



Raychem HWAT DESIGN GUIDE

This step-by-step design guide provides the tools necessary to design a Raychem HWAT Hot Water Temperature Maintenance System. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258. Also, visit our web site at www.pentairthermal.com.

Contents

Introduction	1
Typical Applications	2
Approvals and Code Compliance	2
Safety Guidelines	2
Ground-Fault Protection	3
Design Requirements	3
System Overview	3
HWAT Electronic Controllers	4
HWAT Heating Cables	4
RayClic Connection Kits	5
Design Guidelines	5
Before You Begin	6

INTRODUCTION

The Raychem 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 are the HWAT controllers. 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 when HWAT-R2 heating cable is used in conjunction with the HWAT-ECO 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 V or 240 V. Can also be powered at 277 V when using the DigiTrace ACS-30 controller
- Operated indoors where the ambient temperature is relatively constant and between 60°F (15°C) and 80°F (26°C)

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

Approvals and Code Compliance

The HWAT system, with or without the HWAT-ECO or ACS-30 controller, is UL Listed, CSA Certified, and FM Approved in nonhazardous locations.



Pipe Heating Cable

HWAT is also in compliance 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

Additionally, HWAT has numerous state and local code approvals. Contact your Pentair Thermal Management representative for further information.

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 Pentair Thermal Management 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.

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 Installation and Operations Manual (H57340)
- 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 Pentair Thermal Management web site at www.pentairthermal.com.

SYSTEM OVERVIEW

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

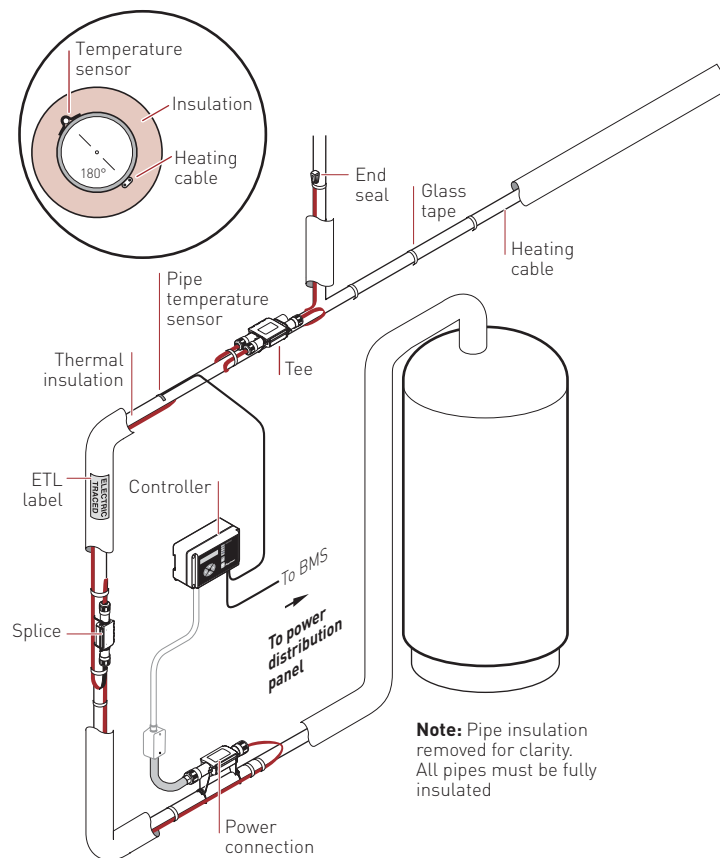


Fig. 1 Typical HWAT heating cable system

HWAT Electronic Controllers

The Raychem HWAT-ECO is an electronic controller 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 provides a variety of features and control options, listed below, for your hot water temperature maintenance system.

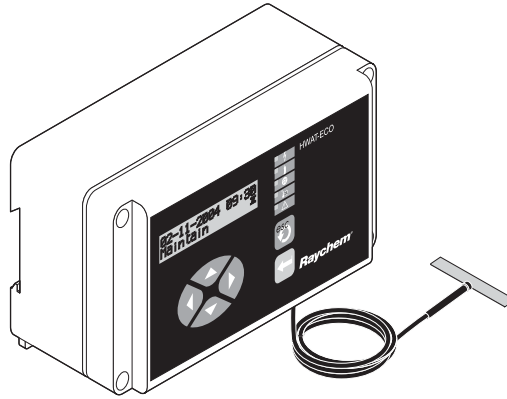


Fig. 2 HWAT-ECO controller

- **Flexible temperature control** – Selectable temperature control set points across the temperature range of the heating cable
- **Energy savings** – Lowers the maintain temperature during low water usage hours and turns off the heating cable during peak water usage hours
- **Heat-up cycle** – Increases the water temperature of a hot water system that is not in use
- **Building Management System (BMS) interface** – Receives a DC voltage to determine the desired maintain temperature
- **Alarm** – Signals power, temperature, or communication problems
- **Water heater sensor** – Monitors the supply pipe temperature, alarms on high temperature and turns off the system to prevent the possibility of scalding
- **Master/slave function** – Allows one HWAT-ECO to control up to eight additional HWAT-ECO controllers
- **Programmable settings** – Nine predefined programs that can be customized by the user

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.

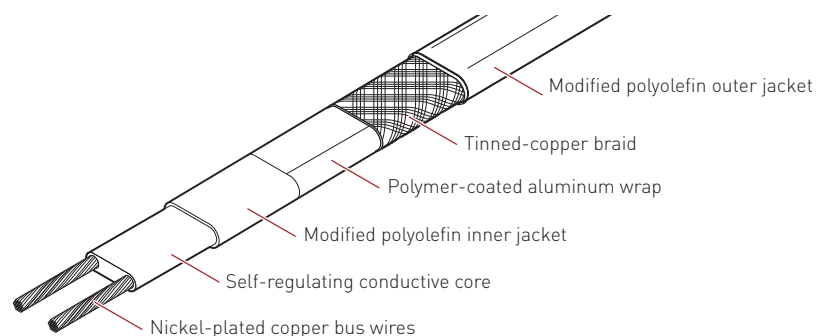


Fig. 3 HWAT-R2 heating cable

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 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.

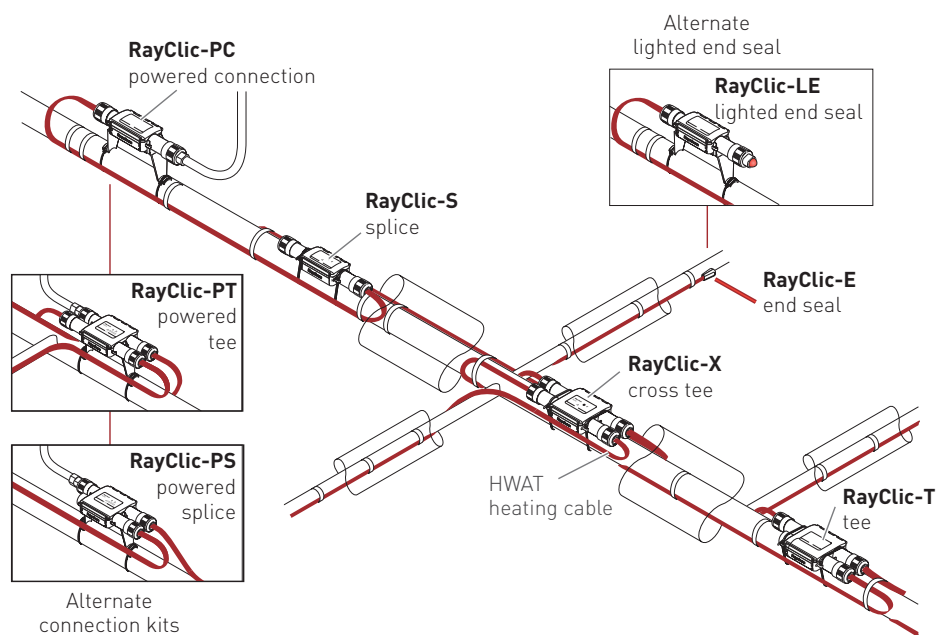


Fig. 4 RayClic connection kits

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 "Expanded HWAT-ECO Electronic Controller Capabilities," H58449; 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

	Example 1	Example 2
Desired maintain temperature	115°F (46°C)	115°F (46°C)
Ambient temperature	70°F (21°C)	70°F (21°C)
Supply voltage	208 V	208 V
Heat-up cycle required	No	Yes
Heat-up cycle temperature	n/a	140°F (60°C)

TABLE 2 HWAT SYSTEM TEMPERATURE RANGE

HWAT-R2	HWAT-ECO	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 Electronic Controller Capabilities."



WARNING Burn Hazard

Water temperatures above 120°F (50°C) can cause skin damage and pain. Be sure the correct insulation schedule is used and the HWAT-ECO or ACS-30 is programmed properly. Avoid exposure to water during heat-up cycles or from water systems with high maintain temperatures during normal operation.

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 for convenience, 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

⚠ WARNING To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with Pentair Thermal Management 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 breakers.

Example: Lay out circuits	Example
HWAT heating cable selected	HWAT-R2
Length of pipe	700 ft
Number of circuits	2
Circuit breaker size	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, Pentair Thermal Management recommends that one RayClic-S be ordered for every 500 feet of cable.

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

Example: Finalize circuit length

Example

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

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

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 5 Select control configuration

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

Example: Select control method

Example 1

Example 2

	Example 1	Example 2
Type	Individual circuit	Multi-circuit
Number of circuits	1	up to 260
Controller	HWAT-ECO	ACS-30

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 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)
Example 1	3/4	1	1
	1	1 1/4	1
	1 1/2	1 1/2	1 1/2
Example 2	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.

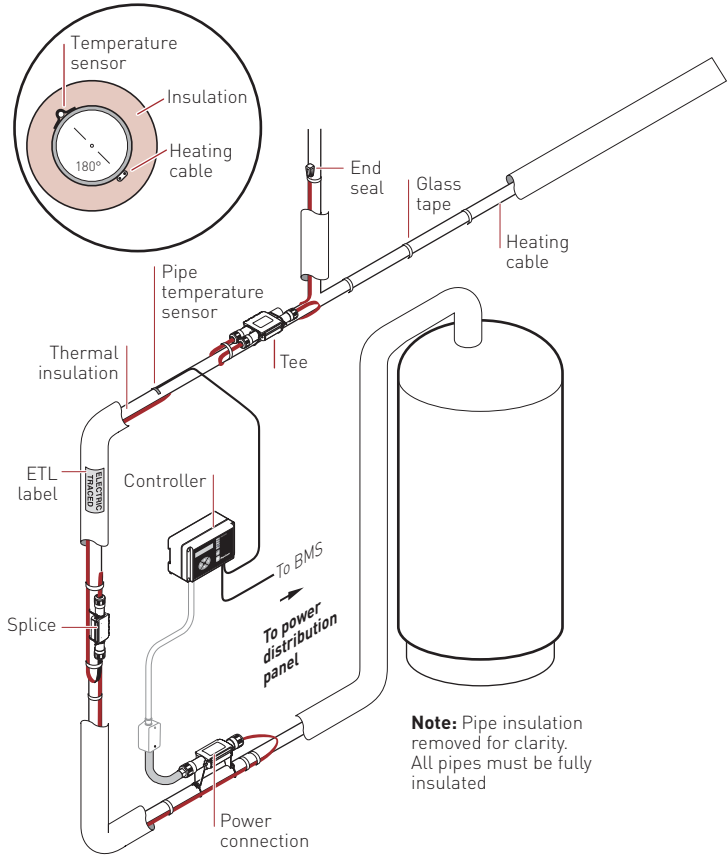


Fig. 5 Typical HWAT heating cable system

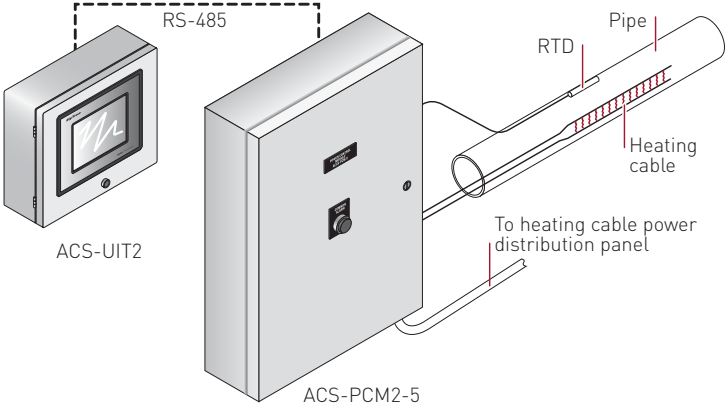


Fig. 6 Typical configuration for the DigiTace ACS-30 system

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	2
Attachment tape	GT-66	12 rolls
Labels	ETL	70



WWW.PENTAIRTHERMAL.COM

NORTH AMERICA

Tel: +1.800.545.6258
Fax: +1.800.527.5703
Tel: +1.650.216.1526
Fax: +1.650.474.7711
thermal.info@pentair.com

EUROPE, MIDDLE EAST, AFRICA

Tel: +32.16.213.511
Fax: +32.16.213.603
thermal.info@pentair.com

ASIA PACIFIC

Tel: +86.21.2412.1688
Fax: +86.21.5426.2917
cn.thermal.info@pentair.com

LATIN AMERICA

Tel: +1.713.868.4800
Fax: +1.713.868.2333
thermal.info@pentair.com

Pentair, DigiTrace, HWAT and RayClic are owned by Pentair or its global affiliates. All other trademarks are the property of their respective owners. Pentair reserves the right to change specifications without prior notice.

© 2013 Pentair.