water system for a three-story high school. The engineer did not believe it necessary to recirculate the risers and was going to run two recirculation loops, one for each wing, in the ground-floor ceiling space. However, the engineer decided that the return lines would have to take the same route as the supply lines. In this situation, the engineer knew the nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) would provide the more economical design. Furthermore, the client had indicated the possibility of extending either wing at some time in the future. The engineer knew that by using HWAT products, the system could be easily expanded if and when the client decided to do so.

The high school required a maintain temperature of 115°F. nVent RAYCHEM HWAT-R2 and two HWAT-ECO-GF electronic controllers were chosen to maintain 115°F during normal operation and to have the ability during the weekend, when

the school is unoccupied, to occasionally elevate the water temperature above 140°F or to maintain a lower temperature for energy savings.

The engineer thought it would be useful to be able to isolate either wing for maintenance, so it was decided to run two separate circuits, each to be operated independently with a HWAT-ECO-GF. The plumbing engineer noted the pipes to be traced with HWAT heating cables on the drawings. He then inserted the standard clauses to provide, install, and test the HWAT system, and called out the correct thicknesses of fiberglass insulation, in Division 15 of the specification.

The electrical engineer noticed that in the electrical drawings, junction boxes were located near each power connection. It was decided to power both circuits from the same panel. Circuit breaker sizes and steady-state current were calculated and included on a table in the electrical drawings. The need for a ground-fault protection device in each circuit was noted on the electrical drawings.



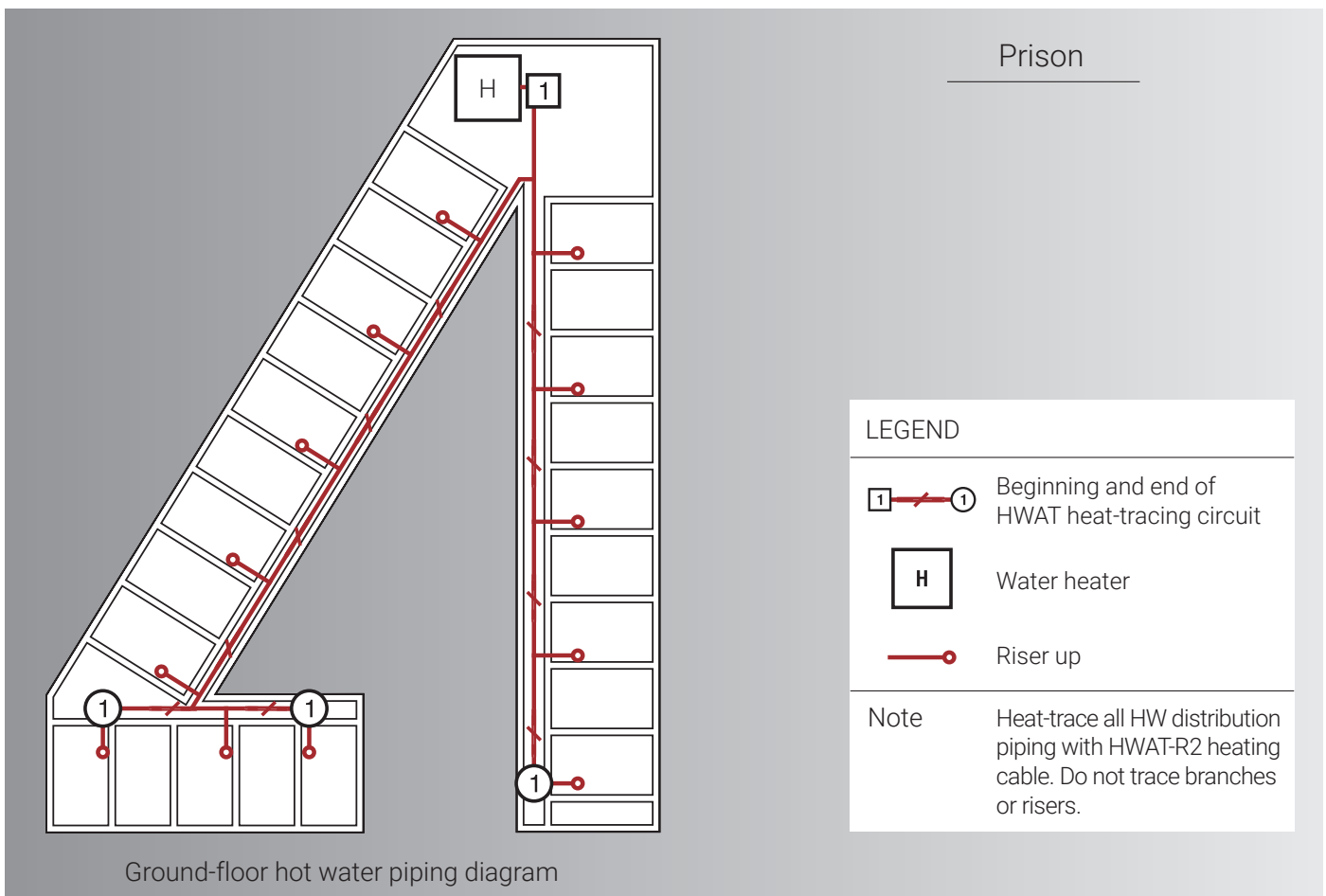
**PRISON**

Reviewing the architectural drawings, the plumbing engineer observed that the design consisted of about a dozen two-story “pods” arranged around an expanse of open space. For security reasons, the County had requested that mechanical equipment and piping, and the associated pipe openings, be kept to an absolute minimum. The layout of the cells in each pod did not allow any “shortcut” for return piping for a recirculation loop; it would have to follow the same corridor as the supply piping. The plumbing engineer knew from experience that in these kinds of situations, the HWAT system would be more economical than recirculation.

For the prison application, HWAT-R2 and one HWAT-ECO-GF controller were selected to maintain 105°F. Each pod would be provided with a separate water heater and it was not considered necessary to heat trace the risers. Upon measuring the length of the ground-floor piping, the plumbing engineer found it was possible to trace the entire piping in each pod with a single HWAT-R2 circuit and stay within the capacity of a 15 amp ground-fault circuit breaker. This would allow the heating cable to be conveniently powered from the electrical panel in the mechanical room.

Because the mechanical rooms were located in isolated areas, the specification was written to connect the network of HWAT-ECO-GF controllers to the building management system (BMS) using the BMS interface. Temperature set points would be programmed into the BMS with continual feedback provided by the HWAT-ECO-GF controller through the alarm contacts, including loss of power and water heater monitoring. The plumbing engineer decided that the situation was sufficiently simple to ignore marking on the plumbing drawing the lines to be heat traced. Instead, the extent of the heat tracing could be called out in the notes. The plumbing engineer then inserted the standard clauses to provide, install, and test the HWAT system, and called out the correct thicknesses of fiberglass insulation, in Division 15 of the specification.

The electrical engineer confirmed that a 15 amp breaker was adequate, and calculated the steady-state current. A junction box was located adjacent to the beginning of the heating cable circuit, and its number and the number of the electrical panel in the table were noted. A draftsman copied the table onto the electrical drawings, along with a note calling out the need for a ground-fault protection device in each circuit.



## APARTMENT BUILDING

The plumbing engineer was faced with laying out the hot water piping for the 35-story state-of-the-art apartment building. The piping was relatively complex, making it especially important to balance the system adequately. As requested by the developer, the architect had squeezed in the maximum number of residential floors by working to the minimum headroom allowed by code. The plumbing engineer was required by code to divide the building into three pressure zones. However, there would be great difficulty in running the horizontal supply and return lines necessary in each zone, given the very limited space provided above the dropped ceilings. And there was not any room for the booster heaters and pumps for the recirculation system.

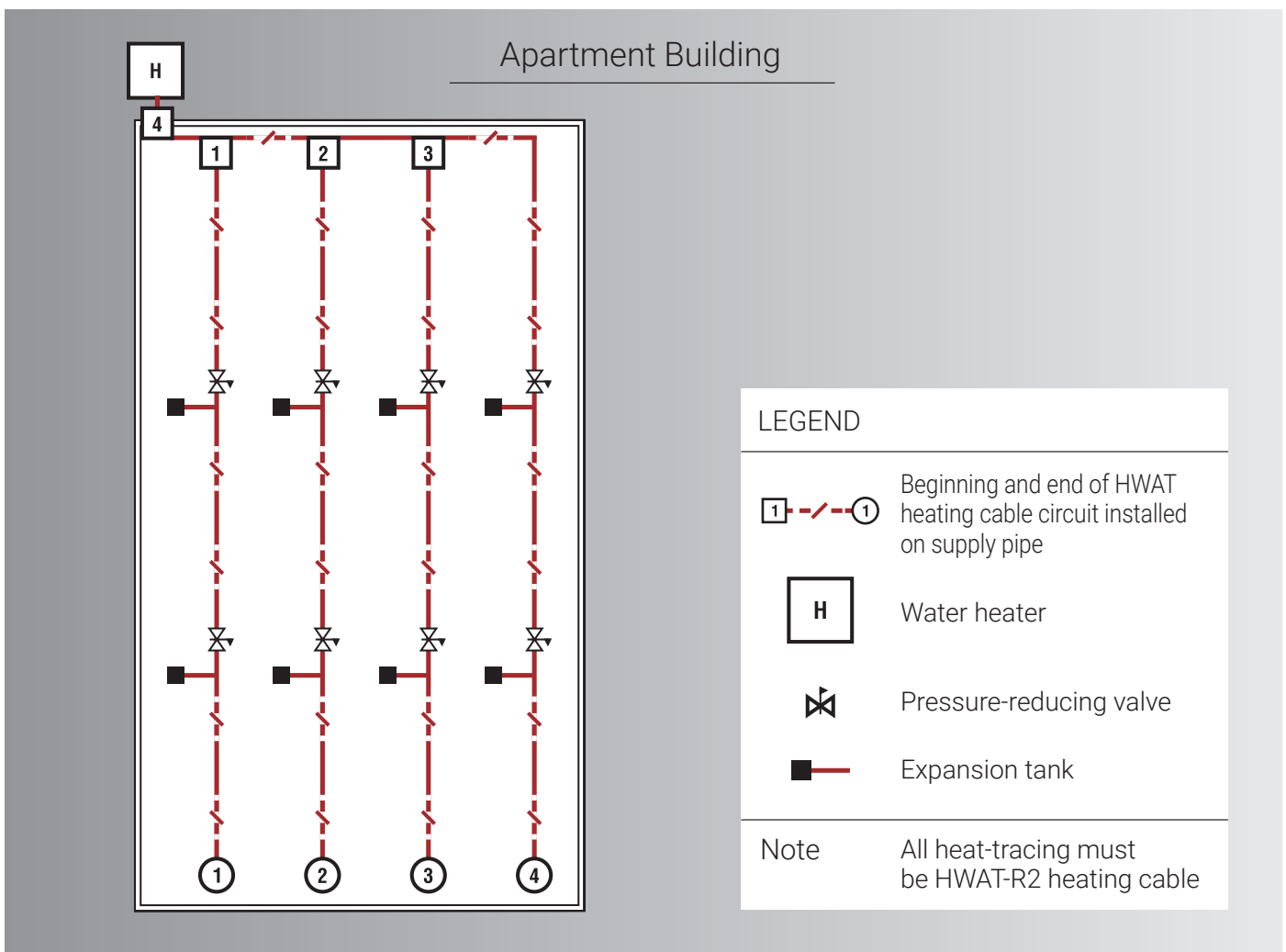
The plumbing engineer decided that an HWAT system would eliminate the need for horizontal piping and additional heaters or pumps. The risers could run continuously from top to bottom, broken only by pressure reducing valves at the 11th and 23rd floors. The plumbing engineer noted that the need for flow balancing was completely eliminated by using the HWAT system.

In order to interface with the Building Management System, the engineer selected the HWAT-ECO-GF electronic controller. Having estimated that a single circuit length on a 20 amp

circuit breaker could run the complete height of the building, the engineer marked an HWAT circuit on each of the four risers and sent copies of the plumbing drawing and the design sheet to the electrical engineer. HWAT-R2 was selected for a maximum circuit length of 500 feet with a 20 amp breaker and to maintain 120°F at a 70°F ambient temperature and a 208 supply voltage. HWAT-R2 was not selected because a high temperature heat-up cycle was not required.

Standard clauses to provide, install, and test the HWAT system were included in Division 15 of the specification. To provide pressure relief in the piping during system startup, an expansion tank was indicated on each riser at each pressure reducing valve.

The electrical engineer looked at the plumbing drawing and determined that it was most convenient to power all the circuits from the penthouse mechanical room. Junction boxes would be located at the beginning of each circuit and power run from a single panel. The electrical engineer calculated the breaker sizes and the steady-state currents. A finished table was included in the electrical drawings, along with a note calling for a ground-fault protection device in each circuit.





**HOTEL**

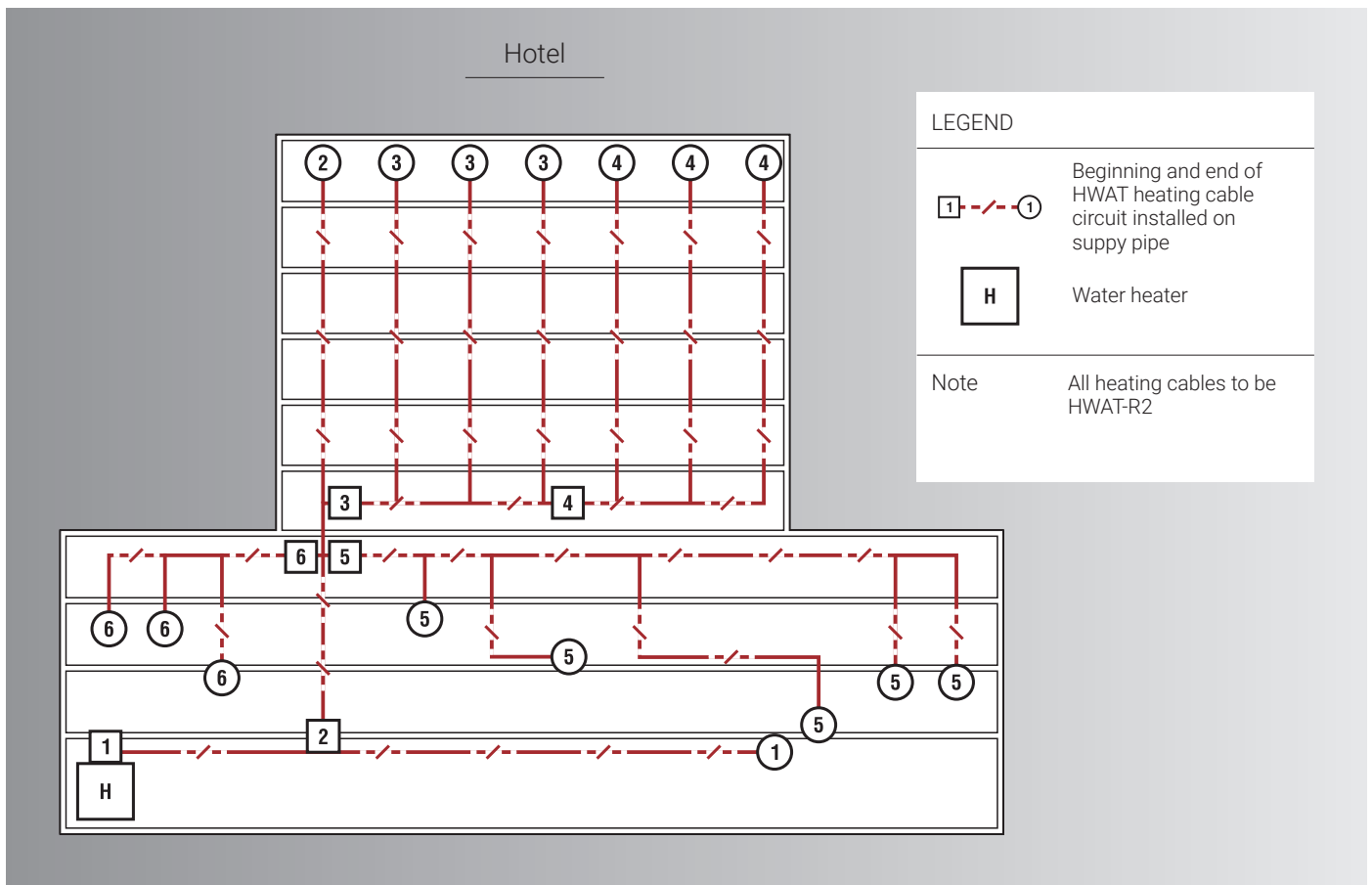
The plumbing engineer reviewed the architectural drawings for a new hotel. The building consisted of six floors of guest rooms over a commercial area containing a health club, restaurants, conference rooms, shops, offices, and a laundry. The plumbing engineer decided to deliver water from the boiler at 140°F directly to the kitchens and laundry, and to mix to 120°F for domestic hot water.

The HWAT system was chosen rather than recirculation because the owner insisted that there be no delay in getting hot water from any fixture, especially for the metered faucets on the first floor. Also, the HWAT system would accommodate all the architectural and construction changes that were bound to occur before the system was operating.

HWAT-R2 was selected for the 140°F line running out of the boiler to the kitchens and laundry, and HWAT-R2 for the 120°F domestic hot water system. After reviewing the circuit

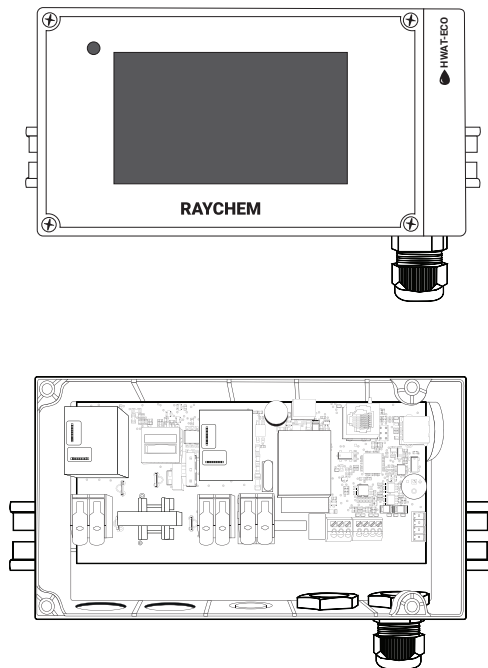
length table, it was determined that the entire domestic hot water piping could be traced with only two HWAT-R2 circuits by utilizing a 30 amp circuit breaker. However, the plumbing engineer decided to lay out the heating cable in smaller discrete zones to facilitate partial shutdown of the system for maintenance. Given the short circuit length for each circuit, 15 amp circuit breakers were specified and the circuits were indicated on the drawing.

The electrical engineer looked at the layout of the circuits and assigned junction box and panel locations for each circuit according to the electrical drawings. The engineer calculated the breaker size and the steady-state current for each circuit. A completed table, with a note that the circuit breakers would incorporate 30 mA ground-fault protection, was then transferred to the electrical drawing.



**WARNING:** Water temperature above 130°F (55°C) presents a significant risk of personal injury and/or death and requires that scald protection measures be implemented for safe use.

## ELECTRONIC CONTROLLER FOR HOT WATER TEMPERATURE MAINTENANCE SYSTEMS



### PRODUCT OVERVIEW

The nVent RAYCHEM HWAT-ECO-GF controller is designed for operation with the nVent RAYCHEM HWAT-R2 self-regulating heating cable.

### FEATURES

- Ground-fault equipment protection (GFEP) built-in
- Intuitive set-up and programming, includes a 5" inch color touch screen
- Flexible temperature control of hot water temperature maintenance systems
- Energy savings through an integrated function that lowers the maintain temperature during hours of low water consumption
- Heat-up cycle function that increases the water temperature of the hot water in the pipes
- Alarm relay to signal power, temperature or communication problems
- Hot water storage & pipe temperature monitoring with high and low temperature alarms and automatic system shut down
- Seven pre-defined building timer programs that can be customized by the user
- Program in advance in power-off mode by using external power bank/charger and USB connection

### GENERAL

Area of use Non-hazardous locations; for HWAT-R2 heating cable only

### APPROVALS

c-UL-us, ROHS, WEEE  
Electromagnetic Compatibility (EMC)  
Complies to EN 5014-1 for emission and EN 50730-1 for immunity



Type 12  
**Energy Management Equipment**  
(for use with HWAT-R2 only.)

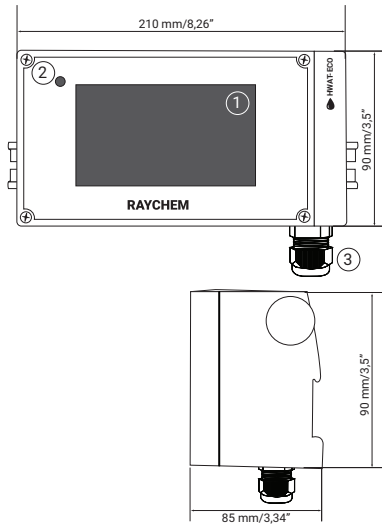
### ELECTRICAL PROPERTIES

Supply Voltage	208/240/277 VAC , 50/60 Hz
Controller ambient exposure temperature	40°F (5°C) to 105°F (+40°C)
Ambient operating range :	60°F (15°C) to 80°F (27°C)
Internal Power consumption	3.5 VA
Output relay switching capacity	30 A @ 208/240/277 +/-10% Vac ; 60 Hz
Alarm relay	Single pole double throw relay, volt-free; Max. switching capacity (resistive load only) 1 A/30 VDC 0.5 A/125 VAC, Max.: 60 VDC/125 VAC
Circuit breaker	30 A Max.
Ground Fault	30 mA, complies with UL 1053 standard
Real time clock	Automatic daylight saving time and leap year correction
Clock accuracy	+/-10 minutes per year
Keylock	Password protection for parameter settings
USB Port	For pre-setup in power off mode; for firmware upgrades

## ENCLOSURE

Dimensions	210 mm x 90 mm x 85 mm / 8.26" x 3.5" x 3.34"
Ingress protection class	TYPE 12/IP54 – indoor use only
Enclosure material	Polycarbonate
Mounting option	Mountable DIN RAIL, 35 mm
Conduit entries	Two each-1/2 in conduit entries
Cable gland	3 -hole grommet for temperature sensors Maximum cable size -2 wire: 20 AWG (0,5 mm <sup>2</sup> )
Storage temperature	-4°F (-20°C) to 105°F (40°C)
Flammability class	DIN EN 60730/VDE 0631-1

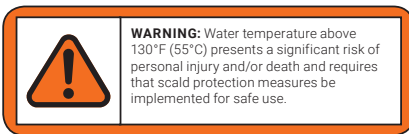
## TYPICAL ENCLOSURE DIMENSIONS AND MODULE LAYOUT



1. Touch screen: size 5" resistive
2. LED Green: Power to heating cable  
Blinking: Error/Warning message
3. M20 Gland: Sensor Hot water storage/Sensor Pipe/external alarm

## PROGRAMMING

Maintain temperatures setpoint	105°F (40°C) to 140°F (60°C) in 24 blocks of 1 hour per day
Default programs	7 built-in building specific programs, editable
Timer	Program can be modified in steps of one hour. Following operation modes are selectable: OFF, ECONOMY, MAINTAIN and HEAT-UP CYCLE



## SENSOR

Temperature sensor type	Thermistor 2 KOhm / 77°F (25°C), 2-wire
Sensor tip dimensions	Ø 0.2" (5 mm) ; length 0.8"(20 mm)
Sensor cable length	10ft (3 m) cable extension up to 328 ft (100m) / 2 x 16 AWG
Sensor temperature range	32°F (0°C) to 194°F (90°C)

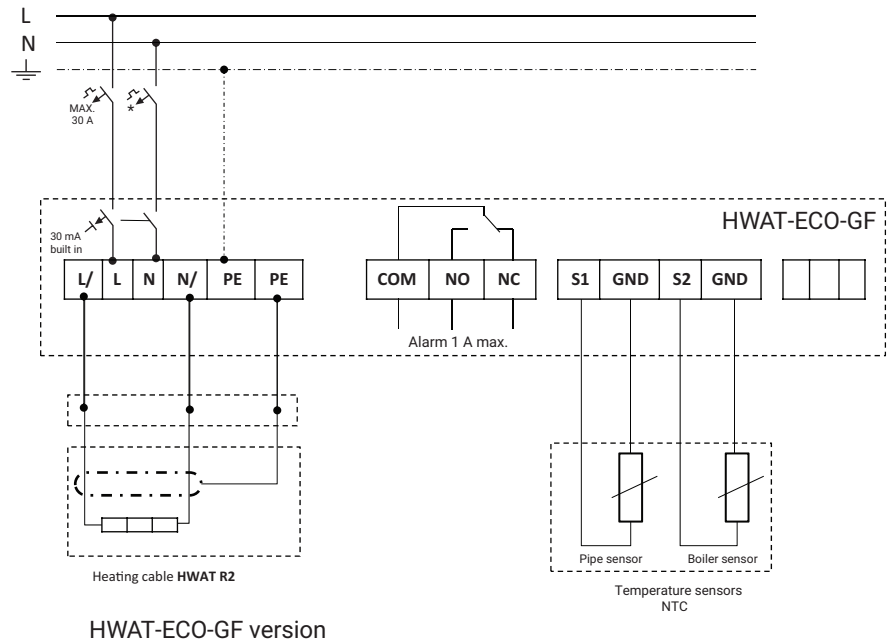
## MONITORING

Boiler temperature alarm	High temperature alarm/cut-out	Adjustable range: maintain temperature to 150°F/66°C or OFF
	Low temperature alarm	Adjustable range: maintain temperature to 100°F/37°C or OFF
Pipe temperature alarm	High temperature alarm/cut-out	Adjustable range: maintain temperature to 150°F/66°C or OFF
	Low temperature alarm	Adjustable range: maintain temperature to 100°F/37°C or OFF
Sensor alarm	Sensor open circuit Sensor short circuit	
Heating cable connection	Heating cable open circuit	

## MEMORY

Parameters	All parameters are stored in nonvolatile memory, except date and time
Clock back-up time	10 days.

## ELECTRICAL SCHEME



Size Power supply terminals	3 x 6 mm <sup>2</sup> max./10 AWG
Size Heating cable terminals	3 x 6 mm <sup>2</sup> max./10 AWG
Size Alarm terminals	3 x 1,5 mm <sup>2</sup> max./16 AWG
Size Sensor terminal - Boiler	2 x 1,5 mm <sup>2</sup> max./16 AWG
Size Sensor terminal - Pipe	2 x 1,5 mm <sup>2</sup> max./16 AWG

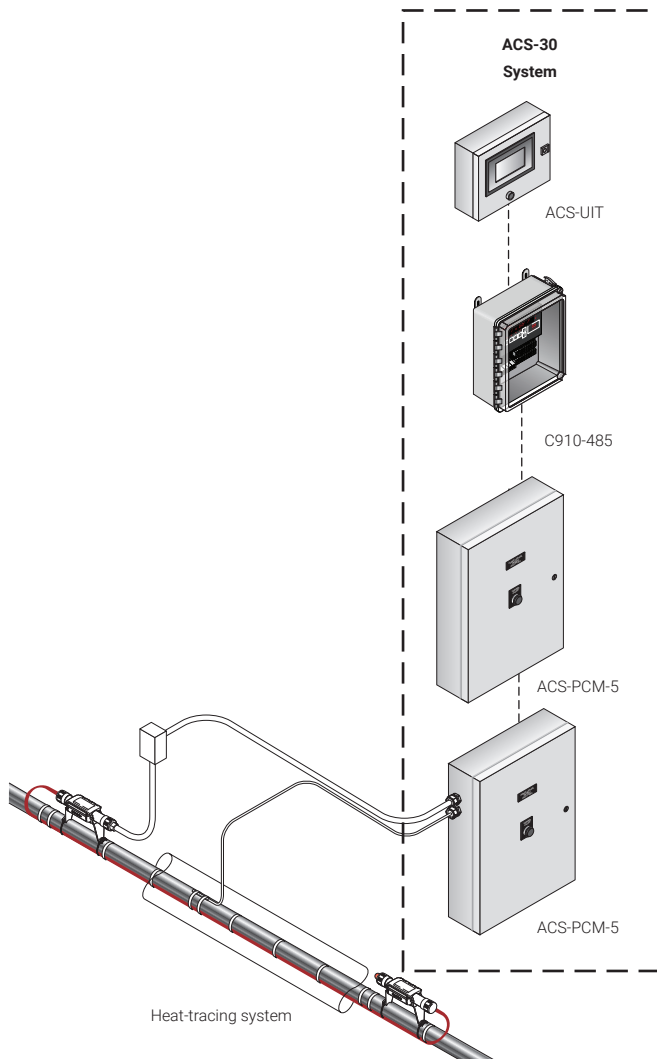
## ORDERING DETAILS

Description	Catalog	Part Number	Weight
Controller with 10ft/3m sensor and din-rail	HWAT-ECO-GF	P000002274	2.3lbs/1050g
<b>Spare Parts and Accessories</b>			
Replacement Pipe Sensor	HWAT-T55-Sensor	1244-015847	0.33lbs/150g
Power Bank	R-PB-Powersmart	1244-020365	0.33lbs/150g

**Important:** The HWAT-ECO-GF controller is for use with the HWAT-R2 heating cable only. The warranty and system listing will be invalidated if the HWAT-ECO-GF controller is used with other heating cables.



## MULTIPOINT COMMERCIAL HEAT-TRACING SYSTEM



### PRODUCT OVERVIEW

The nVent RAYCHEM ACS-30 Advanced Commercial Control System is a multipoint electronic control and monitoring system for heat-tracing applications. These applications include commercial freeze protection, surface snow melting, roof and gutter de-icing, and flow and temperature maintenance.

The ACS-30 system can control up to 260 circuits with multiple networked ACS-PCM2-5 panels, or nVent RAYCHEM C910-485 controllers for single circuit system extension. The ACS-PCM2-5 panel can directly control up to 5 individual heat-tracing circuits using electromechanical relays rated at 30 A up to 277 V. Four Resistance Temperature Detector (RTD) sensor inputs can be assigned for each heating cable circuit providing a variety of temperature control, monitoring, and alarm options. The ACS-30 can be fitted with 16 nVent RAYCHEM RMM2s, providing an additional 128 temperature inputs to a maximum of 388 inputs.

### Control

The ACS-30 is pre-programmed with parameters for commercial hot water temperature maintenance, pipe freeze protection, flow maintenance, freezer frost heave prevention, surface snow melting, roof and gutter de-icing prevention and floor heating applications. The pre-programmed application settings significantly simplify setting up multiple heating cable circuits. Based on the application the ACS-30 can be configured for On/Off, Ambient Sensing, Proportional Ambient Sensing (PASC), and timed duty cycle control modes for HWAT system applications.

The ACS-30 measures temperatures with 3-wire, 100-ohm platinum RTDs connected directly to the unit, or through optional Remote Monitoring Modules (RMM2). Each RMM2 accepts up to eight RTDs. Multiple RMM2s are networked over a single cable to the ACS-30, significantly reducing the cost of RTD wiring.

The built-in calendar function for hot water temperature maintenance, floor heating and greasy waste applications provides flexible timed set points providing energy savings.

## Monitoring

To assist with energy management the ACS-30 monitors the power consumption of each heating cable circuit for up to five years of operation. The data may be graphically displayed daily, weekly, monthly or yearly. The ACS-30 measures 12 control parameters including ground fault, temperature, and current to ensure system integrity. Configurable alarm settings provide options for local or remote alarms. These alarms can be programmed to send notification of the alarm event by e-mail to user-selected distribution. 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 Building Management System (BMS).

## Ground-fault protection

National electrical codes require ground-fault equipment protection on all heat-tracing circuits. The ACS-30 controller has integrated ground-fault equipment protection and therefore does not require additional ground-fault protection, simplifying installation and reducing costs.

## ACS-30 SYSTEM

Multipoint temperature control with ground-fault/current/temperature monitoring when used with the ACS-UIT2

The ACS-30 is a multipoint electronic control, monitoring, and power relay system for heat-tracing cables used in commercial heat-tracing applications. The system consists of a ACS-UIT2 and up to 52 ACS-PCM2-5 power control panels. C910-485 controllers may also be connected to the system for multiple, single circuit extensions. RMM2 heat-tracing remote monitoring modules may also be used with the ACS-30 system to expand the number of temperature measurement points.

The ACS-30 provides the following alarming features per control point.

- High/low temperature
- Ground fault
- RTD failure

The ACS-30 provides ground-fault monitoring and protection for every heat-tracing circuit and fulfills the requirements of national electrical codes.

## ACS-30: HEATING CABLE APPLICATION PROGRAMMING SUMMARY

Control Mode Functions			
Application	nVent RAYCHEM Heating cable	Control Mode	Control Settings
Hot Water Temperature Maintenance	HWAT	Preset power duty cycle (HWAT Design Wizard)	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Variable schedule                             <ul style="list-style-type: none"> <li>- Maintain</li> <li>- Economy</li> <li>- Off</li> <li>- Heat Cycle (R2 only)</li> </ul> </li> </ul>
Floor Heating	RaySol MI heating cable	Floor sensing	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Variable schedule                             <ul style="list-style-type: none"> <li>- Maintain</li> <li>- Economy</li> <li>- Off</li> </ul> </li> <li>• Circuit override through RTD or external device</li> </ul>
Greasy Waste Disposal and Temperature Maintenance	XL-Trace	Line sensing	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Variable schedule                             <ul style="list-style-type: none"> <li>- Maintain</li> <li>- Economy</li> <li>- Off</li> </ul> </li> </ul>

## Installation

The ACS-30 system is configured with the User Interface Terminal (ACS-UIT2) that has an LCD color display with touch-screen technology. The ACS-UIT2 provides an easy user interface for programming without keyboards or cryptic labels. The ACS-30 Program Integrator application tool is available to program, edit and download circuit parameters through the local USB port or from a remote location. The ACS-UIT2 comes in a Type 4X enclosure suitable for nonhazardous, indoor or outdoor locations and comes complete with wiring terminals and an alarm signal light.

## Communications

ACS-30 units support the Modbus® protocol and are available with RS-232, RS-485 or 10/100Base-T Ethernet communication interface. The nVent RAYCHEM ProtoNode multi-protocol gateways are available to integrate the ACS-30 into BACnet® and Metasys® N2 BMS systems.

## Complete system

The ACS-30 is supplied as a complete modular system, ready for field connections to convenient power distribution panels and temperature sensor input, reducing the cost of heating cable installation.

**ACS-30: HEATING CABLE APPLICATION PROGRAMMING SUMMARY**

Control Mode Functions			
Application	nVent RAYCHEM Heating cable	Control Mode	Control Settings
Pipe Freeze Protection	XL-Trace	Ambient, PASC or line sensing	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Circuit override through external device</li> </ul>
Fuel Oil Flow Maintenance	XL-Trace	Ambient, PASC or line sensing	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Circuit override through RTD or external device</li> </ul>
Freezer Frost Heave Prevention	RaySol MI heating cable	Floor sensing	<ul style="list-style-type: none"> <li>• Constant temp</li> <li>• Variable schedule                             <ul style="list-style-type: none"> <li>- Maintain</li> <li>- Off</li> </ul> </li> </ul>
Surface Snow Melting	ElectroMelt MI Heating Cable	Ambient or surface temp External controller	Constant temp External snow controller
Roof and Gutter De-icing	IceStop MI Heating Cable	Ambient or surface temp External controller	Constant temp External snow controller

**TEMPERATURE MONITOR ONLY**

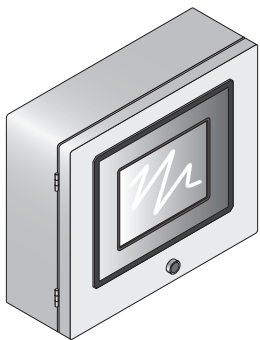
Five temperature monitor only channels  
 Low and high temperature alarms

**VARIABLE SCHEDULE**

Setpoint calendar with:

- 7 days/week calendar
- 48 - 1/2 hr time blocks/day
- Daily schedule copy function

**ACS-UIT2 (USER INTERFACE TERMINAL)**



The ACS-30 User Interface Terminal is a panel-mounted display for use with the ACS panel. The ACS-UIT2 has an 8.4 inch (21.7 cm) VGA color display with touch-screen technology, and provides an easy user interface for programming without keyboards or cryptic labels. It has RS-485, RS-232, or 10/100Base-T Ethernet communications ports that allow communication with external Distributed Control Systems or Building Management Systems. BACnet to Modbus protocol gateways with the Modbus registries pre-programmed are available. A USB interface is included for easy configuration and firmware upgrades.

The ACS-UIT2 is designed for use on indoor or nonhazardous location installations and is rated for NEMA 4 environments.

**General**

Approvals

Nonhazardous Locations



Area of use	Nonhazardous, indoors and outdoors (IP65, Type 4)
Supply voltage	100 – 240 Vac +/-10%, 50/60 Hz
Operating temperature	-25°C to 50°C (-13°F to 122°F)
Supply terminal	26–12 AWG
Storage temperature	-25°C to 80°C (-13°F to 176°F)
Dimensions	386 mm W x 336 mm H x 180 mm D, (15.21 in. W x 13.21 in. H x 7.09 in. D)

**Alarm outputs**

Relay outputs Three form C relays rated at 12 A @ 250 Vac. One relay used for common alarm light. Relays may be assigned for alarm outputs.

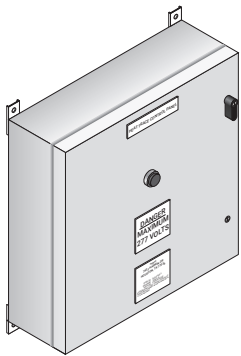
## Network connection

Local port/remote	RS-232/RS-485 ports (RS-485, 2-wire isolated) may be used to communicate with host BMS computers using the ProtoNode-RER or ProtoNode-RER-10K.
Local RS-232	A non-isolated, 9 pin D sub male
Remote RS-485 #2	10 pin terminal block, 24–12 AWG, (0.2 mm to 2.5 mm <sup>2</sup> ) wire size
Data rate	9600 to 57600 baud
Maximum cable length	For RS-485 not to exceed 1200 m (4000 ft). Cable to be shielded twisted pair.
Field port	RS-485, 2-wire isolated. Used to communicate with external devices, such as ACS-PCM2-5, C910-485, and RMM2. Maximum cable length not to exceed 1200 m (4000 ft). Cable to be shielded twisted pair.
Field RS-485 #1	10 pin terminal block, 24–12 AWG, (0.2 mm to 2.5 mm <sup>2</sup> ) wire size
Data rate	To 9600 baud
LAN	10/100 Base-T Ethernet port with Link and Activity Status LEDs
USB port	USB 2.0 Host port Type A receptacle (X2)

## LCD display

Display	LCD is a 8.4 inch (21.7 cm) VGA, color TFT transfective device with integral CCFL backlight
Touch screen	4-wire resistive touch screen interface for user entry

## ACS-PCM2-5 POWER CONTROL PANEL



The nVent RAYCHEM ACS-PCM2-5 enclosure is rated NEMA 4/12 and is approved for nonhazardous indoor or outdoor locations. The ACS-PCM2-5 enclosure provides ground fault and line current sensing, alarming, switching (electromechanical relays) and RTD inputs for five heat tracing circuits when used with the ACS-UIT2.

ACS-30 General (RPN P000001232) panels are available to satisfy special applications which require higher voltage, higher switching capacity, panel heaters, etc. Contact nVent at 1 (800) 545-6258 for design assistance.

### General

Approvals

Nonhazardous Locations



Ambient operating temperature	-13°F to 122°F (-25°C to 50°C)
Dimensions	24" W x 24" H x 6.75" D (610 mm W x 610 mm H x 171 mm D)
Enclosure rating	NEMA 4/12 (indoor/outdoor locations)
Control supply voltage	90 - 280 V dropped to 12 V with switching power supply
Weight	70 lbs (31.75 kg)
Humidity	0–90% non-condensing
Fuse	Bussman MDL
Heating cable circuit contactors	
Rating	3-pole – 30 A/pole 277 Vac
Type	Sprecher-Schuh CA7-16-10-12D
Quantity	5

### Temperature sensors

Type	100-ohm platinum RTD, 3-wire, $\alpha = 0.00385$ ohm/ohm/°C Can be extended with a 3-conductor shielded cable of 20 ohm maximum per conductor
Quantity	Up to five wired directly to the ACS-CRM



**Communication to ACS-UIT2, ACS-PCM2-5 panels, C910-485 and RMM2**

Type	2-wire RS-485
Cable	One shielded twisted pair
Length	4000 ft (1200 M) maximum
Quantity	Up to 52 ACS-PCM2-5 panels may be connected to one ACS-UIT2

**Line current sensors**

Max current	60 A
Accuracy	± 2% of reading

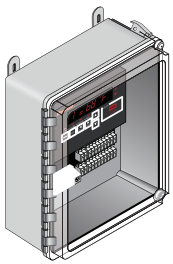
**Ground-fault sensors**

Range	10–200 mA
Accuracy	± 2% of reading

**Connection terminals**

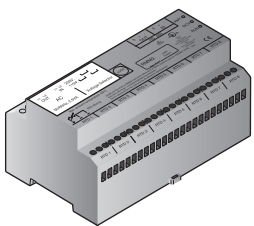
Power supply/line/load	#22 – 8 AWG
RS-485	#24 – 12 AWG
RTD	#24 – 12 AWG

**C910-485 ELECTRONIC CONTROLLER (OPTIONAL)**



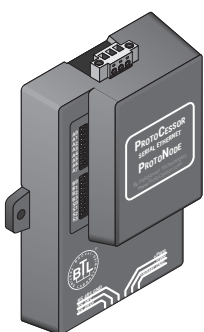
The C910-485 controller Part No. 10170-026 is a compact, full-featured, microprocessor-based, single-point commercial heating cable control system with integrated equipment ground-fault protection. The C910-485 provides control and monitoring of electric heating cable circuits for commercial heating applications. The C910-485 can be set to monitor and alarm for high and low temperature, low current, and ground-fault level. The C910-485 includes an RS-485 communication module to remotely configure, control and monitor the heating cable circuits through a building management system (BMS).

**REMOTE MONITORING MODULE (OPTIONAL)**



A Remote Monitoring Module (RMM2, Part No: 051778-000) is used to collect additional temperatures for control and monitoring of the heat-tracing circuit by the ACS-PCM2-5 control panel, through the ACS-UIT2 user interface terminal. The RMM2 accepts up to eight RTDs that measure pipe, vessel, or ambient temperatures. Multiple RMM2s communicate with a single ACS-UIT2 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. The RMM2 is available for DIN rail mount or pre-installed inside a polycarbonate NEMA-4X enclosure (Part No: 523420-000).

**PROTOCOL GATEWAY (OPTIONAL)**



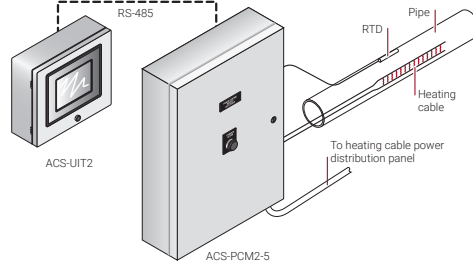
The ProtoNode is an external, high performance multi-protocol gateway for customers needing protocol translation between BACnet® or Metasys® N2 Building Management Systems (BMS) and the ACS-30 controller.

The ProtoNode-RER (Part No P000002008) is for ACS-30 systems with up to 5 PCM panels. The ProtoNode-RER-10K (Part No P000001983) is for ACS-30 systems with up to 34 PCM panels.

## TYPICAL CONFIGURATIONS FOR THE ACS-30 SYSTEM

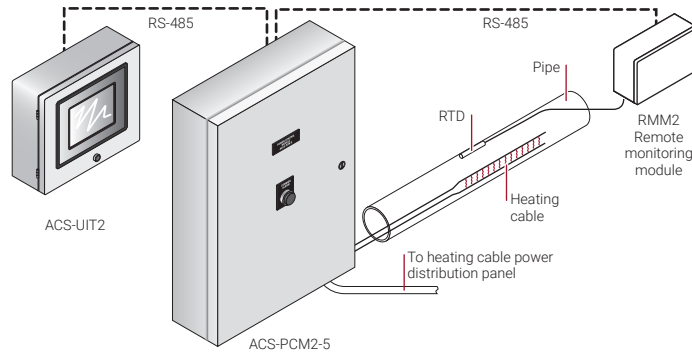
### Individual controls

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current
- Monitors pipe temperature (via RTD inputs wired back to the ACS-PCM2-5 or RMM2)



### Individual controls with RMM2

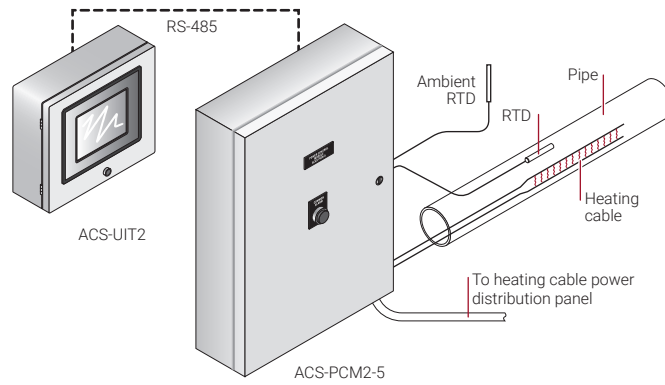
- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current
- Monitors pipe temperature (via RTD inputs wired back to the ACS-PCM2-5)
- Using optional RMM2 (remote monitoring modules) mounted in the field, up to 128 RTD inputs can be added to the ACS-30 system
- 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.



**TYPICAL CONFIGURATIONS FOR THE ACS-30 SYSTEM**

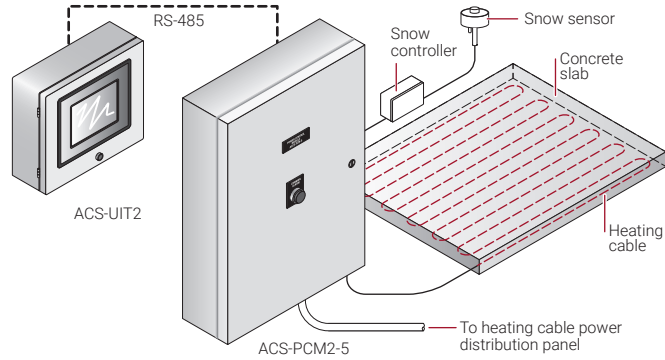
**Individual ambient control**

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current
- Monitors pipe temperature (via RTD inputs wired back to the ACS-PCM2-5 or RMM2)



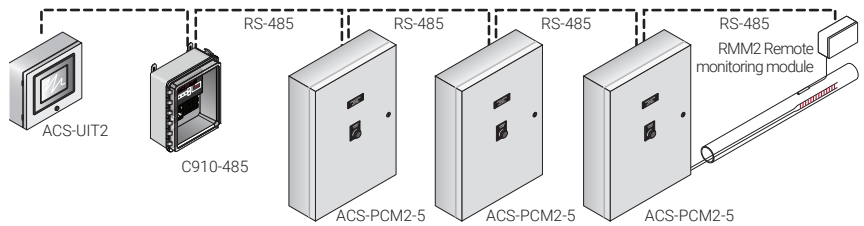
**Individual external control for surface snow melting and roof & gutter application**

- Monitors ground-fault current and alarms/trip control contactor upon fault
- Monitors heater current
- Monitors pipe temperature (via RTD inputs wired back to the ACS-PCM2-5 or RMM2)
- Connects to snow controllers (via RTD input) to power circuits when snow/ice melting is required



**Multipanel configuration**

- Multiple panels can be ganged together for control using a single User Interface Terminal
- Communications is accomplished using RS-485 protocol
- Up to 260 heat trace circuits can be supported using this architecture



# CONNECTION KITS AND ACCESSORIES FOR XL-TRACE, ICESTOP AND HWAT SELF-REGULATING HEATING CABLES

### PRODUCT OVERVIEW

The nVent RAYCHEM RayClic connection system is a simple, fast and reliable set of connection kits developed for select nVent RAYCHEM IceStop and HWAT self-regulating heating cables. There is no wire stripping needed because the insulation displacement connector makes the electrical connection.

The easy-to-install RayClic connection system reduces installation time, lowering the total installed cost of the heating cable system.

#### Simple

- No need for special tools
- Three-step installation

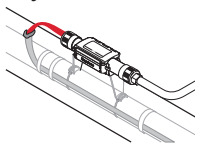
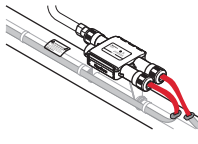
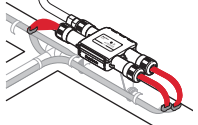
#### Reliable

- Intuitive installation
- Rugged, waterproof, UV-resistant enclosure

#### Cost-effective

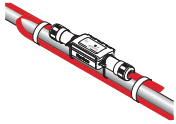
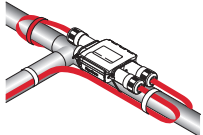
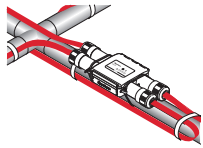
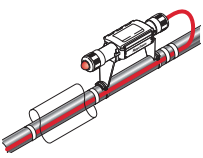
- Quick installation

### POWERED CONNECTION KITS


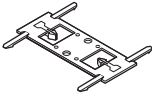
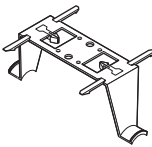
Catalog number	Part number	Description
 <p><b>RayClic-PC</b></p>	233053-000	<p>The RayClic-PC connection kit can supply power to one heating cable. Each kit contains one RayClic-PC power connection, one RayClic-E end seal, and one SB-04 pipe mounting bracket. The kit includes 5' power lead wires and a conduit fitting; the junction box and flexible conduit required to make a complete connection are not included.</p> <p><b>Weight: 1.8 lb (0.8 kg)</b></p>
 <p><b>RayClic-PS</b></p>	861247-000	<p>The RayClic-PS connection kit can be used as a power connection kit for supplying power to two heating cables. Each kit contains one RayClic-PS powered splice connection, two RayClic-E end seals, and one SB-04 pipe mounting bracket. The kit includes 5' power lead wires and a conduit fitting. The junction box and flexible conduit required to make a complete connection are not included.</p> <p><b>Weight: 2.0 lb (0.9 kg)</b></p>
 <p><b>RayClic-PT</b></p>	804231-000	<p>The RayClic-PT connection kit can be used as a power connection kit for supplying power to three heating cables. Each kit contains one RayClic-PT powered tee connection, three RayClic-E end seals, and one SB-04 pipe mounting bracket. The kit includes 5' power lead wires and a conduit fitting. The junction box and flexible conduit required to make a complete connection are not included.</p> <p><b>Weight: 2.0 lb (0.9 kg)</b></p>



**UNPOWERED CONNECTION KITS**

Catalog number	Part number	Description
<b>RayClic-S</b>	559871-000	Splice kits are installed as needed to connect two heating cables together at one point. Each kit contains one the RayClic-S splice. <b>Weight: 1.3 lb (0.6 kg)</b>
		
<b>RayClic-T</b>	014023-000	Tee kits are installed as needed to connect three heating cables together at one point. Each kit contains one the RayClic-T tee connection and one RayClic-E end seal. <b>Weight: 1.9 lb (0.9 kg)</b>
		
<b>RayClic-X</b>	546349-000	RayClic-X kits are installed as needed to connect four heating cables together at one point. Each kit contains one RayClic-X cross and two RayClic-E end seals. <b>Weight: 2.0 lb (0.9 kg)</b>
		
<b>RayClic-LE</b>	P000000770	Lighted end seal kits are installed wherever an end-of-line signal light is required. Each kit contains one RayClic-LE lighted end seal and one RayClic-SB pipe mounting bracket. <b>Weight: 1.8 lb (0.8 kg)</b>
		

**ACCESSORIES**

Catalog number	Part number	Description
<b>RayClic-E</b>	805979-000	The RayClic-E is a replacement end seal kit.
		
<b>RayClic-SB-02</b>	852001-000	The RayClic-SB-02 is a wall mounting bracket for use with any RayClic connection kit.
		
<b>RayClic-SB-04</b>	616809-000	The RayClic-SB-04 is a pipe mounting bracket for use with any RayClic connection kit. One pipe mounting bracket is included with each powered connection kit and the RayClic-LE lighted end seal kit.
		

**RAYCLIC SYSTEM SPECIFICATIONS**

Rated voltage	120–277 V
Maximum circuit breaker size	30 A
Maximum exposure temperature	150°F (65°C)
Minimum installation temperature	0°F (–18°C)
Enclosure rating	NEMA 4X

**APPLICABLE PRODUCTS**

XL-Trace	5/8XL1-CR/CT and 5/8/12XL2-CR/CT
IceStop	GM-1XT, GM-1X, GM-2XT and GM-2X
HWAT	HWAT-R2, HWAT-P1

## APPROVALS

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718K Pipe Heating Cable  
877Z De-Icing and Snow Melting



With XL-Trace and IceStop  
heating cable only  
For Class I, Div. 2,  
Groups A,B,C,D  
hazardous locations- GM-1XT  
and GM-2XT only

## DESIGN AND INSTALLATION

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For proper design and installation of a RayClic connection system, use the appropriate product design guide and the installation instructions included with the connection kit.

## GROUND-FAULT PROTECTION

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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.

## EXPANDED HWAT-ECO-GF ELECTRONIC CONTROLLER CAPABILITIES



The nVent RAYCHEM HWAT-ECO-GF electronic controller has multiple capabilities that help make the nVent RAYCHEM Hot Water Temperature Maintenance System (HWAT) a superior alternative to recirculation systems. This section expands upon some of these capabilities that were introduced in HWAT Design Guide (H57510), including the heat-up cycle and subsequent cool down, Building Management System (BMS) interface, predefined programs, and the water heater sensor function. For additional information, refer to the HWAT-ECO-GF Installation and Operation Manual (H57340).

### HEAT-UP CYCLE AND COOL DOWN

The HWAT-ECO-GF controller includes a heat-up cycle function that allows the HWAT system to increase the water temperature of a hot water system that is not in use. During the heat-up cycle, the HWAT-ECO-GF controller continuously powers the heating cable for the selected timeframe. Using the heat-up graphs below, program the HWAT-ECO-GF controller for the amount of time required to reach the desired temperature. To allow sufficient time for the pipes to cool before hot water is used, refer to the cool-down chart to determine the amount of time required in Off mode after the heat-up cycle is complete and program the HWAT-ECO-GF controller accordingly.

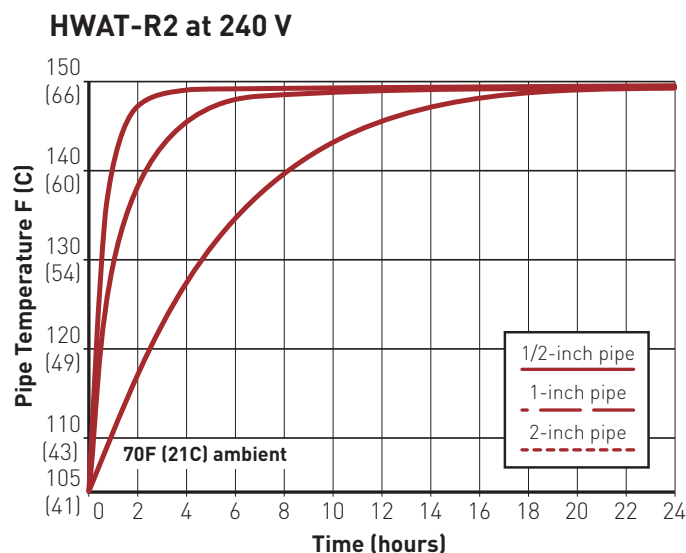
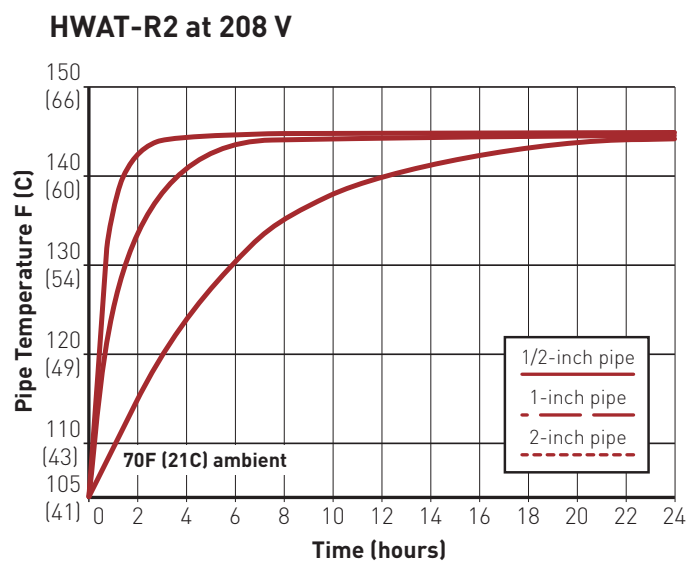
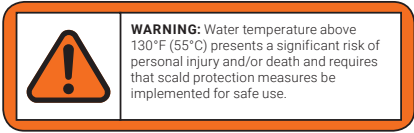


Fig. 1 Heat-up cycle graphs

**SCALD PROTECTION**



HWAT systems present an increased risk of scalding due to the high water temperature. Pay special attention to the scald warning to the left.

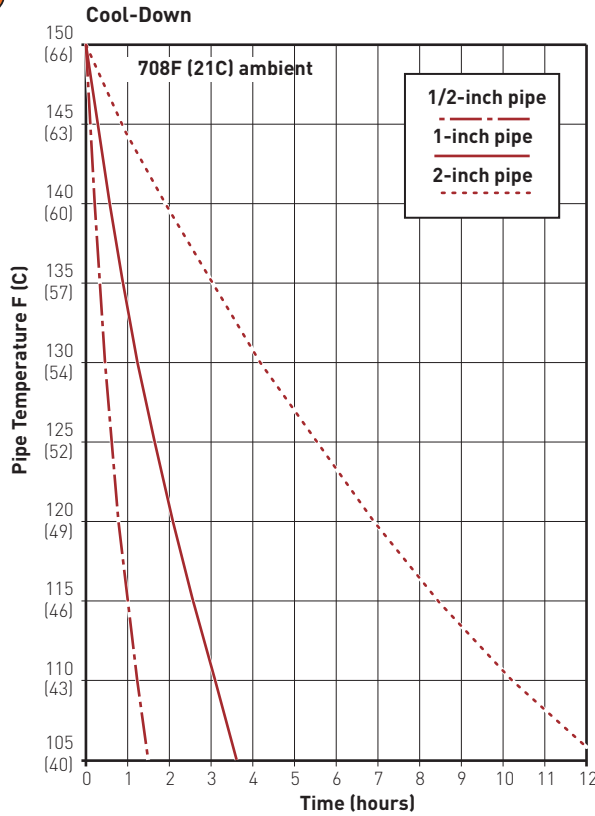


Fig. 2 HWAT cool-down graph

**PREDEFINED PROGRAMS**

The HWAT-ECO-GF controller has nine predefined programs that can be customized by the user. These programs include time intervals for Maintain, Economy, Heat-Up and Off modes. The economy setting is selected for low water usage periods where a lower maintain temperature is acceptable. The Off setting is selected for cool down after a heat-up cycle or for high usage periods where hot water is flowing from the water heater to the point of use with minimal delay thus not requiring energy from the HWAT system.

- = Heat-up cycle
- = Maintain temperature
- = Economy temperature
- = Heating off

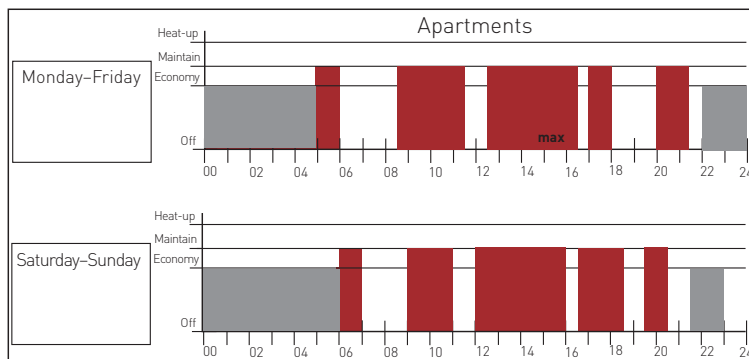


Fig. 4 Predefined program example

**WATER HEATER SENSOR FUNCTION**

The HWAT-ECO-GF controller ensures that the maintain temperature does not exceed a user defined high temperature limit set point. When the water heater sensor option is activated, the HWAT-ECO-GF controller monitors the temperature of the water being supplied to the system. As shown in Fig. 5, the water heater sensor can be installed on the outlet of the water heater or after the mixing valve, depending on the configuration of your system.

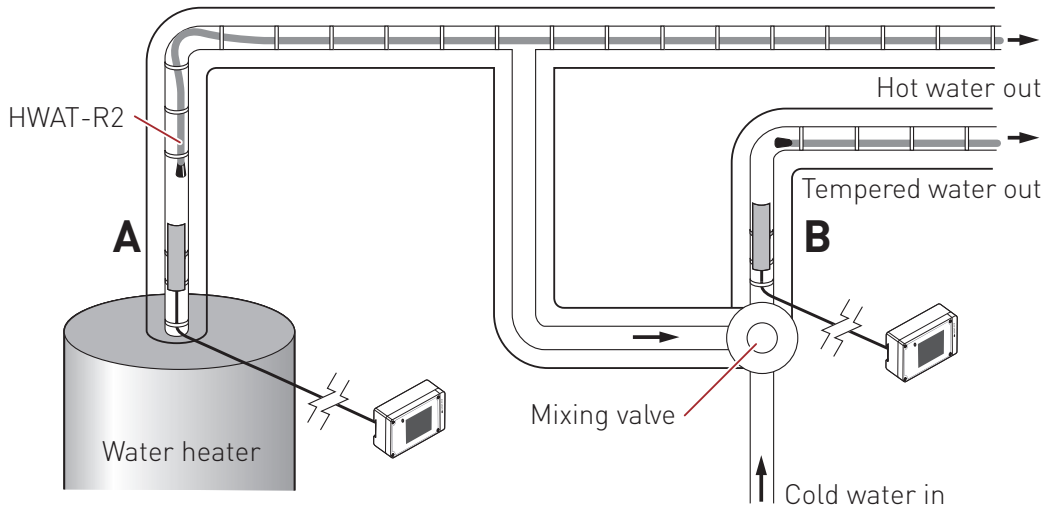


Fig. 5 Water heater sensor function example



# SECTION 22 05 33

## HEAT TRACING FOR PLUMBING PIPING

### HOT WATER TEMPERATURE MAINTAINANCE (HWAT) STANDARD SYSTEM

**This specification is dated 05/01/2019 and supersedes all previous versions.**

**Note: Any text in RED indicates a choice the user needs to decide upon to suit individual project requirements. The alternative not selected must be deleted prior to incorporating into final contract documents. For detailed design information, please contact your local representative, our website [nventthermal.com](http://nventthermal.com) or nVent Technical Support 800-545-6258.**

#### PART 1 GENERAL

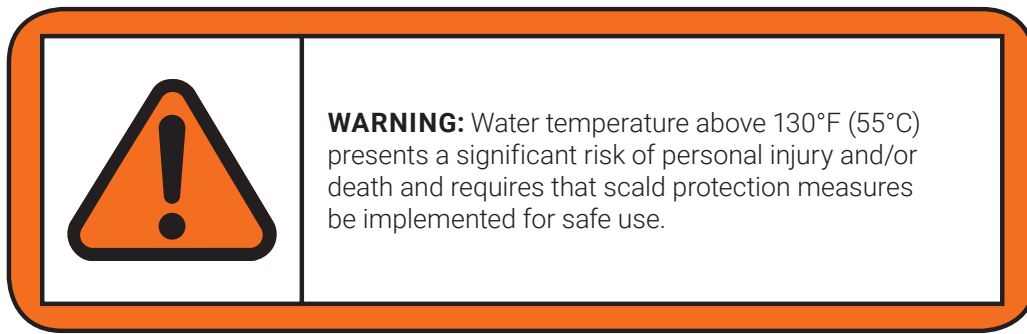
##### 1.1 SUMMARY

- A. The system complies with California Title 24 energy requirements.
- B. Section includes a UL Listed, CSA Certified, or FM Approved temperature maintenance heat tracing system of domestic hot water supply consisting of self-regulating trace heater, connection kits, and energy efficient time based control.
- C. Related Requirements
  - 1. Section 22 07 19 – Plumbing Piping Insulation
  - 2. Section 25 34 00 – Integrated Automation Instrumentation and Terminal Devices for Plumbing
  - 3. Section 25 54 00 – Integrated Automation Control of Plumbing
  - 4. Section 26 05 26 – Grounding and Bonding for Electrical Systems
  - 5. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

##### 1.2 REFERENCES

- A. Reference Standards
  - 1. UL515 – Electrical Resistance Heat Tracing for Commercial Applications
  - 2. IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications
  - 3. CSA Standard C22.2 No. 130-03 Requirements for Electrical Resistance Heating Cables & Heating Device Sets
  - 4. NFPA 70 - National Electrical Code
  - 5. CSA Standard C22.1 – Canadian Electrical Code
  - 6. ANSI/ASHRAE Standard 188-2018 - Legionellosis: Risk Management for Building Water Systems
  - 7. CIBSE TM13-2013 Minimising the Risk of Legionnaires Disease

### 1.3 SCALDING WARNING



### 1.4 SYSTEM DESCRIPTION **[SELECT ONE]**

- A. **[SELECT FOR NVENT RAYCHEM HWAT-ECO-GF]** System for temperature maintenance of domestic hot water supply systems with energy efficient time based control and monitoring and integrated ground-fault circuit protection.
- B. **[SELECT FOR NVENT RAYCHEM ACS-30]** System for temperature maintenance of domestic hot water supply systems with energy efficient time based control, multi-point monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities

### 1.5 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

#### A. Product Data

1. Heating cable data sheet
2. UL, CSA, FM approval certificates for hot water temperature maintenance system components
3. Hot water temperature maintenance design guide
4. System installation and operation manual
5. System installation details
6. Connection kits and accessories data sheet
7. Controller data sheet
8. Controller wiring diagram

#### B. Shop Drawings

1. Provide engineered isometric heat tracing circuit layout drawings indicating power connections, tees, end seals, cable length and circuit cable length.

### 1.6 QUALITY ASSURANCE

- A. Source Limitations: All system components shall be sourced from a single manufacturer, under no circumstances shall any components be installed other than those supplied by the cable manufacturer, to ensure system integrity and to meet warranty requirements.
- B. Qualifications
  1. Manufacturers
    - a. Manufacturer to show minimum of 40 years of experience in manufacturing electric self-regulating heating cables.
    - b. Manufacturer will be ISO-9001 registered.
    - c. Manufacturer to provide products consistent with IEEE 515.1 and CSA 22.2 No. 130-03 requirements.

- d. The self-regulating temperature maintenance cable shall be qualified and tested to demonstrate a useful lifetime in excess of 40 years.

## 2. Installers

- a. System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation. A licensed electrician shall perform all electrical connections.

3. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

## C. Certifications

1. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified, or FM Approved for hot water temperature maintenance.

## 1.7 DELIVERY, STORAGE, AND HANDLING

### A. Delivery and Acceptance Requirements

1. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
  - a. Product and Manufacturer
  - b. Length/Quantity
  - c. Lot Number
  - d. Installation and Operation Manual
  - e. MSDS (if applicable)

### B. Storage And Handling Requirements

1. Store the heating cable in a clean, dry location with a temperature range 0°F (-18°C) to 140°F (60°C).
2. Protect the heating cable from mechanical damage.

## 1.8 WARRANTY

### A. Manufacturer Warranty

1. nVent warrants all goods listed below for 2 years from date of purchase against faulty workmanship and use of defective materials when such goods are properly installed, operated, and maintained according to product documentation. See Limited Product Warranty H57396 at [nventthermal.com](http://nventthermal.com) for details.
  - a. Heating cables, connection kits, and accessories
  - b. Thermostats, controllers, panels contactors, sensors, and accessories

### B. Extended Warranty –

1. Contractor shall provide the owner an extended product warranty. The contractor must complete and forward to owner the Installation, Inspection or Commissioning Record(s) located in the back of installation manual for the heat trace system being installed, and complete the online warranty registration form at [nventthermal.com/support/warranty](http://nventthermal.com/support/warranty) within 30 days from the date of installation, otherwise only standard limited warranty applies. See Limited Product Warranty Extension H57397 at [nventthermal.com](http://nventthermal.com) for details.
  - a. Extended Warranty for heating cable and components shall be 10 years from date of purchase

## PART 2 PRODUCTS

### 2.1 HEAT TRACING SYSTEM

#### A. Manufacturers

1. Basis of Design Manufacturer: Subject to the compliance with requirements, provide nVent RAYCHEM heat tracing products of **nVent Thermal Management, LLC, Redwood City, California 94063, 800-545-6258;**  
Email: thermal.info@nvent.com Website: nventthermal.com

*Specifier: Retain one of the two paragraphs below based upon project requirements.*

2. Submit comparable products of one of the following for approval by Plumbing Engineer:
  - a. [Specifier: Insert name of manufacturer with comparable products]
  - b. Submit request for substitutions in accordance with Instructions to Bidders and Division 01 General Requirements.
3. Provide specified product; Owner will not consider substitution requests.

#### B. Materials

1. Heating cables shall be nVent RAYCHEM HWAT-R2, self-regulating temperature maintenance heating cables specifically designed for this application, tested and approved to IEEE 515.1 and CSA 22.2 No 130-03.
  - a. The construction of the self-regulating temperature maintenance heating cable shall consist of a continuous core of conductive polymer that is radiation crosslinked, extruded between two 16 AWG nickel-plated copper bus wires that varies its power output in response to pipe temperature changes.
  - b. The heating cable shall have a modified polyolefin inner jacket for dielectric integrity and long life expectancy.
  - c. The heating cable shall have a laminated aluminum foil layer (Mylar wrap) for additional mechanical protection and shall act as a plasticizer diffusion shield.
  - d. The heating cable shall have a thicker gauge (5/24) tinned copper braid with minimum 70% coverage for ground path and mechanical ruggedness.
  - e. The heating cable shall have a **POLYOLEFIN** outer jacket printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).
  - f. The heating cable shall have a self-regulating factor of at least 70 percent for HWAT-R2. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 40°F (5°C) pipe temperature to 150°F (65°C) pipe temperature.
  - g. The heating cable shall operate on line voltages of **[SELECT ONE: 208, 220, 240 or 277]** without the use of transformers.
  - h. The heating cable shall be UL Listed, CSA Certified, and FM Approved system.
  - i. Constant wattage cables are not acceptable.
2. Heating Cable Connection Kits
  - a. Heating cable connection kits shall be nVent RAYCHEM RayClic Connection Kits.
  - b. Contractor shall provide power connections, splices/tees, and end seal kits to properly connect and terminate the heating cable.

- c. All splices, tees and crosses shall be installed underneath the pipe insulation with service loops installed to allow for future service of the piping.
  - d. Connection kits shall be rated Type 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require the installing contractor to cut into the heating-cable core to expose the bus wires.
  - e. Connection kits shall be UL Listed, CSA Certified, and FM approved.
3. Attachment of Heating Cable
- a. Attachment method of heating cable to the piping shall be either
    1. nVent RAYCHEM GT-66 – general purpose, high temperature, glass filament tape for installation @ 40°F (5°C) and above. Contractor to affix the heating cable to the pipe every 12” by wrapping the GT-66 tape around the pipe and over the heating cable.
    2. nVent RAYCHEM AT-180 – aluminum tape, high temperature for all plastic piping for installations @ 32°F (0°C) and above. Tape is installed lengthwise over the heating cable.
  - b. Metal cable ties are not permitted.
4. Identification of Heating Cable System
- a. Contractor shall provide and install **nVent RAYCHEM ETL “Electric Heat Traced” labels** on exterior of pipe insulation every 10 feet on opposite sides of the pipe for the entire length of heat traced piping.
  - b. In addition, all splices, tees, crosses and power connections shall be labeled on the exterior of the pipe insulation indicating the presence of a connection kit.
5. Energy Efficient Control System **[SELECT ONE OPTION]**
- a. **[OPTION 1] Single Circuit Local Digital Controller**
    1. All self-regulating temperature maintenance cable shall be controlled via an energy saving, programmable single circuit controller to provide adjustable maintained temperatures in the range of 105°F (40°C) to 140°F (60°C), known as nVent RAYCHEM HWAT-ECO-GF, manufactured by nVent.
    2. Digital controller shall operate on 208 – 277 V.
    3. Pre-programmed duty cycles based on ambient temperature ranging from 60°F (15°C) to 80°F (27°C).
    4. The pre-programmed duty cycles shall be based on HWAT-R2 heating cables only. No other heating cables may be used with the HWAT-ECO-GF controller.
    5. Flexible temperature control from 105°F (40°C) to 140°F (60°C).
    6. Three programmable temperature set points for maximum energy efficiency: Maintain, Economy, Off.
    7. Controller shall have heat cycle setting.
    8. The controller shall have a USB port to allow for quick and easy software update.
    9. Digital controller shall have an integrated GFPD (30 mA).
    10. Heating cable manufacturer shall provide a local digital controller with 24/7 pre-programmed time based profiles specific to the selected heating cable application such as schools, hospitals and prisons
    11. Controller shall have remote alarming capability to a BMS interface.



12. Controller shall have a pipe temperature sensor, low/high pipe temperatures alarms and high temperature cut-out to maximize the energy efficiency of the nVent RAYCHEM HWAT system by verifying that the hot water pipe temperature is at or above the programmed minimum temperature (low temperature set point); and to monitor and alarm if the pipe temperature is higher than the maximum programmed temperature (high temperature set point and cut-out).
13. Controller shall have an optional boiler temperature sensor, low/high boiler temperatures alarms and high temperature cut-out to maximize the energy efficiency of the HWAT system by verifying that the boiler temperature is at or above the correct minimum temperature (low temperature set point); and to monitor and alarm if the pipe temperature is higher than the maximum programmed temperature (high temperature set point and cut-out).
14. Controller shall have 30 A switching capacity rating.
15. Enclosure type shall be Type 12 (Polycarbonate).
16. Controller shall have NO/NC alarm contacts. Controller shall alarm on:
  - a. Loss of power
  - b. Controller reinitialized
  - c. Pipe temperature above high set point
  - d. Pipe temperature below low set point
  - e. Boiler temperature above high set point
  - f. Boiler temperature below low set point
17. Digital controller shall have c-UL-us approvals specifically for use with the HWAT-R2 heating cable.

b. **OPTION 2 Multi-Circuit, Distributed Digital Control System**

1. All hot water temperature maintenance circuits shall be controlled and monitored using a distributed digital control system, known as ACS-30, manufactured by nVent.
2. Multi-application: distributed digital control system shall have pre-programmed parameters to provide concurrent control for heating cables used for pipe freeze protection, flow maintenance, hot water temperature maintenance, surface snow melting, roof and gutter de-icing, freezer frost heave prevention and floor heating applications.
3. All programming shall be done through the central User Interface Terminal (ACS-UIT2).
4. The ACS-UIT2 shall have a color LCD touch-screen display with password protection to prevent unauthorized access to the system.
5. The ACS-UIT2 shall communicate with up to fifty-two (52) ACS Power Control Panels (ACS-PCM2-5) where each panel can control up to five (5) circuits and accept up to five (5) temperature inputs. C910-485 controllers may also be added to the ACS-30 system for single circuit extensions.
6. Digital control system shall be capable of assigning up to four (4) RTD temperature inputs per heat-tracing circuit.
7. The ACS-UIT2 shall communicate with up to sixteen (16) Remote Monitoring Modules (RMM2), where each module can accept up to eight (8) temperature inputs.
8. The ACS-UIT2 shall have a USB port to allow for quick and easy software update.
9. The ACS-UIT2 shall have three (3) programmable alarm contacts including an alarm light on the enclosure cover.
10. A separate offline software tool shall be made available to allow users to pre-program the digital control system and transfer program via a USB drive or Ethernet.

11. The ACS-UIT2 enclosure shall be Type 4 rated for indoor or outdoor locations.
12. The ACS-PCM2-5 panel shall be in a Type 4/12 rated enclosure approved for nonhazardous indoor and outdoor locations.
13. The ACS-PCM2-5 panel shall provide ground-fault and line current sensing alarming, switching and temperature inputs for five (5) heat tracing circuits.
14. Each ACS-PCM2-5 panel shall have five (5) 3-pole, 30 A contactors (EMR type).
15. The ACS-PCM2-5 panel shall be capable of operating at 120 V to 277 V.
16. The ACS-PCM2-5 shall have an alarm contact including an alarm light on the panel cover.
17. Digital controller shall have an integrated adjustable GFPD (10 – 200 mA).
18. Digital control system can be configured for On/Off, ambient sensing, PASC and timed duty cycle control (HWAT only) modes based on the application. PASC control proportionally energizes the power to the heating cable to minimize energy based on ambient sensed conditions.
19. Upon communication loss with the user interface terminal (ACS-UIT2), the ACS-PCM2-5 panels shall control with the last downloaded set point.
20. In HWAT system control mode, the ACS-30 shall have time based control algorithm with three programmable temperature set points for maximum energy efficiency (Maintain, Economy, Off).
21. In HWAT system control mode, the pre-programmed duty cycle algorithm is based upon HWAT heating cables only. No other heating cables shall be used in the HWAT control mode.
22. Digital control system will have a built-in self-test feature to verify proper functionality of heating cable system.
23. Digital control system will also be able to communicate with BMS by one of the following protocols using the ProtoNode multi-protocol gateway.
  - a. Modbus®
  - b. BACnet® or Metasys® N2 **[use PROTONODE-RER]**
24. The following variables will be monitored by the digital controller and reported back to the BMS:
  - a. Temperature
  - b. Ground-fault
  - c. Current draw
  - d. Power consumption
  - e. Associated alarms
25. The ACS-UIT2 shall be c-CSA-us Certified. The ACS-PCM2-5 panel shall be c-UL-us Listed.

## 6. Thermal Pipe Insulation

- a. Pipes must be thermally insulated in accordance with the HWAT Design Guide H57510 requirements. No deviation from the insulation schedule will be allowed.
- b. Thermal insulation must be a type that is flame retardant (closed-cell or fiberglass) with waterproof covering.

## 7. Approval

- a. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified, or FM Approved for hot water temperature maintenance.
- b. The temperature maintenance system shall have a design, installation and operating manual specific to domestic hot water piping.

## PART 3 EXECUTION

### 3.1 EXAMINATION

#### A. Verification Of Conditions

1. Prior to installation of heating cable system, verify that all piping which will be heat traced has passed all hydrostatic/pressure tests and is signed off by plumbing inspector.

#### B. Preinstalling Testing

1. Prior to installing heating cable on the piping, an insulation resistance test shall be performed by the installing contractor to ensure integrity of heating cable as described in the installation and maintenance manual.

### 3.2 PREPARATION

#### A. Protection Of In-Place Conditions

1. All heating cable ends shall be protected from moisture ingress until cable is terminated.
2. Acceptable methods are by installing nVent RAYCHEM RayClic-E end seals.

### 3.3 INSTALLATION

#### A. Comply with manufacturer's recommendations in the HWAT System Installation and Operation Manual H57548.

#### B. Apply the heating cable linearly on the pipe after piping has successfully completed any pressure tests.

#### C. Secure the heating cable to piping with the approved attachment method which shall be either:

1. GT-66 – general purpose, high temperature, glass filament tape for installation @ 40°F (5°C) and above. Contractor to affix the heating cable to the pipe every 12" by wrapping the GT-66 tape around the pipe and over the heating cable.
2. AT-180 – aluminum tape, high temperature is required for all plastic piping, for installations @ 32°F (0°C) and above. Tape is installed lengthwise over the heating cable.

#### D. Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a completely functional system, installed in accordance with applicable national and local requirements.

#### E. Any deviation in circuitry, insulation, or piping material must be approved by engineer prior to execution.

#### F. Distribution pipes and express risers must be isolated electrically. Each shall have its own circuit.

#### G. Branch lines shall be grouped electrically based on location.

#### H. All power connections must be located in accessible areas. Access panels for power connection shall be a minimum of 12" x 12" and within reach of power connection kit.

#### I. Refer to Electrical Specification for power connection locations.

#### J. All power, tee, and splice connection points shall be shown on the plumbing as-built drawings.

- K. Installation training, provided by an authorized manufacturer's representative, must be completed prior to work mobilization.
- L. Interface with Other Work
  - 1. Grounding of controller shall be equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
  - 2. Connection of all electrical wiring shall be according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
  - 3. Pipe shall be thermally insulated in accordance with the HWAT design guide insulation requirements.

### 3.4 FIELD QUALITY CONTROL

- A. Initial start-up and field testing (commissioning) of the system shall be performed by factory technician or factory representative per the owner's requirements.
- B. Field Tests and Inspections
  - 1. The system shall be commissioned in accordance to the HWAT Installation and Operation Manual H57548
  - 2. The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals:
    - a. Before installing the heating cable
    - b. After heating cable has been installed onto the pipe
    - c. After installing connection kits
    - d. After the thermal insulation is installed onto the pipe
    - e. Prior to initial start-up (commissioning)
    - f. As part of the regular system maintenance
    - g. Minimum acceptable insulation resistance shall be 1000 megohms or greater
  - 3. The technician shall verify the insulation schedule is in compliance with the HWAT Installation and Operation manual.
  - 4. The technician shall verify that the **[SELECT ONE: HWAT-ECO-GF or ACS-30]** control parameters are set to the application requirements.
  - 5. The technician shall verify that the **[SELECT ONE: HWAT-ECO-GF or ACS-30]** alarm contacts are correctly connected to the BMS.
  - 6. The technician shall verify that the ACS-30 and ProtoNode-RER are configured correctly with the BMS.
- C. Non-Conforming Work
  - 1. Any heat tracing circuit which fails the any of the above tests must be corrected prior to commissioning or startup of the system.
- D. Retain the services of nVent to provide factory design build and inspection services to prepare submittals for complete design layouts, wiring diagrams, installation details for all heat trace equipment including heating cable, connection kits, controllers and sensors. nVent shall supply 11"x17" isometric drawings for every circuit for a complete heat tracing system.
- E. Provide factory inspection report as part of a complete manufacturer approved installation that is compliant to Code.
- F. Start-up – Start-up of system shall be performed by factory technician or factory representative per the owner's requirements.

### 3.5 SYSTEM STARTUP

- A. Provide a factory-certified technician or manufacturer's representative for startup and commissioning of the heat tracing system and controller.
- B. Coordinate all controller settings with plumbing engineer prior to programming the controller.
- C. Provide commissioning report in submittals package to owner.

END OF SECTION





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Our powerful portfolio of brands:

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