WarmTrace™

Systems for Hot Water Temperature Maintenance

AUSTRALASIAN DESIGN GUIDE

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THERMON®

The Heat Tracing Specialists®

Commercial Products

WarmTrace™

Systems for Hot Water Temperature Maintenance

DESIGN GUIDE

Contents

WarmTrace™ Systems for Hot Water Temperature Maintenance

Introduction . . .

A WarmTrace system replaces heat lost through the thermal insulation on hot water supply piping to maintain the water at desired nominal temperatures without the need for costly insulated recirculation lines, pumps and balancing valves. Preventing the hot water from cooling also ensures readily available hot water when needed.

Like many other systems installed in a facility, the successful installation of a heat tracing system for maintaining[1] hot water may require coordination among the various trades involved. Mechanical and electrical contractors must be made aware of the specific requirements each must provide.

The information contained in this design guide will take the reader through a step-by-step procedure[2] to:

- Identify the piping which requires heat tracing.
- Determine the maintain temperature and make the proper cable selection.
- Specify the electrical circuit breaker requirements based on the estimated heat tracing circuit lengths.
- Specify the thermal insulation type and thickness to complete the thermal design.
- Incorporate the design information provided into a complete package for a facility.

To further facilitate this interaction, an additional installation, operation and start-up guide has been prepared to provide troublefree installation of the heating cable and accessories.

Product Description . . .

HSX® self-regulating heating cables utilize a specifically formulated carbon matrix heating element which responds to temperature changes. Whenever the temperature in the heat-traced piping begins to rise, the cable automatically reduces its heat output. Conversely, when the water temperature begins to drop, the cable reacts by increasing its heat output. This self-regulating feature occurs along the entire length of a heat tracing circuit to ensure each point receives the required amount of heat necessary to maintain thermal equilibrium.

Because the natural layout of a facility requires plumbing to be spread throughout the building, the length of hot water supply lines and heat tracing requirements can be extensive. To meet these requirements, HSX is manufactured with 2.3 mm^2 bus wires. These larger voltage supply wires (larger than any other system currently available) allow longer heat tracing circuit lengths. These longer circuit lengths mean fewer power connection kits and fewer heat tracing power supply branch circuit breakers.

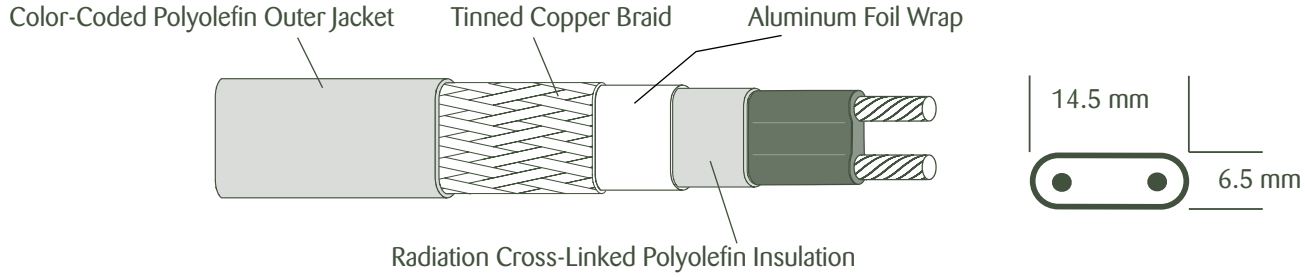
HSX is designed to be installed without thermostatic control to maintain nominal maintenance temperatures of 45°C, 50°C or 60°C. Projects with more than one maintain temperature can be traced without confusion since HSX is color-coded for easy identification of each temperature range.

For ease of installation, HSX is a cut-to-length cable and requires no detailed dimensions of the piping. Taped directly to the hot water supply piping, HSX requires only ordinary hand tools for installation. Power connection, end termination, in-line splicing and T-splicing kits have been designed specifically for the application to complete a WarmTrace system.

Notes . . .

1. An electrical heat tracing system is not a substitute for a complete, efficient domestic hot water system; it does not replace the need for an efficient water heater.
2. The examples and descriptions contained in this guide are based on **copper water pipe with fiberglass thermal insulation** (ASTM Std C-547) and other design conditions typical of most applications. For installations on non-metallic piping or design conditions other than those shown, contact Thermon.

Characteristics . . .

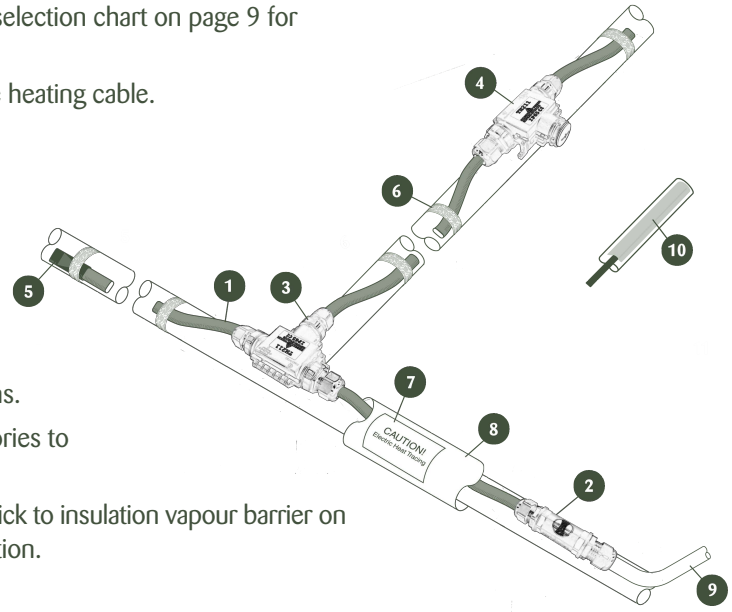


Bus wire	2.3 mm² nickel-plated copper
Heating core	radiation cross-linked polyolefin
Primary dielectric insulation	radiation cross-linked polyolefin
Foil wrap	polyester aluminum laminate
Metallic braid	2.3 mm² (equivalent size) tinned copper
Outer jacket	polyolefin; 1 mm nominal
Minimum bend radius	13 mm
Supply voltage	240 Vac
Circuit protection[1]	30 mA ground-fault protection mandatory

System Components . . .

A WarmTrace HSX hot water temperature maintenance system will typically include the following components:

1. **HSX** self-regulating heating cable (refer to cable selection chart on page 9 for proper cable).
2. **HSX Power-1** power connection kit[2] to terminate heating cable.
3. **HSX Splice** allows three heating cables to be-spliced together.
4. **HSX Splice** allows two heating cables to be spliced together.
5. **ET-6-COM** cable end termination. Each HSX Power-1 and HSX Splice includes one ET-6. Each HSX Power-2 includes two ET-6 terminations.
6. **Attachment** tape secures cable and HSX accessories to pipe; use on 300mm intervals.
7. **CL-COM** "Electric Heat Tracing" labels peel and stick to insulation vapour barrier on 3 m intervals or as required by code or specification.
8. Fiberglass thermal insulation[3] and vapour barrier.
9. Incoming power to energize heating cables.
10. **AL-20-COM** Aluminum tape installed over the entire length of the heater cable to increase heat transfer into non-metallic pipe.



Notes . . .

1. Ground-fault equipment is mandatory for all hot water temperature maintenance heat tracing circuits.
2. HSX Power-2, power connection kit also available for connecting two cables to power.
3. All heat-traced lines must be thermally insulated with fiberglass or equivalent thermal conductivity factor. Refer to Table 4.1 on page 10 for insulation information.

Basis for a Good Design . . .

Step 1: Identify Piping Which Requires Heat Tracing

Typically, the main and branch lines 20 mm and larger are the primary applications for a WarmTrace hot water temperature maintenance system. Where a recirculation system would only be able to provide temperature maintenance within the recirculation loop, a heat-traced line can maintain hot water to every point of use. Systems which have different pressure or temperature zones can be easily accommodated in the design and layout of HSX heating circuits.

Determining the amount of piping that will require heat tracing is easy. The extent of the heat tracing is dictated by the layout of the building and the need for water conservation.

Deciding on how close to the point of use the heat tracing should be installed is dependent on the following conditions:

- The litres per minute (LPM) of the fixture.
- The diameter of the "runout" line.
- The number of times per day the fixture will be used.
- Any acceptable time period waiting on water to get hot.
- Any acceptable level of water waste per fixture per use.
- Special requirements at the point of use.

A wait of 15 or 20 seconds for the water to get hot at a utility room mop sink may be acceptable; however, it would not be appropriate for a public washroom. Here the need to have water hot when the tap is operated would dictate installing heating cable to the rough-in point.

Most new facilities require the use of lavatory and shower fixtures that have LPM flow limits. As a result, the length of piping not recirculated or heat traced has become increasingly important. Tables 1.1 and 1.2 show the time correlation between fixture flow rate and length of runout piping that is not temperature maintained. Table 1.3 shows the water wasted while waiting for temperatures to reach proper levels where low flow fixtures are used.

Time (in Seconds) for Hot Water to Reach Fixture[1]

Table 1.1 20 mm Nominal Diameter Copper Tubing

Fixture Flow Rate LPM	Distance From End of Heat Tracing Circuit to Point of Use				
	4.6 m	6 m	7.6 m	9 m	12.2 m
3.8	23	30	38	45	60
5.7	15	20	25	30	40
7.6	11	15	19	23	30
9.5	9	12	15	18	24
11.4	8	10	13	15	20
13.2	6	9	11	13	17
15.1	6	8	9	11	15
17.0	5	7	8	10	13
18.9	5	6	8	9	12

Table 1.2 25 mm Nominal Diameter Copper Tubing

Fixture Flow Rate LPM	Distance From End of Heat Tracing Circuit to Point of Use				
	4.6 m	6 m	7.6 m	9 m	12.2 m
3.8	39	51	64	77	103
5.7	26	34	43	51	69
7.6	19	26	32	39	51
9.5	15	21	26	31	41
11.4	13	17	21	26	34
13.2	11	15	18	22	29
15.1	10	13	16	19	26
17.0	9	11	14	17	23
18.9	8	10	13	15	21

Water Wasted (in Litres) While Waiting for Hot Water to Reach Fixture[2]

Table 1.3 Based on Line Diameter/Distance From End of Heat Tracing

Copper Tubing (nom. dia.)	Distance From End of Heat Tracing Circuit to Point of Use				
	4.6 m	6 m	7.6 m	9 m	12.2 m
15 mm	0.7	0.9	1.2	1.4	1.8
20 mm	1.4	1.9	2.4	2.9	3.8
25 mm	2.4	3.3	4.1	4.8	6.5

Notes . . .

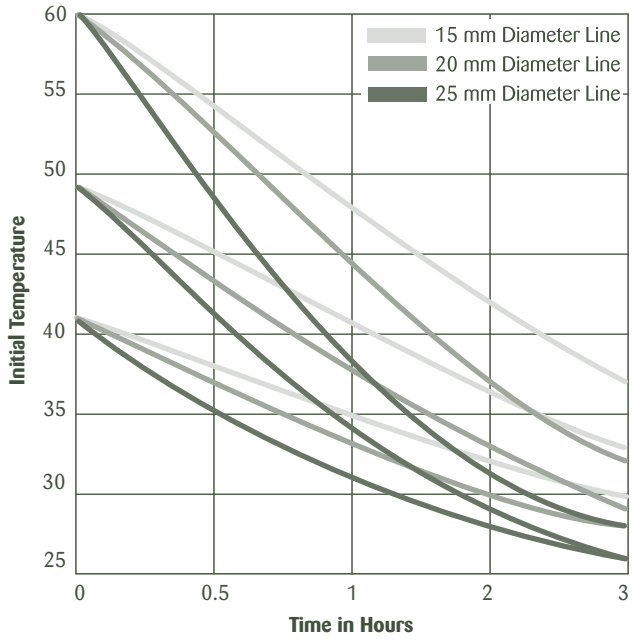
1. Based on flow rates, line diameter and distance from end of temperature maintenance to fixture.
2. Remember to add up all the fixtures throughout a facility and multiply by both the waste number shown plus the expected number of usages per day.

Unheated Water Cools Fast . . .

Although protected by means of the fiberglass or equivalent thermal insulation, hot water lines will lose their heat to the surrounding ambient in a very short period of time.

While Tables 1.1, 1.2 and 1.3 identify the amount of time and/or water lost during the waiting process, Graph 1.1 demonstrates how quickly the cooling process occurs.

Graph 1.1 15 mm, 20 mm & 25 mm Diameter Lines with 25 mm Fiberglass Insulation



Coordinating Design Information . . .

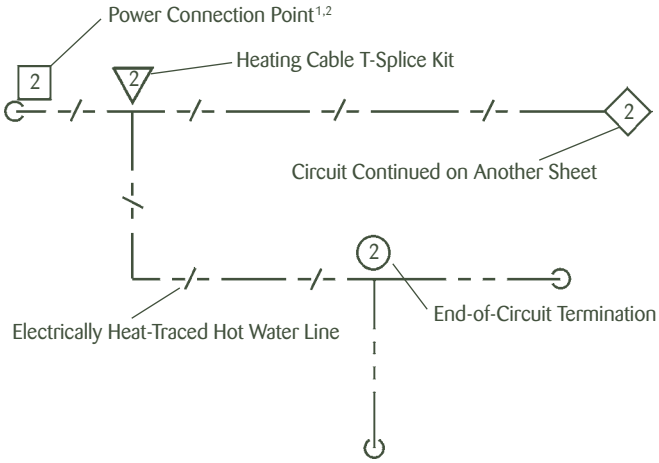
To get the most from each heat tracing circuit, establish the maximum circuit length based on the available circuit breakers for the project. (Note that the maximum circuit lengths will vary based on temperature selection.) Regardless of the shape and size of a building, Thermon recommends that the heat tracing circuits be organized to provide a means of recording the layout of the cable. For ease of identification during the layout process and for effective communication in the contract drawings, it is recommended that the pipes re-quiring heat tracing be identified. This is a simple process that can also include locating power connection points, end terminations and heating cable T-splice locations. The symbols at right are routinely used to show the various components of a heat-traced hot water supply system.

Example: A lavatory tap located in a hospital patient room is used an average of six times per day with a minimum time between each use of one hour.

Design Parameters

Pipe..... 20 mm nominal diameter copper
Insulation ..... 25 mm fiberglass
Maintain temperature ..... 49°C
Ambient temperature..... 24°C
Fixture flow rate ..... 5.7 LPM
Uses per day..... 6 (average)
Time between uses..... 1 hour (minimum)
Unmaintained distance ..... 6 m

After only one hour of non use, the water in the insulated (but not heat-traced) line will drop from the 49°C initial temperature to 38°C. Additionally, each time the tap is opened, 20 seconds will pass before the water gets hot. During this time approximately 1.9 litres of water will be wasted. When these values are extended to every patient room for a 250-bed facility with a 75% occupancy rate, the annual water wasted is significant.



Notes . . .

1. Circuit number is shown inside symbol.
2. While the indication of heating cable, power connection, end termination and T-splice kits are shown on the plumbing drawings, only the power connection points will need referencing on the electrical drawings.

Heat Tracing Horizontal Mains . . .

Designing a heat tracing temperature maintenance system for horizontal mains and branch lines can be done on the plumbing plan drawings. By referring to the heating cable selection chart (see Table 2.1, page 9) for the desired maintain temperature, the maximum heating cable circuit length can be determined for different circuit breaker sizes (refer to Table 3.1, page 9). Coordinating the layout of the hot water lines with the heating cable circuit length information will allow optimum use of the extended circuit lengths possible with HSX.

Note that the main and branch lines are heat traced and insulated while the short runouts are only insulated. (The branches that feed the individual points of use would typically contain minimal amounts of water. If the tap flow rate was above 5.7 litres per minute, hot water would reach the point of use within ten seconds.) Should the distance between the branch line and the runout be much longer or the flow rate be lower, the amount of water potentially wasted and the time required for hot water to reach the point of use may be beyond the acceptable level for the facility. To remedy this condition, simply heat trace closer to the point of use.

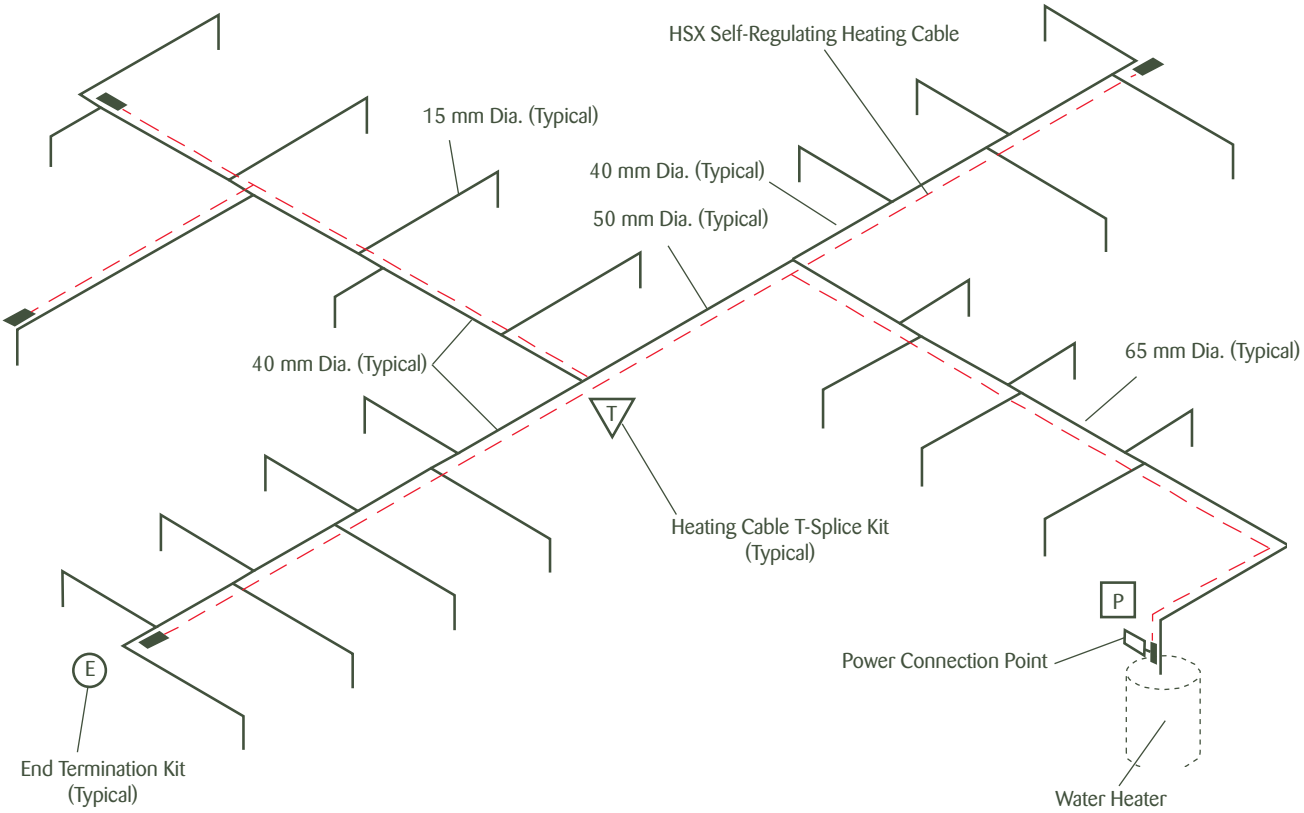


Figure 1.1
Partial Simplified System Typical of Hospitals, Correctional Facilities and Hotels

Heat Tracing Dropper Lines . . .

When the layout of the hot water supply piping results in numerous droppers (with minimal lengths of horizontal branches), only the droppers need heat tracing.

When the horizontal branches from a dropper are long enough to require temperature maintenance, each floor should be treated as a separate heat tracing circuit. This will simplify the layout and installation process plus facilitate future building renovations or expansions.

Bottom-fed systems may require a site-specific design. In these cases it is recommended that the designer/ engineer responsible for the plumbing system contact Thermon.

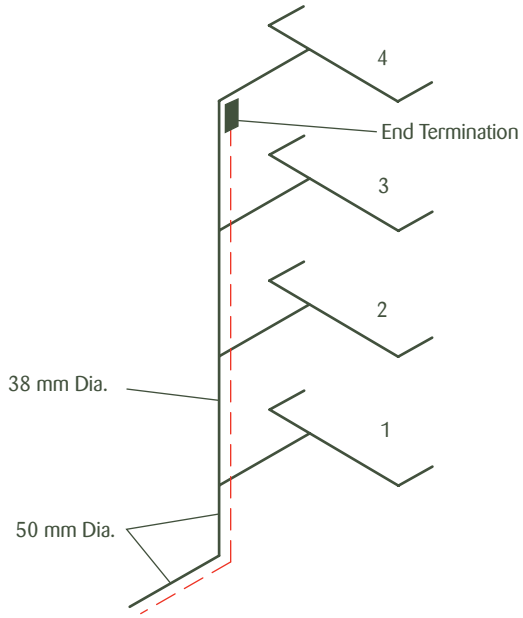


Figure 1.2
Typical Partial Simplified System for High-Rise Buildings

Combining Horizontal Mains with Supply Risers and Droppers . . .

Many multilevel facilities duplicate floor plans over several levels. This practice simplifies the layout of electrical, air handling and mechanical equipment. Hot water supply lines are no exception to this ease of layout unless a maze of recirculation piping and balancing valves are required. Figure 1.3 shows a typical layout found in two- to four-story facilities such as hospitals, research labs, correctional facilities and campus dormitories.

In this example, the supply main is located in the interstitial space between the first-floor ceiling and the second floor. Because each floor has roughly the same layout with water use points stacked, a riser and drop would supply water at each plumbing location. Electric heat tracing has been installed on the horizontal mains and risers. Since the distance between the horizontal piping and the first-floor runouts is minimal (less than 5 m), it would typically not require heating cable beyond the horizontal line connecting the main to the dropper. As the example shown is for a four-story facility, it is recommended that heating cable be installed up to the feed point for the third floor. The line feeding from level three to level four would again be within 5 m and, under most conditions, would not require heat tracing. The untraced lines should be insulated to prevent rapid heat loss between usages.

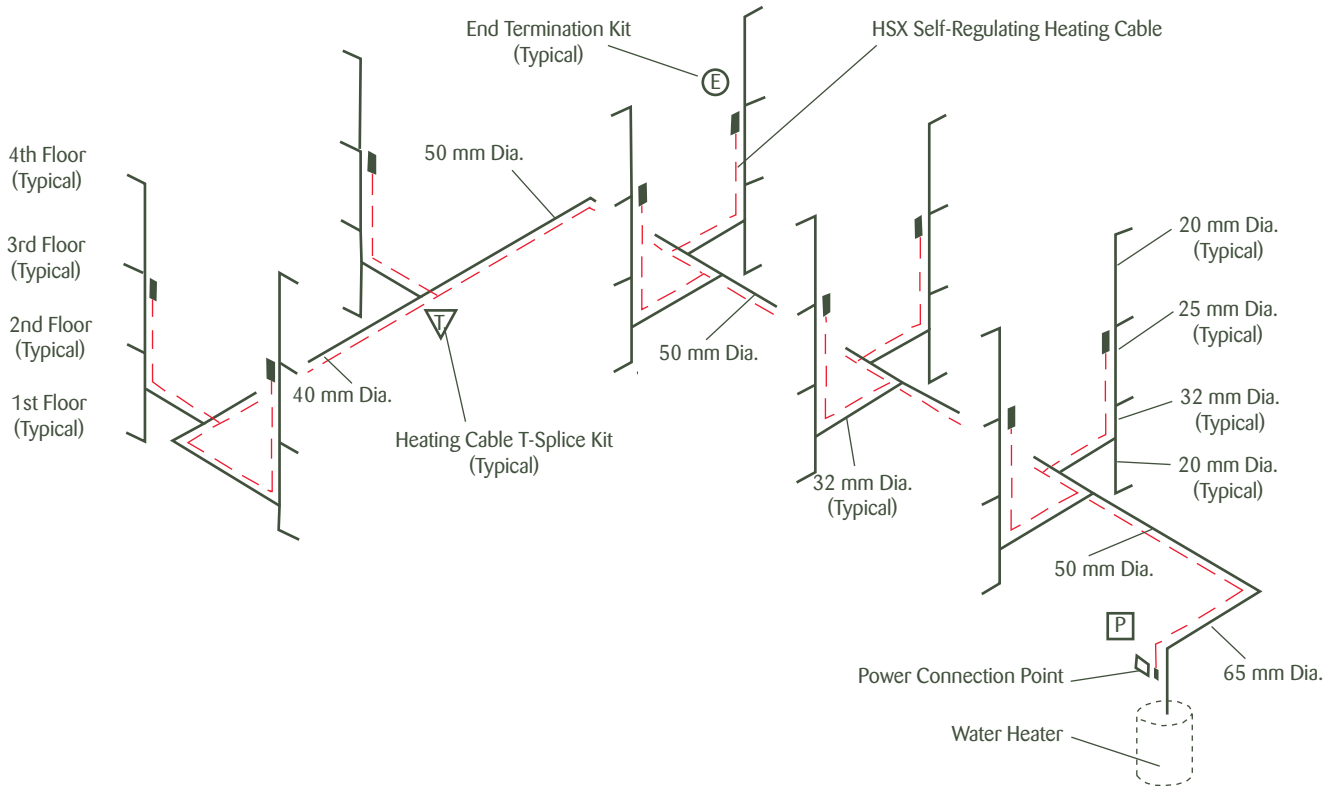


Figure 1.3
Typical Layout for 2- to 4-Story Hospitals, Research Labs, Correctional Facilities and Dormitories

Step 2: Determine the Maintain Temperature and Make Cable Selection

The desired maintenance temperatures for most applications are listed in Table 2.1. Based on the maintain temperature desired, choose the appropriate HSX self-regulating cable. For temperatures other than those shown below, contact Thermon.

Table 2.1 Nominal Maintain Temperature

	45°C	50°C	60°C
	As Consistent with AS/NZ Std. 3500.4.2:1997[1]	As Consistent with AS/NZ Std. 3500.4.2:1997[2]	Kitchens, Laundries
Ambient Range[3]	22°C-27°C	22°C-27°C	22°C-27°C
Cable Jacket Color	Blue	Green	Red
240 Vac Power Supply	HSX 45-2	HSX 50-2	HSX 60-2

Notes . . .

1. Includes hospitals, nursing homes, early childhood centres, primary and secondary schools and similar facilities for young, aged and disabled persons.
2. Includes all other buildings.
3. Ambient temperature ranges below 22°C and above 27°C are possible; contact Thermon.

Step 3: Specify Circuit Breaker Requirements Based on Heat Tracing Circuit Lengths

After determining the extent of the hot water supply piping to be heat traced, determine the quantities to be maintained at 45°C, 50°C and/or 60°C. At this point, the total meterage of each type of HSX self-regulating cable can be determined.

Because HSX is designed specifically for hot water temperature maintenance and is manufactured with 2.3 mm^2 nickel-plated copper bus wires, the maximum circuit length possible is far greater than any other product approved for hot water temperature maintenance. These maximum circuit lengths must be observed to prevent excessive electrical currents in the bus wires of the heating cable. The maximum circuit length is defined as total length of cable that can be fed from a single power connection point, inclusive of all splices and tees. Note that longer circuit lengths may require larger circuit breakers. Be sure to verify the available amperages of the branch circuit breakers supplying power to the heat tracing.

Table 3.1 outlines the maximum lengths possible with each type of HSX self-regulating cable.

Table 3.1 Maximum Circuit Length vs. Circuit Breaker Size

Catalog Number	Service Voltage (Vac)	Steady-State Current Draw[1] amps/m	Breaker Size 10 Amp	Breaker Size 15 Amp
HSX 45-2 (Blue)	240	0.016	230 m	350 m
HSX 50-2 (Green)	240	0.023	125 m	185 m
HSX 60-2 (Red)	240	0.0327	70 m	110 m

Note . . .

1. Steady-state current draw is defined as the theoretical current draw of the heating cable at the desired maintain temperature. Because temperature fluctuations will exist, this current should be used for reference purposes only. Current during start-up when the water in the piping is at ambient temperature will be greater and should be accounted for when sizing circuit breakers.
2. Longer circuit lengths may be possible, please consult Thermon for design assistance.
3. Maximum published circuit lengths are based on the use of “C” Type circuit breakers.

Step 4: Specify Insulation Thickness

The following information should be made part of the thermal insulation specification. Variations to this insulation schedule may result in different maintain temperatures.

Table 4.1 Fiberglass Insulation Specifications for WarmTrace Systems

Insulation Thickness	Nominal Pipe Size	Nominal Insulation Size
25 mm	15 mm	20 mm
	20 mm	25 mm
	25 mm	32 mm
38 mm	32 mm	40 mm
	40 mm	40 mm
	50 mm	50 mm
50 mm	65 mm	65 mm
	80 mm	80 mm
	100 mm	100 mm

Notes . . .

1. This insulation schedule is applicable for 45°C, 50°C and 60°C WarmTrace systems.
2. All selections are based on using fiberglass insulation with an aluminum foil moisture vapour barrier (consistent with ASTM Std C-547). Other types of thermal insulation with equivalent thermal conductivity properties may also be used. If in doubt, consult Thermon.
3. To accommodate the heating cable on copper piping that is 32 mm or less in diameter, the thermal insulation will need to be one line size larger than the nominal pipe diameter.
4. Allowances are based on one single pass of heating cable. Consideration should be given to areas of additional heat loss (pipe supports, floor penetrations, valves, etc.). If in doubt, contact Thermon.
5. Installation of insulation shall be carried out to Australia Standards No. AS 4426 - Thermal insulation of pipework, ductwork and equipment - selection, installation and finish.
6. WarmTrace systems installed outside are not addressed in this design guide, please contact Thermon for design assistance.

General Specification

Part 1 . . . General

Furnish and install a complete UL Listed system of heaters and components approved specifically for maintaining hot water at selected temperatures. The heat tracing system shall conform to ANSI/IEEE Standards 515 and 515.1 and be consistent with AS/NZ Std. 3500.4.2 temperature delivery requirements.

Part 2 . . . Products

1. The self-regulating heater shall consist of two 2.3 mm^2 nickel-plated copper bus wires embedded in parallel in a radiation cross-linked self-regulating conductive polymer core specifically designed for hot water temperature maintenance. The heater shall be capable of varying its heat output along its entire length to maintain the water in the selected temperature range. The heater shall be covered by a polyolefin dielectric jacket rated 300 Vac at 105°C, foil wrap, a tinned-copper braid (2.3 mm^2 equivalent wire size) and a nominal 1 mm polyolefin outer jacket color-coded for easy identification.
2. The heater shall operate on a line voltage of 240 Vac without the use of thermostats.
3. Self-regulating cable must be designed and specifically approved for maintaining hot water. Cables used for freeze protection of water lines will not be allowed.
4. All heating cable core will be permanently marked with the manufacturer's identification number for traceability.
5. Quality assurance test certificates are to accompany each reel of heating cable signed by the manufacturer's quality control officer. Certificates are to indicate cable type, cable rating, watts/meter, voltage rating, test date, batch number, reel number and length of cable, test voltage and test amperage reading.
6. Acceptable products and manufacturers: HSX® as manufactured by Thermon.
7. Refer to the manufacturer's "Hot Water Temperature Maintenance Design Guide" for design details, insulation requirements, maximum circuit lengths and accessory information.

Part 3 . . . System Performance

1. Heat-traced and insulated piping shall maintain nominal hot water temperatures in the supply lines at (select 45°C, 50°C, 60°C) when powered at 240 Vac.
2. For each hot water maintenance temperature selected, only one product will be allowed. All cables must be installed in parallel passes; no spiral wrapping will be allowed.
3. Power retention of the heating element shall be in accordance with Australian/IEEE Standard 515.1, Item 4.2.6, Performance After Thermal Aging.

Part 4 . . . Manufacturer

1. The manufacturer shall demonstrate experience maintaining hot water supply lines with self-regulating heating cables. This experience may be documented with a list of ___ projects utilizing at least 600 metres of self-regulating heating cable specifically for hot water temperature maintenance.
2. Heating cable shall be QAS Certified, License Number SMK 02408.

Part 5 . . . Installation

1. Heating cable shall be installed on the hot water supply piping in areas indicated on the plumbing drawings.
2. Refer to the manufacturer's installation instructions (Form CPD1014A) and design guide (Form TEP0013A) for proper installation and layout methods. Deviations from these instructions could result in peformance characteristics different than intended.
3. All installations and terminations must conform to any applicable national or local code requirements.
4. Circuit breakers supplying power to the heat tracing must be equipped with 30 mA minimum ground-fault equipment protection.
5. Hot water lines shall be pressure tested prior to installation of heating cable and thermal insulation. Thermal insulation shall not be installed until heating cable installation is complete and a megohmeter (megger) test has been passed (see Testing below). Heat-traced hot water lines shall be insulated within two weeks of the heat tracing installation.
6. The insulation shall not be installed with staples. Insulation jackets should be closed with tape or adhesive to avoid damage to the heating cable.
7. All drops, runouts, valves, tees and elbows on domestic hot water piping shall be insulated in accordance with the insulation specification.
8. Heating cables shall be installed to within _____ metres of fixtures.
9. System shall be connected to power by the electrician.

Part 6 . . . Testing

1. Heating cable shall be tested with a 2,500 Vdc megohmeter (megger) between the heating cable bus wires and the heating cable metallic braid. While a 2,500 Vdc megger test is recommended, the minimum acceptable level for testing is 1,000 Vdc. This test should be performed a minimum of three times:
   a. Prior to installation while the cable is still on reel(s).
   b. After installation of heating cable and completion of circuit fabrication kits (including any splice kits) but prior to installation of thermal insulation.
   c. After installation of thermal insulation but prior to installation of wall or ceiling materials.
2. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.
3. Test shall be witnessed by the construction manager for the project and the heating cable manufacturer or authorized representative. Results of the megger readings shall be recorded and submitted with the operation and maintenance manuals at the completion of the project.

Product Approvals, Tests, Compliances . . .

Thermon's WarmTrace HSX carries the following major agency approvals:

No. 2043400

AS ANSI IEEE 515.1
Lic SMK2408
Standards Australia

Underwriters Laboratories Inc.®: HSX cables and accessories are UL Listed specifically for hot water temperature maintenance (Pipe Heating Cable 134N).

Canadian Standards Association: HSX cables and accessories are CSA certified for the intended application.

Other approvals for HSX heating cables and accessories are also in place. Contact Thermon for additional information.

HSX self-regulating heating cables and accessories comply with all aspects of ANSI/IEEE Standards 515 and 515.1.

HSX Cables Meet or Exceed the Following Tests . . .

Test	Standard Followed
Abrasion Resistance	UL 1588 (8.3); AS/IEEE 515.1 (4.3.4)
Elevated Temperature	AS/IEEE 515.1 (4.2.5)
Deformation	AS/IEEE 515.1 (4.2.8)
Dielectric Withstand	AS/IEEE 515.1 (4.2.1)
Resistance to Impact	UL 1588 (8.2)
Resistance to Cutting	AS/IEEE 515.1 (4.3.3)
Resistance to Crushing	UL 1588 (8.1)
Temperature	UL 1588 (9.1-9.3); AS/NZ Std. 3500.4.2:1997
Vertical Flame	UL 1588 (8.5)
Thermal Stability	Thermon OP 7.24
Self-Regulating Index	Thermon OP 7.94

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