Steam Tracing
DESIGN GUIDE

THERMON

The Heat Tracing Specialists®

Steam Tracing

DESIGN GUIDE

Contents

For additional information about steam tracing, please refer to the Steam Tracing Specification Guide (Thermon Form TSP0010U) or contact TC-E.

Steam Tracing

Introduction . . .

All too often an old steam tracing specification or previously adopted practices are followed which overlook new product developments or improvements. Today there are more types of steam tracers to choose from than ever before, providing a range of conductances to closely match the actual heat requirements for a given pipe heating system. By maximising performance with a range of steam tracers while minimising the total cost of unnecessary components, the cost of ownership for a steam tracing system is optimised.

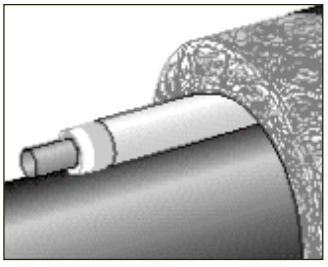
This design guide addresses the steam tracing requirements of piping and equipment by matching the heating requirements with the type of steam tracer best suited for that application. The information contained in this design guide will take the reader through a step-by-step procedure to make proper steam tracer selections based on:

- Pipe size
- Thermal insulation type and thickness
- Desired maintain temperature range
- Maximum exposure temperature limitations
- Minimum ambient temperature

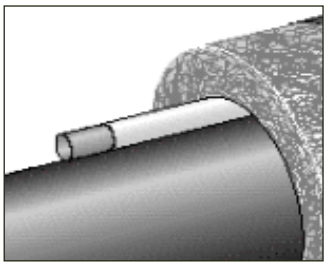
After following the prescribed steps in this design guide, the reader will be able to design, select and/or specify or establish a bill of materials for a steam tracing system.

For applications ranging from freeze protecting water lines to maintaining elevated process temperatures as high as 677°C, Thermon has a tracing product to fit the application. These product families are distinctly broken down into three groups: isolated tracers, bare convection tracers and conduction tracers.

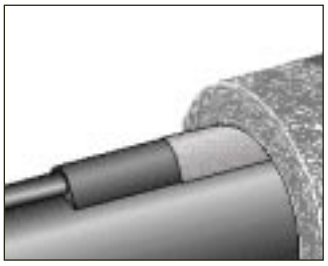
Isolated Tracers . . . Designed for use with low to medium-low heat requirements, Thermon's SafeTrace™ SLS-IT and DLS-IT are metallic tracer tubes covered with composite materials that lower thermal conductance to reduce heat output and temperature. The reduced heat output of SafeTrace SLS-IT and DLS-IT is predictable to ensure controlled heat distribution along the length of a traced pipe without hot spots or overheating. These tracers also utilise a safety yellow identification jacket to signify the presence of inherently dangerous materials such as steam. A feature unique to SafeTrace SLS-IT and DLS-IT is their ability to run continuously from the steam supply manifold, along the pipe and to the condensate return manifold.



Convection Tracers . . . By using bare tracers or SafeTrace BTS tracers, convection tracing provides medium-low to medium heat transfer requirements. SafeTrace BTS is a metallic tracer tube covered with a special high temperature polymer jacket that provides a measure of personnel burn protection without sacrificing thermal performance. The safety yellow jacket also provides corrosion resistance to most acids and alkalis.



Conduction Tracers . . . When the heat requirements exceed the capabilities of isolated and convection tracers, tracers aided by heat transfer compounds should be used. Thermon's heat transfer compounds, available in a wide variety of configurations to meet the application requirements, provide excellent heat transfer at a fraction of the cost of a jacketed pipe system while eliminating the possibility of product contamination. The heat transfer properties of Thermon's compounds are so good that a single tracer utilising heat transfer compound will do the work of three to five bare tracers.



Computer-Aided Design Program . . .

Thermon has developed a sophisticated yet easy-to-use computer program, CompuTrace™, that provides detailed design and performance information. Users of CompuTrace are able to input application-specific information into the program and obtain detailed performance information. Calculations made within the program are based on universally accepted process heat transfer equations.

The information input to and/or generated from CompuTrace can be printed and summary reports, including "condensate load" information, exported for use in other programs. While CompuTrace is a valuable asset to use in designing a steam tracing system, the design steps detailed in this guide will still form the basis for identifying the design process necessary to establish a properly functioning steam tracing system.

Steam Tracing Design Outline . . .

The six steps below outline the design and selection process for a steam tracing system. The step-by-step procedures that follow the outline will provide the reader with the detailed information required to design, select and/or specify a fully functional steam tracing system.

Step 1: Establish Design Parameters

Collect relevant project data:

a. Piping/equipment
   - Diameter – Length

b. Temperature
   - Low ambient
   - Maintain temperature
   - High temperature – Limits/excursions

c. Insulation
   - Type – Thickness – Oversized?

d. Availability of steam
   - Pressure
   - Location

Step 2: Select the Proper Thermon Steam Tracing Method

Using information gathered in Step 1 and based on:

a. General selection tables

b. CompuTrace computer design program

Step 3: Identify Base Maintain Temperature

Using supplied tables and based on:

a. Pipe size

b. Insulation thickness

c. Steam pressure

d. Tracer type and quantity

Step 4: Apply Any Adjustment Factors

Based on:

a. Different low ambient temperatures

b. Different thermal insulation types

Step 5: Determine Steam Tracing Circuit Lengths

Based on:

a. Steam pressure

b. Quantity of tracers

c. Tracer tubing diameter

d. Adjustments for accumulated vertical tracer rise, elbows and bends

Step 6: Choose Options/Accessories

Based on:

a. Tracer type

b. Attachment method

Basis for a Good Design . . .

Every steam tracing design will involve six design factors of which three are given (fixed) and three are variable. The given factors are: nominal pipe size, desired maintain temperature and low ambient temperature. The variable factors are: tracer type, size and number; steam pressure (temperature); and insulation type and thickness. Establishing a balance amongst the variable factors will provide maintain temperatures within the desired range. Conversely, should any of the variable factors deviate, the balance will be upset and the temperature could be outside of the desired range.

To become familiar with the requirements of a properly designed steam tracing system, use the six design steps detailed below and on the following pages. Once comfortable with the steps and the information required, apply these steps to any size steam tracing project.

Step 1: Establish Design Parameters

Collect information relative to the following design parameters:

Application Information . . .

- Pipe sizes
- Pipe lengths
- Type and number of valves, pumps or other equipment
- Type and number of pipe supports

Expected Minimum Ambient Temperature . . . Generally, this number is obtained from weather data compiled for an area and is based on recorded historical data. There are times, however, when the minimum ambient will not be the outside air temperature. Examples include pipes and equipment located underground or inside buildings.

Desired Maintain Temperature . . . While the desired temperature might be a specific value, there will usually exist a temperature range where the product can effectively exist without any damage or upset. Any temperature extreme that could result in product or equipment damage should be noted to ensure this point is not reached.

Insulation Material and Thickness . . . While the type and thickness of insulation should be a variable in the design equation, there are times where a plant specification dictates a specific insulation standard. The selection tables in this design guide are based on calcium silicate insulation with thicknesses as shown in the various tables. If insulation materials other than calcium silicate are used, refer to the insulation correction factors shown in Table 4.2 or contact TC-E for design assistance.

Steam Tracing

Step 2: Select the Proper Thermon Steam Tracing Method

For a steam tracing system to perform at optimum levels, choose the type of tracer that most closely meets the process design requirements using Table 2.1.

Table 2.1 Process Temperature vs. Tracer Type

Process Temperature Range	Tracer Type
Low 10°-38°C	Isolated
Medium-Low 39°-66°C	Isolated/Convection
Medium 67°-93°C	Convection/Conduction
Medium-High 94°-149°C	Conduction
High 150°-204°C	Conduction

Proper selection will avoid the effects of overheating and conserve energy. Where possible use only one tracer per process pipe (certain critical process lines may require a redundant heater). This will reduce the number of trap stations, isolation valves and fittings required while eliminating future maintenance on omitted materials.

After determining the tracer type, use Table 2.2 to establish the proper insulation thickness based on the temperature range to be maintained for a given nominal pipe size[1].

Table 2.2 Typical Insulation Thickness (mm)

Pipe Size mm	Temperature Range				
	10°-38°C	39°-66°C	67°-93°C	94°-149°C	150°-204°C
40	25	25	25	25	25
50	25	25	25	25	25
80	25	25	25	25	25
100	25	40	40	40	40
150	25	40	40	40	50
200	40	40	40	50	50
250	40	40	50	50	50
300	40	40	50	50	50
350	40	40	50	50	64
400	40	50	50	50	64
450	40	50	50	64	64
500	50	50	50	64	64
600	50	50	50	64	64
750	50	50	50	64	75

To obtain more accurate design results and view what effects changing any of the variable inputs may have on the maintenance temperature, use Thermon's CompuTrace computer-aided design and selection software program. Available on request from Thermon, this program provides accurate steam tracing performance data and load chart information that can be exported.

Step 3: Identify Base Maintain Temperature

Apply the fixed design factors established in Step 1 and the variable design factors selected in Step 2 to Tables 3.1 through 3.4 (see below for determining which table to use). Each table is divided based on tracer type with rows denoting the nominal pipe diameter and columns denoting steam pressure (temperature) and number of tracers. All of the tables are based on a minimum ambient temperature of -18°C and a wind speed of 11 m/s.

Process Temperature Maintenance (SI System)

Tracer Type	Steam Pressure	Table
Bare/BTS & Isolated	205, 308, 446 & 618 kPa	3.1
Bare/BTS & Isolated	791, 1136, 1480 & 1825 kPa	3.2
Heat Transfer Compound	205, 308, 446 & 618 kPa	3.3
Heat Transfer Compound	791, 1136, 1480 & 1825 kPa	3.4

Example . . . A process line requires steam tracing. The particulars for the line are:

Pipe diameter ..... 250 mm
Desired maintain temperature ..... 120°C
Insulation thickness ..... 50 mm
Steam pressure (temperature) ..... 791 kPa (170°C)
Minimum ambient/wind speed ..... -18°C/11 m/s

Table 2.1 identifies the application as a "medium-high" temperature category and indicates the need for a conduction heater using heat transfer compound. Table 2.2 identifies that for a 250 mm diameter pipe maintaining 120°C, 50 mm thick insulation is needed. Based on these factors, use Table 3.4 to determine that one 10 mm or 12 mm diameter tube tracer with heat transfer compound will provide the desired maintain temperature.

Note . . .

1. Table is based on calcium silicate insulation oversized by one nominal pipe size to accommodate tracer. Refer to Table 4.2 for details on using other insulation materials.

Table 3.1 Process Temperature Maintenance (°C) ..... IT, BT or BTS Tracers

Nominal Pipe Size mm	Nominal Insulation Thickness mm	Steam Pressure in kPa											
		205 kPa 121°C			308 kPa 134°C			446 kPa 148°C			618 kPa 160°C		
		DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare
40	25	33	46	65	38	53	82	43	59	82	48	65	90
	40	41	55	73	48	63	86	54	70	91	59	77	100
	50	46	59	76	52	67	92	59	75	95	65	82	104
50	25	27	40	60	32	46	68	37	52	76	41	57	83
	40	36	49	68	42	56	77	48	63	86	53	70	94
	50	41	54	72	47	61	89	53	69	99	59	75	99
80	25	20	31	50	24	36	56	28	41	64	32	46	70
	40	29	41	59	34	47	67	39	53	75	44	59	82
	50	34	46	64	39	52	72	45	59	80	49	77	88
100	25	14	24	42	18	28	48	22	32	55	25	36	60
	40	23	33	53	27	38	60	32	44	67	36	49	73
	50	28	38	57	32	44	65	37	50	73	42	68	80
150	25	7	12	27	10	16	32	12	19	37	15	22	41
	40	15	21	38	18	26	44	22	30	49	25	34	55
	50	19	26	43	23	31	49	38	35	56	30	40	75
200	40	9	13	29	11	17	34	15	20	39	17	23	44
	50	12	18	34	16	21	40	19	25	45	22	29	50
	80	22	28	45	26	32	52	30	37	59	34	42	65
250	40	5	10	24	8	12	28	10	15	33	12	18	37
	50	9	13	29	11	17	34	14	20	39	17	23	43
	80	17	23	40	21	27	46	24	31	52	28	35	58
300	40	--	6	20	--	9	24	6	11	28	9	14	31
	50	6	10	25	8	13	29	10	16	34	13	18	38
	80	13	19	36	17	23	41	20	27	47	23	30	52
350	40	--	5	18	--	7	22	5	10	26	7	12	29
	50	--	9	23	7	11	27	9	14	31	11	17	35
	80	12	17	34	15	21	39	18	25	45	21	28	50
400	40	--	--	15	--	5	18	--	7	22	5	10	25
	50	--	6	20	--	9	24	6	11	28	9	14	31
	80	10	15	31	12	18	36	15	22	41	18	25	45
450	40	--	--	12	--	--	16	--	5	19	--	7	22
	50	--	--	17	--	7	21	--	9	24	7	11	28
	80	8	12	28	10	16	33	13	19	37	16	22	42
500	40	--	--	10	--	--	13	--	--	16	--	5	19
	50	--	--	15	--	--	18	--	7	22	5	9	25
	80	6	10	25	8	13	30	11	16	34	13	19	39
600	40	--	--	7	--	--	10	--	--	12	--	--	15
	50	--	--	11	--	--	14	--	--	17	--	6	20
	80	--	7	21	5	10	25	7	12	29	10	15	33
750	40	--	--	--	--	--	--	--	--	--	--	--	--
	50	--	--	--	--	--	--	--	--	--	--	--	--
	80	--	--	--	--	--	--	--	--	--	--	--	--

Notes . . . Tables 3.1 and 3.2 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. Bare tracers are 12 mm O.D. tubing to provide for economical trap distances. Isolated tracers have 10 mm O.D. tubing. Use Table 4.1 to adjust for ambient temperatures other than -18°C.

For pipe temperatures below 27°C, consider using cellular glass or other insulation materials with a low moisture permeability.

Steam Tracing

Table 3.2 Process Temperature Maintenance (°C) ..... IT, BT or BTS Tracers
Ambient Temperature: -18°C, Wind: 11 m/s, Insulation: Calcium Silicate

Nominal Pipe Size mm	Nominal Insulation Thickness mm	Steam Pressure in kPa											
		791 kPa 170°C			1136 kPa 185°C			1480 kPa 198°C			1825 kPa 208°C		
		DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare	DLS-IT Isolated	SLS-IT Isolated	BT or BTS Bare
40	25	52	70	96	57	78	104	62	82	112	65	87	118
	40	64	82	106	70	90	116	75	96	124	80	102	130
	50	69	88	111	76	96	121	82	103	129	87	108	136
50	25	44	62	88	49	68	97	53	73	104	57	77	109
	40	57	74	100	63	82	109	67	88	117	72	92	123
	50	63	80	105	69	88	115	74	94	123	79	100	129
80	25	35	50	75	39	55	82	43	60	88	46	63	93
	40	47	63	88	52	69	96	57	74	103	60	79	108
	50	53	69	94	59	76	102	63	82	109	67	86	115
100	25	27	39	65	31	44	71	34	48	76	36	51	81
	40	39	52	79	43	58	86	47	62	92	50	66	97
	50	45	59	85	50	65	93	54	70	99	57	74	105
150	25	16	25	45	19	28	49	22	31	54	24	33	57
	40	27	37	59	31	41	65	34	45	70	36	48	74
	50	33	43	66	37	48	72	40	52	78	43	55	82
200	40	19	26	47	22	29	52	25	32	56	27	34	60
	50	25	31	54	28	35	60	31	39	64	33	41	68
	80	37	45	69	41	50	76	45	54	81	48	57	86
250	40	14	20	40	16	23	45	19	26	48	21	28	52
	50	19	26	47	22	29	52	24	32	56	26	34	60
	80	31	39	62	34	43	68	38	47	73	41	50	78
300	40	10	15	34	12	18	38	14	20	42	16	22	45
	50	14	21	41	17	24	45	19	27	49	21	29	53
	80	26	33	56	29	37	62	32	41	66	34	43	70
350	40	9	14	32	11	16	36	12	18	39	14	20	42
	50	13	19	38	15	22	43	17	24	47	19	26	50
	80	24	31	53	27	35	59	30	38	64	32	41	68
400	40	6	11	28	8	13	32	10	15	35	11	17	37
	50	10	15	34	12	18	38	14	21	42	16	23	45
	80	20	27	49	23	31	54	26	34	59	28	37	62
450	40	--	9	25	6	10	28	7	12	31	9	14	33
	50	8	13	31	10	15	35	11	17	38	13	19	41
	80	17	24	45	20	28	50	23	30	54	25	33	58
500	40	--	7	21	--	9	25	5	10	27	6	11	30
	50	6	10	27	8	13	31	10	15	34	10	16	37
	80	15	21	42	18	25	46	20	27	50	22	29	53
600	40	--	--	17	--	5	20	--	6	22	--	8	24
	50	--	7	22	--	9	25	6	10	28	7	12	30
	80	11	17	36	13	20	40	15	22	43	17	24	47
750	40	--	--	--	--	--	--	--	--	--	--	--	--
	50	--	--	--	--	--	--	--	--	--	--	--	--
	80	--	--	--	--	--	--	--	--	--	--	--	--

Notes . . . Tables 3.1 and 3.2 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. Bare tracers are 12 mm O.D. tubing to provide for economical trap distances. Isolated tracers have 10 mm O.D. tubing. Use Table 4.1 to adjust for ambient temperatures other than -18°C.

For pipe temperatures below 27°C, consider using cellular glass or other insulation materials with a low moisture permeability.

Table 3.3 Process Temperature Maintenance (°C) ..... HTC Tracers
Ambient Temperature: -18°C, Wind: 11 m/s, Insulation: Calcium Silicate

Nominal Pipe Size mm	Nominal Insulation Thickness mm	Steam Pressure in kPa											
		205 kPa 121°C			308 kPa 134°C			446 kPa 148°C			618 kPa 160°C		
		One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers
40	25	107	--	--	120	--	--	132	--	--	144	--	--
	40	109	--	--	122	--	--	135	--	--	147	--	--
	50	110	--	--	123	--	--	136	--	--	148	--	--
50	25	104	110	--	117	122	--	129	135	--	140	147	--
	40	107	111	--	120	124	--	132	137	--	144	149	--
	50	108	112	--	121	125	--	134	138	--	146	150	--
80	25	100	107	--	111	119	--	123	132	--	134	144	--
	40	104	109	--	116	122	--	128	135	--	139	147	--
	50	105	110	--	117	123	--	130	136	--	141	148	--
100	25	95	103	107	106	115	120	118	127	132	128	139	144
	40	100	107	110	112	119	122	124	131	135	135	143	147
	50	102	108	111	114	120	123	126	133	137	137	145	149
150	25	87	100	103	97	111	115	107	123	128	117	134	139
	40	94	104	107	104	116	119	116	128	134	126	140	144
	50	96	105	108	108	118	121	125	131	137	130	142	146
200	40	87	100	104	97	112	116	108	124	128	118	134	140
	50	91	102	106	102	114	118	112	126	131	122	137	142
	80	97	106	109	109	118	121	120	131	134	131	142	146
250	40	79	94	100	88	106	111	98	117	124	107	127	134
	50	83	98	102	93	109	114	103	120	126	112	131	137
	80	91	102	106	102	114	118	113	126	131	123	138	142
300	40	67	86	93	76	96	104	84	107	116	92	117	126
	50	73	90	96	82	101	108	91	111	119	99	121	130
	80	83	97	102	92	108	114	102	120	126	111	130	137
350	40	60	80	88	67	90	99	75	99	110	82	108	119
	50	65	84	92	73	94	103	82	105	114	89	114	124
	80	76	92	99	85	103	110	94	114	122	103	124	132
400	40	49	71	81	56	80	90	62	88	100	68	96	109
	50	55	76	85	62	85	95	69	94	105	76	103	115
	80	67	85	93	75	95	104	83	106	115	91	115	125
450	40	46	68	78	52	76	88	58	85	97	64	93	106
	50	52	73	83	58	82	93	65	91	103	71	99	112
	80	64	83	91	72	93	102	80	103	113	87	112	123
500	40	43	65	76	49	73	85	55	81	94	60	89	103
	50	49	71	81	55	79	90	62	88	100	68	96	109
	80	61	81	90	68	91	100	77	101	111	84	110	121
600	40	38	60	71	43	68	80	49	75	89	54	82	97
	50	43	66	76	49	74	86	56	82	95	61	90	104
	80	56	77	86	63	86	96	71	96	107	77	104	117
750	40	31	54	66	36	60	73	41	68	82	45	74	89
	50	37	39	71	42	67	79	48	75	89	52	81	97
	80	49	71	82	55	80	91	63	89	102	68	97	110

Notes . . . Tables 3.3 and 3.4 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. Tracers are 10 or 12 mm O.D. tubing with TFK-4 channel. Use Table 4.1 to adjust for ambient temperatures other than -18°C.

With HTC and channel, the contact area is the same for 10 or 12 mm O.D. tracers; therefore, the pipe temperature is the same for either tracer under like conditions.

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Table 3.4 Process Temperature Maintenance (°C) ..... HTC Tracers
Ambient Temperature: -18°C, Wind: 11 m/s, Insulation: Calcium Silicate

Nominal Pipe Size mm	Nominal Insulation Thickness mm	Steam Pressure in kPa											
		791 kPa 170°C			1136 kPa 185°C			1480 kPa 198°C			1825 kPa 208°C		
		One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers
40	25	153	--	--	166	--	--	177	--	--	186	--	--
	40	156	--	--	169	--	--	180	--	--	190	--	--
	50	157	--	--	170	--	--	182	--	--	191	--	--
50	25	149	156	--	162	170	--	173	181	--	182	191	--
	40	153	158	--	166	172	--	177	184	--	186	194	--
	50	155	160	--	168	174	--	179	185	--	188	197	--
80	25	142	152	--	155	165	--	165	176	--	174	190	--
	40	148	156	--	161	169	--	171	180	--	180	191	--
	50	150	157	--	163	171	--	174	182	--	183	194	--
100	25	136	147	153	148	160	166	158	170	177	166	179	186
	40	143	152	156	155	165	170	165	176	181	174	185	191
	50	146	154	158	158	167	171	174	178	183	178	188	192
150	25	124	142	148	135	155	160	144	165	171	152	173	180
	40	134	148	152	145	161	166	155	172	176	163	181	186
	50	138	151	154	149	163	168	160	174	179	168	183	188
200	40	125	143	148	136	155	161	145	165	172	153	174	181
	50	130	146	151	141	158	164	151	169	175	158	178	184
	80	139	151	155	151	164	169	161	175	179	169	184	189
250	40	113	135	143	124	147	155	132	156	165	139	165	174
	50	120	139	146	130	151	158	139	161	169	146	169	178
	80	130	146	151	142	159	164	151	169	175	159	178	185
300	40	98	124	134	107	134	145	114	143	155	120	151	163
	50	105	129	138	114	140	150	122	149	160	128	157	168
	80	118	138	145	128	150	158	137	160	168	144	168	177
350	40	87	115	126	95	125	137	102	134	147	107	140	154
	50	95	121	131	103	132	143	110	140	153	116	148	160
	80	109	132	140	119	143	153	127	153	163	134	161	171
400	40	73	103	116	80	112	126	85	119	134	90	125	142
	50	81	109	122	88	119	133	94	127	141	99	134	149
	80	96	122	133	105	133	144	112	142	154	118	149	162
450	40	68	98	112	75	107	122	80	115	131	85	121	137
	50	76	106	119	83	115	129	89	122	138	94	129	145
	80	93	119	130	101	130	142	108	138	151	113	146	159
500	40	64	95	109	71	103	119	76	110	127	80	116	134
	50	72	102	116	79	111	126	85	118	134	89	125	141
	80	89	116	128	97	127	139	104	135	148	109	142	156
600	40	58	88	103	63	96	112	68	102	120	72	108	126
	50	65	95	110	72	104	120	77	111	128	81	117	135
	80	82	111	124	90	121	134	96	129	143	101	135	151
750	40	49	79	95	54	86	103	58	92	111	61	97	117
	50	56	87	103	62	94	111	67	101	119	70	107	126
	80	73	103	117	80	112	127	86	120	136	90	126	143

Notes . . . Tables 3.3 and 3.4 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. Tracers are 10 or 12 mm O.D. tubing with TFK-4 channel. Use Table 4.1 to adjust for ambient temperatures other than -18°C.

With HTC and channel, the contact area is the same for 10 or 12 mm O.D. tracers; therefore, the pipe temperature is the same for either tracer under like conditions.

Step 4: Apply Any Adjustment Factors

Ambient Temperature . . . If the minimum ambient will differ from the base level of -18°C established in Step 3, use Table 4.1 to apply an ambient correction factor. Multiply this coefficient by the difference in the ambient temperature and apply the result to the maintain temperature.

Insulation Materials . . . When insulation material other than calcium silicate is used, it will be necessary to apply an insulation correction factor. Use Table 4.2 to add or subtract the applicable value to the temperature maintenance value established in Step 3.

Note: If both the ambient temperature and the insulation material differ from the -18°C and calcium silicate base values established in Step 3, apply the ambient temperature change first followed by the insulation material change.

Examples . . . Using the information from the example on page 4:

1. What would be the effect on the pipe maintain temperature if the ambient temperature was -29°C instead of -18°C?

   Locate the 250 mm diameter pipe size and 50 mm thick insulation rows under the one heat transfer compound (HTC) column to find a coefficient multiplier of 0.24. Multiply this value by the ambient temperature change: **0.24 x 11 = 2.6°C**

   Rounding 2.6 to the nearest whole value results in 3°C. Subtracting this number from the 120°C pipe temperature previously established results in a new maintain temperature of 117°C.

2. What would be the effect on the pipe maintain temperature if the thermal insulation was mineral wool?

   In the mineral wool column of Table 4.2, find the appropriate value for a 250 mm diameter line utilising one HTC tracer. Apply this value (12.8°C) to the 120°C maintain temperature established in Step 3 to obtain a new maintain temperature of 132.8°C.

Table 4.1 Ambient Temperature Adjustment Factors
Maintain Temperature Change Coefficient Per Degree Change in Ambient Temperature

Nominal Pipe Size mm	Nominal Insulation Thickness mm	Number and Type of Tracer(s)					
		One DLS-IT	One SLS-IT	One BT or BTS	One HTC	Two HTC	Three HTC
40	25	.62	.53	.39	.08	--	--
	40	.55	.45	.34	.07	--	--
	50	.51	.42	.31	.06	--	--
50	25	.66	.57	.43	.10	.06	--
	40	.61	.51	.35	.08	.05	--
	50	.57	.47	.33	.07	.05	--
80	25	.71	.63	.47	.13	.09	--
	40	.66	.57	.42	.11	.07	--
	50	.62	.53	.39	.10	.07	--
100	25	.76	.70	.52	.17	.11	.08
	40	.71	.64	.47	.14	.09	.07
	50	.61	.59	.43	.12	.08	.06
150	25	.82	.77	.67	.23	.15	.11
	40	.76	.72	.60	.18	.12	.09
	50	.73	.67	.52	.16	.10	.07
200	40	.81	.77	.66	.23	.14	.11
	50	.76	.72	.60	.19	.11	.09
	75	.71	.67	.54	.16	.09	.07
250	40	.83	.80	.69	.28	.17	.13
	50	.80	.76	.65	.24	.15	.12
	75	.75	.70	.58	.20	.12	.10
300	40	.86	.83	.74	.38	.25	.19
	50	.83	.79	.69	.33	.21	.16
	75	.77	.74	.62	.28	.17	.13
350	40	.87	.84	.74	.44	.29	.23
	50	.84	.80	.70	.39	.25	.19
	75	.79	.75	.63	.32	.20	.15
400	40	.88	.85	.77	.52	.36	.29
	50	.85	.82	.72	.47	.31	.24
	75	.80	.77	.65	.39	.26	.20
450	40	--	.87	.78	.54	.38	.31
	50	.86	.84	.74	.49	.33	.26
	75	.82	.78	.68	.42	.27	.27
500	40	--	.88	.80	.57	.40	.32
	50	.88	.85	.76	.51	.35	.28
	75	.83	.80	.69	.44	.29	.22
600	40	--	--	.82	.60	.44	.35
	50	--	.87	.79	.54	.38	.30
	75	.85	.82	.76	.47	.31	.24
750	40	--	--	--	.65	.49	.39
	50	--	--	--	.59	.42	.32
	75	--	--	--	.51	.35	.28

Steam Tracing

Table 4.2 Insulation Material Adjustment Factors

Maintain Temperature Change for Other Insulants of Equal Thicknesses

Nominal Pipe Size mm	Tracer Type	Number of Tracers	Insulation Type			
			Cellular Glass °C	Fiberglass °C	Mineral Wool °C	Expanded Perlite °C
40	HTC	1	+0.5	+2.8	+3.3	-2.2
		2-4	--	--	--	--
	BT or BTS	1	+2.2	+12.8	+14.4	-6.7
	SLS-IT, DLS-IT	1	+4.4	+16.7	+19.4	-8.3
50	HTC	1	+1.1	+3.9	+4.4	-2.2
		2-4	+0.5	+2.2	+2.2	-1.1
	BT or BTS	1	+3.3	+13.3	+15.0	-7.0
	SLS-IT, DLS-IT	1	+4.4	+16.1	+19.4	-8.3
80	HTC	1	+1.1	+5.0	+5.6	-3.3
		2-4	+0.5	+2.8	+3.3	-1.6
	BT or BTS	1	+3.9	+14.4	+17.2	-7.8
	SLS-IT, DLS-IT	1	+4.4	+15.6	+18.9	-7.8
100	HTC	1	+1.1	+6.7	+7.0	-3.9
		2-4	+0.5	+3.9	+4.4	-1.6
	BT or BTS	1	+4.4	+15.6	+18.3	-7.8
	SLS-IT, DLS-IT	1	+4.4	+15.0	+18.3	-7.0
150	HTC	1	+1.1	+8.3	+8.3	-5.0
		2-4	+0.5	+3.9	+5.0	-3.9
	BT or BTS	1	+4.4	+16.1	+19.4	-7.8
	SLS-IT, DLS-IT	1	+4.4	+15.0	+17.8	-6.7
200	HTC	1	+1.6	+8.9	+10.0	-5.0
		2-4	+0.5	+3.9	+5.6	-2.8
	BT or BTS	1	+4.4	+16.1	+20.0	-7.8
	SLS-IT, DLS-IT	1	+4.4	+14.4	+17.8	-6.0
250	HTC	1	+2.2	+11.1	+12.8	-6.0
		2-4	+1.1	+6.0	+7.8	-3.3
	BT or BTS	1	+4.4	+16.1	+19.4	-7.8
	SLS-IT, DLS-IT	1	+3.9	+13.3	+16.1	-5.6
300	HTC	1	+3.3	+13.9	+16.1	-7.0
		2-4	+1.6	+7.8	+10.6	-4.4
	BT or BTS	1	+4.4	+15.6	+19.4	-7.0
	SLS-IT, DLS-IT	1	+3.3	+11.7	+15.0	-5.0
350	HTC	1	+3.3	+15.0	+17.2	-7.8
		2-4	+1.6	+8.9	+12.8	-5.6
	BT or BTS	1	+5.0	+15.6	+18.9	-6.7
	SLS-IT, DLS-IT	1	+3.3	+11.7	+14.4	-5.0
400	HTC	1	+4.4	+16.7	+19.4	-8.3
		2-4	+1.6	+10.6	+15.0	-6.0
	BT or BTS	1	+5.0	+15.0	+18.3	-6.7
	SLS-IT, DLS-IT	1	+3.3	+10.6	+13.9	-5.0
450	HTC	1	+4.4	+16.7	+19.4	-8.3
		2-4	+2.2	+11.1	+15.6	-6.7
	BT or BTS	1	+5.0	+14.4	+17.8	-6.7
	SLS-IT, DLS-IT	1	+3.3	+10.0	+12.8	-4.4
500	HTC	1	+4.4	+16.7	+19.4	-8.3
		2-4	+2.2	+11.7	+15.6	-6.7
	BT or BTS	1	+5.0	+14.4	+17.8	-6.0
	SLS-IT, DLS-IT	1	+3.3	+9.4	+11.7	-4.4
600	HTC	1	+4.4	+16.7	+19.4	-8.3
		2-4	+2.8	+12.8	+15.6	-6.7
	BT or BTS	1	+5.0	+13.3	+16.7	-5.6
	SLS-IT, DLS-IT	1	--	--	--	--
750	HTC	1	+4.4	+16.7	+19.4	-8.3
		2-4	+2.8	+12.8	+15.6	-6.7
	BT or BTS	1	--	--	--	--
	SLS-IT, DLS-IT	1	--	--	--	--

Note . . . Temperature adjustments are approximations only.

Step 5: Determine Steam Tracing Circuit Lengths

Steam tracing circuit lengths are frequently short due to the length or configuration of the traced piping and equipment. However, on long transfer lines, long circuit lengths are desirable to minimise the number of supply lines, valves and trapping stations required. Table 5.1 is based on 38 mm calcium silicate insulation, maximum pipe size groupings and variables for tracer size, conductance and low temperature limitations. Longer tracer runs may be possible based on a given pipe size, insulation type and thickness and allowable circuit pressure drop. Thermon's CompuTrace design and selection program should be used to obtain optimum circuit lengths based on application-specific design conditions.

The trapping distances found in Table 5.1 are based on tracer runs where the accumulated vertical tracer rise (AVTR) in metres does not exceed a given percentage of the inlet steam pressure as described below. It is important to consider the amount of vertical tracer rise when laying out steam tracing circuitry.

AVTR . . . The sum of all the increases in elevation is called the accumulated vertical tracer rise. A field-tested approach is to limit the AVTR (numerically) for any steam tracing circuit to a percentage of the inlet steam pressure. The approximate multiplier for pressure in kilopascals is 0.0066 to arrive at an allowable AVTR in metres (see Figure 5.1). Since kilopascals are usually given in absolute pressure, subtract 101 kPa from kPa absolute before using the 0.0066 multiplier. No adjustment in the trapping distance from the table is necessary if the above AVTR limit is adhered to and if the pressure drop is limited to 10% for computer-generated trapping distances. However, reductions in length are required for pressure losses due to bends, valves and fittings as shown in Table 5.2.

Notes . . .

1. Maximum pipe size 200 mm.
2. For SLS-IT and DLS-IT, distance is based on maximum pipe size that can be held at 10°C or above.
3. Maximum pipe size 600 mm.
4. Maximum pipe size 750 mm.

Table 5.1 Trapping Distances (m)

Based on 38 mm Calcium Silicate Insulation

Steam Pressure kPa Absolute	Tracer Type	Number of Tracers	Tracer Tubing Size		
			10 mm[1,2]	12 mm[3]	20 mm[4]
205	HTC	1	15	23	41
		2	20	29	52
		3	23	34	59
	BT or BTS	1	23	34	--
	DLS-IT	1	38	--	--
	SLS-IT	1	35	--	--
308	HTC	1	18	30	56
		2	27	38	70
		3	32	44	81
	BT or BTS	1	30	46	--
	DLS-IT	1	52	--	--
	SLS-IT	1	46	--	--
446	HTC	1	24	40	70
		2	35	49	88
		3	41	56	102
	BT or BTS	1	38	58	--
	DLS-IT	1	66	--	--
	SLS-IT	1	56	--	--
618	HTC	1	29	47	85
		2	41	59	107
		3	50	69	123
	BT or BTS	1	46	72	--
	DLS-IT	1	79	--	--
	SLS-IT	1	69	--	--
791	HTC	1	34	55	98
		2	47	69	122
		3	58	78	142
	BT or BTS	1	53	82	--
	DLS-IT	1	91	--	--
	SLS-IT	1	116	--	--
1136	HTC	1	40	67	119
		2	58	82	149
		3	70	94	152
	BT or BTS	1	66	99	--
	DLS-IT	1	108	--	--
	SLS-IT	1	96	--	--
1480	HTC	1	46	76	137
		2	66	94	152
		3	79	110	152
	BT or BTS	1	75	114	--
	DLS-IT	1	123	--	--
	SLS-IT	1	108	--	--
1825	HTC	1	52	85	152
		2	73	105	152
		3	88	120	152
	BT or BTS	1	82	126	--
	DLS-IT	1	137	--	--
	SLS-IT	1	119	--	--

Steam Tracing

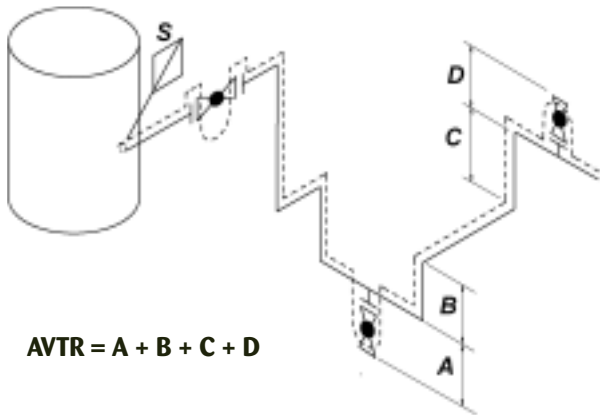


Figure 5.1

Table 5.2 Circuit Length Allowances

Type of Bend or Fitting	Equivalent Length m
45°	0.2
90°	0.3
180°	0.49
Gate Valve	0.2
Globe Valve	5.2

Note . . . The equivalent lengths of fittings and bends in a tracing circuit must be subtracted from the circuit lengths determined in Table 5.1.

Table 5.3 Header Sizing

Recommended Header Size for Steam Supply Lines			
Header Size	Number of Tracers		
mm	10 mm	12 mm	20 mm
20	3	2	--
25	4 to 8	3 to 5	2
40	9 to 24	6 to 15	3 to 6
50	25 to 48	16 to 30	7 to 13

Recommended Header Size for Condensate Return Lines			
Header Size	Number of Tracers		
mm	10 mm	12 mm	20 mm
25	Up to 8	Up to 5	Up to 2
40	9 to 16	6 to 10	3 to 4
50	17 to 40	11 to 25	5 to 11

Step 6: Choose Options/Accessories

Thermon offers a variety of accessories to simplify the installation of isolated, convection and conduction tracers. Figure 6.1 identifies the typical accessories and their uses. For specific information on the accessories used with each product, refer to the Thermon product specification sheet for the tracer type/material.

Isolated Tracers . . . SafeTrace SLS-IT and DLS-IT tracers are attached to the process pipe with temperature-rated tape while the ends are protected from moisture penetration by self-vulcanising silicone rubber tape.

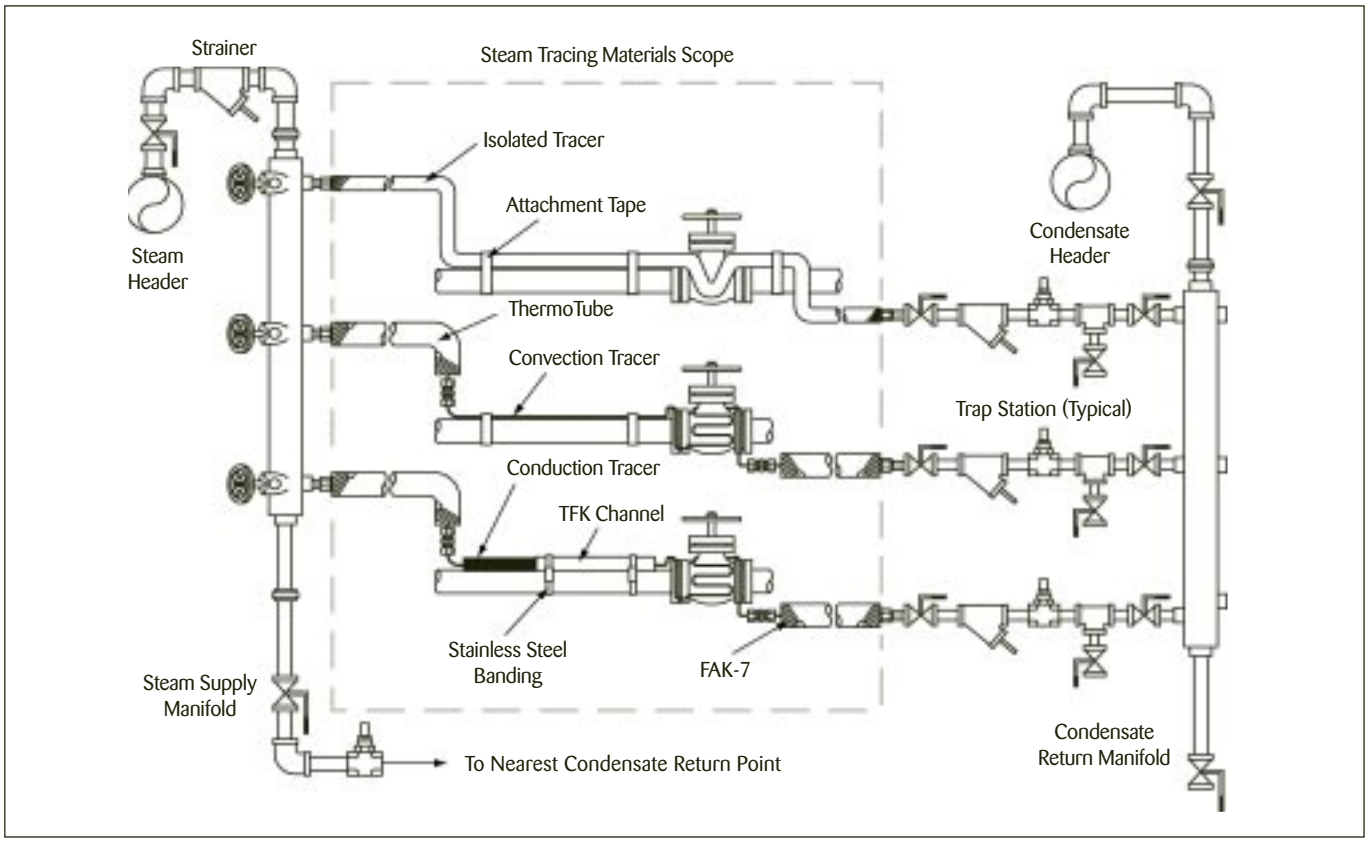
Convection Tracers . . . Bare tracers are typically installed with stainless steel banding. SafeTrace BTS tracers may be installed with the same tape used for SLS-IT and DLS-IT tracers. No end preparation is required for BTS tracers.

Conduction Tracers . . . Accessories to install Thermon heat transfer compounds include stainless steel banding, crimp seals, banding tools and galvanised steel channel.

Steam Supply and Condensate Return . . . Every steam tracing circuit requires a method to move the steam medium from the supply header to the tracer starting point and from the tracer end point to a condensate return manifold. SafeTrace SLS-IT and DLS-IT isolated tracers, because of their thermal retardant characteristics, can be installed continuously from the supply header, along the length of traced pipe and to the condensate return manifold.

When the tracers will be convection or conduction tracers, separate steam supply and condensate return lines are required. Thermon simplifies this requirement with ThermoTube™ preinsulated tubing. These copper or stainless steel tubes, available in numerous diameters, utilise nonhygroscopic glass fibre insulation, a heat reflective foil wrap and a weather-resistant outer covering. The preinsulated feature of ThermoTube allows installation to be completed in one step as opposed to multiple steps required when using field-installed materials. For additional product information, refer to Thermon Form TSP0009U.

Figure 6.1 Typical Steam Tracing System



Basic Accessories . . .

Stainless Steel Banding...used to secure tracer, compound and channel to piping.

- **T2SSB** (12 mm wide, 0, 5 mm thick) for 10 mm and 12 mm O.D. tube tracers.
- **T3SSB** (12 mm wide, 0, 8 mm thick) for 20 mm or 25 mm O.D. tube and DN 20 or 25 pipe tracers.

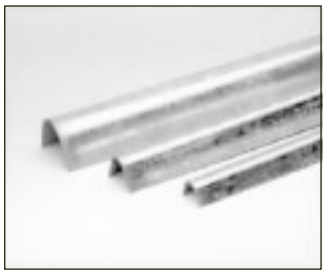
C001...banding tool for applying tension to T2SSB or T3SSB banding.

1950A..crimping tool for T34PB-CR seals.

T34PB-CR...crimp seals for fastening tensioned banding.

FT-1H...polyester fibre tape for circumferential banding of SafeTrace tracer to piping every 30 cm or as required by code or specification. Tape is 19 mm wide x 55 m long and has a maximum exposure temperature of 260°C.

FAK-7... end termination kit contains a roll of self-vulcanising silicone rubber tape and RTV sealant (sufficient materials to waterproof approximately six terminations). No heat gun or special tools are needed for installation. The FAK-7 has a maximum exposure temperature of 204°C.



TFK-4...galvanised steel channel covers heat transfer compound applied to 10 mm and 12 mm O.D. tube tracers.

TFK-7...galvanised steel channel covers heat transfer compound applied to 20 mm O.D. tube and DN 15 pipe tracers.

TFK-9...galvanised steel channel covers heat transfer compound applied to 25 mm O.D. tube and DN 20 or 25 pipe tracers.

Steam Tracing

Design Optimisation Tips . . .

To ensure a properly operating steam tracing system and avoid commonly made mistakes, the following steam tracing recommendations have been compiled:

1. Select the tracer type that most closely meets the process design temperature requirements.
   a. Conserves energy.
   b. Avoids the effects of overheating.
2. Use only one tracer per process pipe where possible to reduce the number of trap stations, isolation valves and fittings required. (Certain critical process lines may require a redundant heater.)
   a. Reduces initial cost.
   b. Eliminates maintenance of omitted materials.
3. Select a tracer that will meet the above conditions with existing steam pressure (up to 1825 kPa) where possible to decrease the use of pressure-reducing valves and increase the distance between traps, thus reducing the number of trap stations required. Isolated tracers can provide a low conductive heat path to reduce temperatures and conserve energy.
   a. Reduces capital equipment cost.
   b. Reduces installation costs.
   c. Reduces system maintenance.
4. Use conduction tracers rather than steam-jacketed pipe where possible.
   a. Significantly reduce material and labour costs.
   b. Provide flexibility for maintenance.
   c. Greatly reduce the number of trap stations required, forestalling future maintenance costs.
   d. Can significantly reduce energy consumption.
5. Use flash steam from condensate or steam from exothermic processes where available.
   a. Significantly reduces energy costs.
   b. Low pressure steam provides more usable enthalpy, further increasing efficiency.
6. Use tubing rather than pipe for the tracer.
   a. Reduces initial labour cost due to ease of installation.
   b. Reduces number of fittings required, lowering the risk of steam leaks and future maintenance.
7. Use appropriate trapping distance determinations rather than rule-of-thumb distances, which may not provide cost-effective lengths where long piping runs exist.
   a. Reduce the number of trap stations and isolation valves and thus material and installation costs.
   b. Eliminate maintenance of omitted materials.
8. Use preinsulated steam supply and condensate return lines.
   a. Reduce labour and energy costs over field-installed and insulated lines.
   b. Extruded outer jacket ensures that the thermal insulation is always weather-protected.
9. Use prefabricated steam supply and condensate collection manifolds for multiple tracing circuits.
   a. Provide centralised location for steam distribution and condensate collection.
   b. Minimise design time and installation costs.
   c. Condensate collection manifolds with an internal siphon pipe prevent freezing and water hammer during start-up.
10. Use prefabricated trap stations.
    a. Minimise installation and labour costs.
    b. Standardised design reduces maintenance and spare parts.

Design Tips on Tracers . . .

For nearly every application, the following comments on steam tracer selection will apply:

- One BT or BTS bare convection tracer is the least expensive tracing system to install.
- Multiple BT or BTS tracers cannot be economically justified when one tracer with heat transfer compound (HTC) will suffice because of the additional steam supply connections and trap assemblies required. BT or BTS tracers may be doubled back where allowable pressure drops are not exceeded.
- Spiraled BT or BTS tracers on horizontal runs are not recommended because circumferential expansion reduces the heat transfer coefficient (by increasing the air gap between the tracer and the pipe) and the increased number of pockets requires more frequent trapping.
- Horizontal tracer runs are less labour-intensive to install and reduce water hammer.
- Isolated tracers (IT) provide energy savings in the range of 25% to 50% over bare convection tracers where they meet the process temperature requirements.
- In all cases, tracers that provide a measure of safety to aid compliance with applicable standards should be chosen.

Properties of Saturated Steam (SI Metric Units)

Pressure kPa Absolute	**Temp.** °C	**Heat** kJ/kg			**Specific Volume** m^3/kg
		Sensible	**Latent**	**Total**	
101.3	100	419	2257	2674	1.67
108.8	102	428	2251	2679	1.57
116.7	104	436	2245	2681	1.47
125.0	106	444	2241	2685	1.37
133.9	108	453	2235	2688	1.29
143.3	110	461	2230	2691	1.21
153.2	112	470	2224	2694	1.14
163.6	114	478	2219	2697	1.07
174.6	116	487	2213	2700	1.01
186.3	118	495	2208	2703	0.947
198.5	120	504	2202	2706	0.892
211.4	122	512	2197	2709	0.841
225.0	124	521	2191	2712	0.793
239.3	126	529	2186	2715	0.749
254.3	128	538	2180	2718	0.707
270.1	130	546	2174	2721	0.668
286.7	132	555	2168	2723	0.632
304.1	134	563	2162	2725	0.598
322.2	136	572	2156	2728	0.566
341.4	138	580	2125	2731	0.537
361.4	140	589	2145	2734	0.509
382.3	142	598	2139	2737	0.482
404.2	144	606	2133	2739	0.458
419.2	146	615	2127	2742	0.435
451.0	148	623	2121	2744	0.413
476.0	150	632	2114	2746	0.393
502.0	152	641	2108	2749	0.373
557.6	156	658	2096	2754	0.338
587.2	158	667	2089	2756	0.322
618.0	160	676	2082	2758	0.307

Pressure kPa Absolute	**Temp.** °C	**Heat** kJ/kg			**Specific Volume** m^3/kg
		Sensible	**Latent**	**Total**	
650.2	162	684	2076	2760	0.293
683.6	164	693	2069	2762	0.279
718.3	166	702	2062	2764	0.266
754.5	168	711	2056	2667	0.254
792.0	170	719	2050	2769	0.243
831.1	172	728	2043	2771	0.232
871.6	174	737	2036	2773	0.222
913.7	176	746	2029	2774	0.212
957.4	178	754	2022	2776	0.203
1002.7	180	763	2015	2778	0.194
1049.7	182	772	2008	2780	0.186
1098.4	184	781	2000	2781	0.178
1148.8	186	790	1993	2783	0.170
1201.1	188	799	1986	2784	0.163
1255.3	190	808	1979	2786	0.156
1311.2	192	816	1971	2787	0.150
1369.2	194	825	1964	2789	0.144
1429.1	196	834	1956	2790	0.138
1491.0	198	843	1949	2792	0.133
1555.1	200	852	1941	2793	0.127
1621.2	202	862	1932	2794	0.122
1689.5	204	871	1924	2795	0.117
1760.1	206	880	1917	2797	0.113
1832.9	208	889	1908	2797	0.108
1908.0	210	898	1900	2798	0.104
1985.5	212	907	1892	2799	0.100
2065.4	214	916	1884	2800	0.0965
2147.7	216	925	1875	2800	0.0929
2232.7	218	935	1867	2802	0.0894
2320.1	220	944	1858	2802	0.0861

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