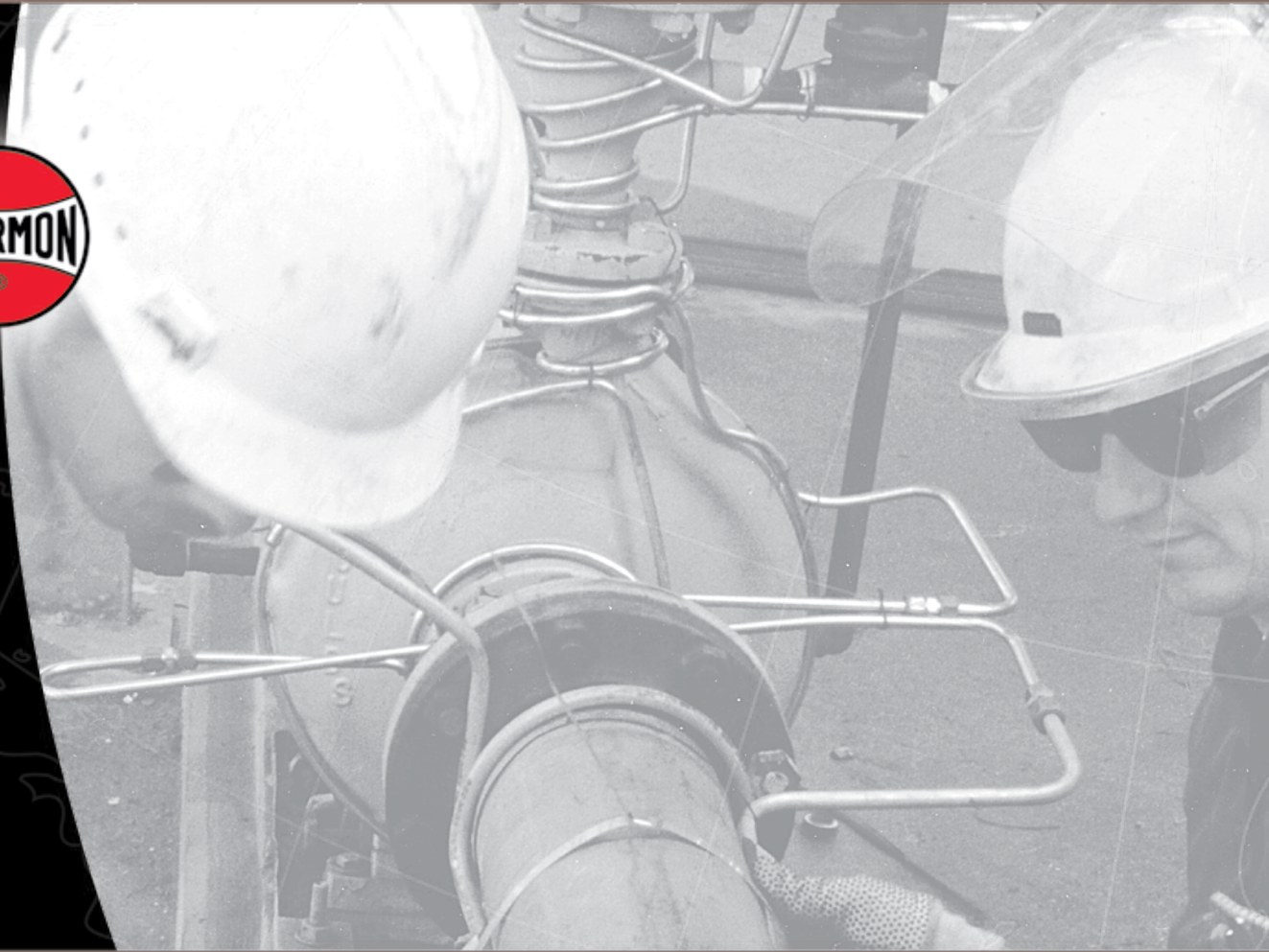


DESIGN GUIDE

FOR STEAM TRACING APPLICATIONS



THERMON The Heat Tracing Specialists®



Design Guide

For Steam Tracing Applications

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For additional information about steam tracing, please refer to the Steam Tracing Specification Guide (Thermon Form TSP0010) or contact Thermon.



Design Guide For Steam Tracing Applications

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 maximizing performance with a range of steam tracers while minimizing the total cost of unnecessary components, the cost of ownership for a steam tracing system is optimized.

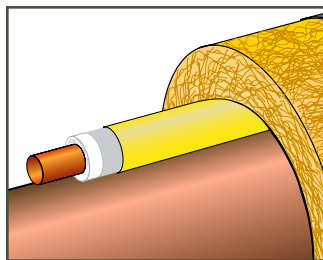
This design guide addresses the steam tracing requirements of piping and equipment by matching the heating requirements with the type of steam tracers best suited for that application. The information contained in this design guide will take the reader through a step-by-step procedure to make proper 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 1,250°F (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.

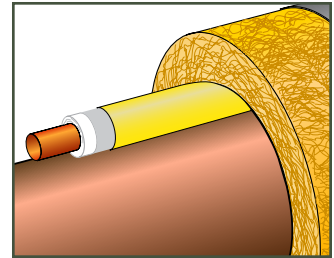
Isolated Tracers . . . Designed for use with low to medium-low heat requirements, Thermon's SafeTrace™ SLS-IT and DLS-IT are metallic tracer tubes covered with composite materials that lower thermal conductance to reduce heat output and temperature. The reduced heat output of SafeTrace SLS-IT and DLS-IT is predictable to ensure controlled heat distribution



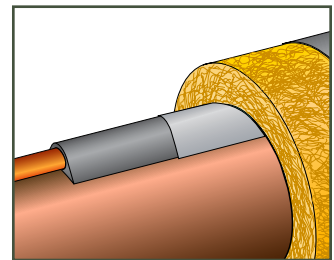
along the length of a traced pipe without hot spots or overheating. These tracers also utilize a safety yellow identification jacket to signify the presence of inherently dangerous materials such as steam. A feature unique to SafeTrace SLS-IT and DLS-IT is their ability to run con-

tinuously 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 utilizing 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 here 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 charts 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 Thermon or a Thermon factory representative for design assistance.



Design Guide For Steam Tracing Applications

Step 2: Select the Proper Thermon Steam Tracing Method

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

Table 2.1 Process Temperature vs. Tracer Type

Process Temperature Range	Tracer Type
LOW 50°-100°F (10°-38°C)	Isolated
MEDIUM-LOW 101°-150°F (39°-66°C)	Isolated/Convection
MEDIUM 151°-200°F (67°-93°C)	Convection/Conduction
MEDIUM-HIGH 201°-300°F (94°-149°C)	Conduction
HIGH 301°-400°F (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 size¹.

Table 2.2 Typical Insulation Thickness

Pipe Size in (mm)	Temperature Ranges				
	50°-100°F (10°-38°C)	101°-150°F (39°-66°C)	151°-200°F (67°-93°C)	201°-300°F (94°-149°C)	301°-400°F (150°-204°C)
1½ (40)	1 (25)	1 (25)	1 (25)	1 (25)	1 (25)
2 (50)	1 (25)	1 (25)	1 (25)	1 (25)	1 (25)
3 (80)	1 (25)	1 (25)	1 (25)	1 (25)	1 (25)
4 (100)	1 (25)	1½ (40)	1½ (40)	1½ (40)	1½ (40)
6 (150)	1 (25)	1½ (40)	1½ (40)	1½ (40)	2 (50)
8 (200)	1½ (40)	1½ (40)	1½ (40)	2 (50)	2 (50)
10 (250)	1½ (40)	1½ (40)	2 (50)	2 (50)	2 (50)
12 (300)	1½ (40)	1½ (40)	2 (50)	2 (50)	2 (50)
14 (350)	1½ (40)	1½ (40)	2 (50)	2 (50)	2½ (64)
16 (400)	1½ (40)	2 (50)	2 (50)	2 (50)	2½ (64)
18 (450)	1½ (40)	2 (50)	2 (50)	2½ (64)	2½ (64)
20 (500)	2 (50)	2 (50)	2 (50)	2½ (64)	2½ (64)
24 (600)	2 (50)	2 (50)	2½ (64)	2½ (64)	3 (64)
30 (750)	2 (50)	2 (50)	2½ (64)	2½ (64)	3 (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 or a Thermon factory representative, 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 3.8 (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 0°F (-18°C) and wind speeds of 25 mph (11 m/s).

Process Temperature Maintenance (Inch-Pound System)

Tracer Type	Steam Pressure	Table
Bare/BTS & Isolated	15, 30, 50 & 75 psig	3.1
Bare/BTS & Isolated	100, 150, 200 & 250 psig	3.2
Heat Transfer Compound	15, 30, 50 & 75 psig	3.3
Heat Transfer Compound	100, 150, 200 & 250 psig	3.4

Process Temperature Maintenance (SI System)

Tracer Type	Steam Pressure	Table
Bare/BTS & Isolated	205, 308, 446 & 618 kPa	3.5
Bare/BTS & Isolated	791, 1136, 1480 & 1825 kPa	3.6
Heat Transfer Compound	205, 308, 446 & 618 kPa	3.7
Heat Transfer Compound	791, 1136, 1480 & 1825 kPa	3.8

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

Pipe diameter	10"
Design process temperature	250°F
Insulation thickness	2"
Steam pressure (temperature)	100 psig (338°F)
Minimum ambient/wind speed	0°F/25 mph

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 10" diameter pipe maintaining 250°F, 2" thick insulation is needed. Based on these factors, use Table 3.4 to determine that one 3/8" or 1/2" 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 (°F) IT, BT or BTS Tracers
 Ambient Temperature: 0°F, Wind: 25 mph, Insulation: Calcium Silicate

Pipe Size in	Insulation Thickness in	Steam Pressure											
		15 psig 250°F			30 psig 274°F			50 psig 298°F			75 psig 320°F		
		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
1½	1	93	118	151	102	130	167	112	142	182	121	152	196
	1½	113	138	164	125	151	180	136	165	197	147	178	212
	2	121	145	171	134	160	188	146	175	206	157	188	222
2	1	83	106	142	91	116	157	101	127	171	108	138	184
	1½	97	121	161	108	133	177	118	146	193	127	157	208
	2	107	131	167	119	144	184	130	157	201	140	170	217
3	1	71	91	132	78	100	146	86	110	159	93	118	171
	1½	85	105	144	94	116	159	102	127	173	111	137	187
	2	95	116	153	104	128	168	115	140	184	124	151	198
4	1	59	75	120	65	83	132	71	91	144	77	98	156
	1½	72	90	132	80	100	146	87	109	159	95	117	171
	2	83	102	141	91	112	156	100	123	170	108	132	183
6	1	--	55	81	50	60	89	53	66	98	58	72	106
	1½	58	70	99	64	77	110	70	85	120	76	92	129
	2	67	81	111	74	89	123	82	98	134	88	106	144
8	1½	--	56	84	52	61	92	57	67	101	62	73	109
	2	58	67	98	64	75	108	71	82	118	76	89	128
	3	72	82	114	79	91	126	87	99	138	94	108	149
10	1½	--	--	76	--	54	84	50	60	92	55	65	100
	2	--	58	87	54	65	97	60	71	106	65	77	114
	3	63	73	104	69	81	115	76	89	126	82	95	136
12	1½	--	--	65	--	--	72	--	50	79	--	54	85
	2	--	50	77	--	55	85	51	61	93	55	66	100
	3	55	64	94	60	71	104	66	78	114	72	84	123
14	1½	--	--	62	--	--	69	--	--	75	--	52	82
	2	--	--	74	--	52	81	--	58	89	52	63	96
	3	52	62	91	58	68	100	63	75	110	69	81	119
16	1½	--	--	57	--	--	63	--	--	69	--	--	75
	2	--	--	68	--	--	75	--	53	82	--	57	89
	3	--	57	85	53	63	94	58	69	103	63	74	111
18	1½	--	--	52	--	--	58	--	--	64	--	--	69
	2	--	--	63	--	--	70	--	--	77	--	52	83
	3	--	52	80	50	58	88	54	64	97	58	69	105
20	1½	--	--	--	--	--	54	--	--	59	--	--	64
	2	--	--	59	--	--	65	--	--	71	--	50	77
	3	--	--	76	--	54	83	50	59	91	54	65	98
24	1½	--	--	--	--	--	--	--	--	51	--	--	56
	2	--	--	52	--	--	58	--	--	63	--	--	68
	3	--	--	67	--	--	75	--	52	82	--	57	89
30	1½	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	--	--	--	--	--	--	--	--	--
	3	--	--	--	--	--	--	--	--	--	--	--	--

Notes . . . Tables 3.1 and 3.2 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. All tracers are 3/8" O.D. tubing to provide for economical trap distances. Use Table 4.1 to adjust for ambient temperatures other than 0°F. For pipe temperatures below 80°F, consider using cellular glass or other insulation materials with a low moisture permeability.



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For Steam Tracing Applications

Table 3.2 Process Temperature Maintenance (°F) IT, BT or BTS Tracers
 Ambient Temperature: 0°F, Wind: 25 mph, Insulation: Calcium Silicate

Pipe Size in	Insulation Thickness in	Steam Pressure											
		100 psig 338°F			150 psig 366°F			200 psig 388°F			250 psig 406°F		
		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
1½	1	128	161	207	138	173	223	146	184	236	153	192	247
	1½	155	188	224	167	202	241	177	215	255	185	224	267
	2	166	199	234	178	214	252	189	227	267	198	237	280
2	1	114	145	194	123	156	209	131	166	222	137	174	232
	1½	134	166	219	144	178	236	153	189	250	160	198	262
	2	147	179	228	159	193	246	168	204	261	176	214	273
3	1	98	125	181	106	135	195	112	143	206	118	149	216
	1½	116	145	197	126	156	212	133	165	225	140	173	235
	2	130	159	208	141	171	224	149	182	238	156	190	249
4	1	81	104	164	88	112	176	94	119	187	98	124	196
	1½	100	124	180	108	134	194	115	142	206	120	148	216
	2	114	139	193	123	150	208	130	159	221	137	167	231
6	1	61	76	112	66	82	120	71	87	128	74	92	134
	1½	80	97	136	86	105	147	92	111	156	96	116	163
	2	93	111	152	100	120	164	106	127	174	112	134	182
8	1½	66	77	115	71	83	125	76	89	132	79	93	138
	2	81	94	134	87	101	145	92	107	154	97	113	161
	3	99	113	157	107	122	169	113	129	179	119	136	187
10	1½	57	69	105	62	74	113	66	79	120	70	83	126
	2	69	81	120	74	87	129	79	93	138	83	98	144
	3	87	101	143	94	108	154	99	115	163	104	121	171
12	1½	--	57	90	52	62	97	55	66	103	58	69	108
	2	58	70	106	63	75	114	67	80	121	71	84	127
	3	76	89	129	82	96	140	87	102	148	92	107	155
14	1½	--	54	86	50	59	93	52	63	99	55	66	104
	2	55	66	101	60	71	110	64	76	116	67	80	122
	3	72	85	125	78	92	135	83	98	143	87	102	150
16	1½	--	50	79	--	53	85	--	57	91	50	60	95
	2	50	61	94	55	65	101	58	69	108	61	73	113
	3	66	79	117	72	85	127	77	90	134	80	95	141
18	1½	--	--	73	--	50	79	--	52	84	--	54	88
	2	--	55	87	50	60	94	53	64	100	56	67	105
	3	62	73	111	66	79	119	71	84	126	75	88	132
20	1½	--	--	68	--	--	73	--	--	78	--	50	82
	2	--	52	82	--	55	88	50	59	94	51	62	99
	3	57	68	104	62	74	112	66	78	119	69	82	125
24	1½	--	--	59	--	--	64	--	--	68	--	--	72
	2	--	--	72	--	--	78	--	51	83	--	54	87
	3	50	60	94	54	65	101	58	69	107	61	73	112
30	1½	--	--	--	--	--	--	--	--	--	--	--	--
	2	--	--	--	--	--	--	--	--	--	--	--	--
	3	--	--	--	--	--	--	--	--	--	--	--	--

Table 3.3 Process Temperature Maintenance (°F) HTC Tracers
 Ambient Temperature: 0°F, Wind: 25 mph, Insulation: Calcium Silicate

Pipe Size in	Insulation Thickness in	Steam Pressure											
		15 psig 250°F			30 psig 274°F			50 psig 298°F			75 psig 320°F		
		One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers
1½	1	226	--	--	248	--	--	271	--	--	292	--	--
	1½	230	--	--	253	--	--	276	--	--	298	--	--
	2	232	--	--	256	--	--	278	--	--	300	--	--
2	1	221	232	--	243	254	--	265	278	--	286	300	--
	1½	225	234	--	248	256	--	271	280	--	291	302	--
	2	228	235	--	251	258	--	274	282	--	295	304	--
3	1	213	227	--	234	250	--	255	273	--	275	294	--
	1½	218	230	--	240	253	--	263	276	--	283	298	--
	2	222	232	--	244	255	--	267	279	--	288	300	--
4	1	204	217	225	224	239	248	244	261	271	263	282	291
	1½	212	223	229	232	246	252	254	268	275	274	289	297
	2	217	227	232	238	249	255	260	272	278	280	294	300
6	1	188	211	218	206	232	240	225	254	262	242	273	282
	1½	200	219	225	219	240	247	240	263	270	258	283	291
	2	207	223	227	227	245	250	247	267	273	267	288	294
8	1½	189	212	219	207	232	241	226	254	263	243	274	284
	2	199	218	223	218	239	246	238	262	269	256	282	289
	3	207	223	228	228	246	251	249	268	274	267	289	295
10	1½	175	202	212	192	223	233	209	243	255	225	261	274
	2	184	209	217	202	229	239	221	251	261	237	270	281
	3	196	217	223	215	238	246	235	260	268	253	280	289
12	1½	151	185	199	166	203	218	181	222	238	194	239	256
	2	163	194	206	179	213	226	195	233	247	210	251	266
	3	179	205	215	196	225	236	214	246	258	230	265	277
14	1½	137	174	189	150	191	208	164	208	227	176	224	244
	2	150	184	198	164	202	217	179	221	237	192	237	255
	3	167	197	208	183	216	229	200	236	250	215	254	269
16	1½	117	157	175	129	173	192	140	188	209	151	202	226
	2	131	169	184	144	186	204	157	202	222	169	218	239
	3	150	184	198	164	202	217	179	221	238	192	237	256
18	1½	111	152	170	123	166	187	133	181	204	143	195	220
	2	126	164	181	137	180	199	150	196	217	161	211	234
	3	144	180	195	158	198	214	173	215	234	186	232	251
20	1½	106	146	166	116	161	182	127	175	198	137	188	213
	2	120	159	178	132	175	194	144	190	213	154	205	229
	3	139	176	192	153	193	211	166	211	230	180	227	247
24	1½	97	137	158	106	151	173	116	164	189	125	176	203
	2	111	151	170	121	165	187	132	180	204	142	194	219
	3	130	169	186	143	185	204	156	202	222	168	217	239
30	1½	84	123	147	92	135	161	100	147	176	108	158	189
	2	99	139	160	108	153	176	118	167	192	127	179	206
	3	117	157	176	128	172	193	140	188	211	151	202	226

Notes . . . Tables 3.3 and 3.4 are based on calcium silicate insulation and give approximate values for cellular glass and perlite. Tracers are 3/8" or 1/2" O.D. tubing with TFK-4 channel. Use Table 4.1 to adjust for ambient temperatures other than 0°F.

With HTC and channel, the contact area is the same for 3/8" or 1/2" O.D. tracers; therefore, the pipe temperature is the same for either tracer under like conditions.



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For Steam Tracing Applications

Table 3.4 Process Temperature Maintenance (°F) HTC Tracers
 Ambient Temperature: 0°F, Wind: 25 mph, Insulation: Calcium Silicate

Pipe Size in	Insulation Thickness in	Steam Pressure											
		100 psig 338°F			150 psig 366°F			200 psig 388°F			250 psig 406°F		
		One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers	One Tracer	Two Tracers	Three Tracers
1½	1	308	--	--	332	--	--	352	--	--	369	--	--
	1½	314	--	--	339	--	--	359	--	--	376	--	--
	2	316	--	--	341	--	--	361	--	--	379	--	--
2	1	301	316	--	325	341	--	344	361	--	360	379	--
	1½	307	319	--	332	344	--	351	364	--	368	382	--
	2	311	320	--	335	345	--	355	366	--	372	384	--
3	1	290	310	--	312	334	--	331	355	--	346	371	--
	1½	298	314	--	321	339	--	340	359	--	356	376	--
	2	303	316	--	327	341	--	346	362	--	362	379	--
4	1	277	297	307	311	320	331	316	339	351	331	355	368
	1½	288	305	313	318	328	337	329	348	358	344	364	375
	2	295	309	316	327	334	341	336	354	362	352	370	379
6	1	255	288	298	275	310	321	291	328	340	304	344	356
	1½	272	298	306	293	321	330	310	340	350	324	357	366
	2	281	304	311	303	327	335	320	347	355	335	363	372
8	1½	256	289	300	276	311	322	292	329	342	306	344	358
	2	270	297	305	290	320	328	307	339	348	322	355	365
	3	282	304	311	304	328	335	322	348	355	337	364	372
10	1½	237	276	289	255	297	311	270	314	330	282	329	345
	2	250	284	296	269	306	319	285	324	338	298	340	354
	3	266	295	304	287	318	328	303	336	348	318	352	364
12	1½	204	252	270	220	271	291	233	286	308	243	300	322
	2	221	264	280	238	284	302	252	301	320	263	315	335
	3	243	279	292	261	301	315	276	318	334	288	333	349
14	1½	185	236	257	199	254	276	211	269	293	220	281	306
	2	203	250	269	218	269	290	231	285	306	241	298	321
	3	226	268	283	243	288	305	257	305	323	269	319	338
16	1½	159	213	237	171	229	255	181	242	270	189	254	283
	2	177	229	252	191	246	271	202	261	286	211	273	300
	3	203	250	269	218	269	290	230	285	307	241	298	321
18	1½	151	205	231	162	221	248	171	234	263	180	244	275
	2	169	222	246	182	239	264	193	253	280	201	264	293
	3	195	244	265	210	263	285	222	278	302	233	291	316
20	1½	144	198	225	155	213	242	163	226	256	171	236	268
	2	162	216	241	175	232	259	185	246	274	193	257	287
	3	189	239	260	203	257	280	214	272	297	224	284	310
24	1½	131	185	214	141	200	230	149	211	243	156	221	254
	2	150	204	231	161	220	248	170	232	263	178	243	275
	3	176	228	252	190	246	271	201	260	287	210	272	300
30	1½	113	167	199	122	179	214	129	190	226	135	198	237
	2	134	189	217	144	203	234	152	215	247	178	243	275
	3	159	213	239	171	229	257	181	242	272	207	270	299

Table 3.5 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 Absolute											
		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 3.5 and 3.6 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.



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Table 3.6 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 Absolute											
		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	--	--	--	--	--	--	--	--	--	--	--	--

Table 3.7 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 Absolute											
		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 3.7 and 3.8 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.



Design Guide For Steam Tracing Applications

Table 3.8 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 Absolute											
		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

Step 4: Apply Any Adjustment Factors

Ambient Temperature . . . If the minimum ambient will differ from the base level of 0°F (-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 process temperature.

Insulation Materials . . . When insulation materials other than calcium silicate are 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 0°F (-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 were -20°F instead of 0°F?

Locate the 10" diameter pipe size and 2" 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 20 = 4.8°F

Rounding 4.8 to the nearest whole value results in 5°F. Subtracting this number from the 250°F pipe temperature previously established results in a new maintain temperature of 245°F.

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 10" diameter line utilizing HTC. Apply this value (+23°F) to the 250°F maintain temperature established in Step 3 to obtain a new maintain temperature of 273°F.

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

Nominal Pipe Size in (mm)	Nominal Insulation Thickness in (mm)	Number and Type of Tracer(s)					
		One DLS-IT	One SLS-IT	One BT or BTS	One HTC	Two HTC	Three HTC
1½ (40)	1 (25)	.62	.53	.39	.08	--	--
	1½ (40)	.55	.45	.34	.07	--	--
	2 (50)	.51	.42	.31	.06	--	--
2 (50)	1 (25)	.66	.57	.43	.10	.06	--
	1½ (40)	.61	.51	.35	.08	.05	--
	2 (50)	.57	.47	.33	.07	.05	--
3 (80)	1 (25)	.71	.63	.47	.13	.09	--
	1½ (40)	.66	.57	.42	.11	.07	--
	2 (50)	.62	.53	.39	.10	.07	--
4 (100)	1 (25)	.76	.70	.52	.17	.11	.08
	1½ (40)	.71	.64	.47	.14	.09	.07
	2 (50)	.61	.59	.43	.12	.08	.06
6 (150)	1 (25)	.82	.77	.67	.23	.15	.11
	1½ (40)	.76	.72	.60	.18	.12	.09
	2 (50)	.73	.67	.52	.16	.10	.07
8 (200)	1½ (40)	.81	.77	.66	.23	.14	.11
	2 (50)	.76	.72	.60	.19	.11	.09
	3 (75)	.71	.67	.54	.16	.09	.07
10 (250)	1½ (40)	.83	.80	.69	.28	.17	.13
	2 (50)	.80	.76	.65	.24	.15	.12
	3 (75)	.75	.70	.58	.20	.12	.10
12 (300)	1½ (40)	.86	.83	.74	.38	.25	.19
	2 (50)	.83	.79	.69	.33	.21	.16
	3 (75)	.77	.74	.62	.28	.17	.13
14 (350)	1½ (40)	.87	.84	.74	.44	.29	.23
	2 (50)	.84	.80	.70	.39	.25	.19
	3 (75)	.79	.75	.63	.32	.20	.15
16 (400)	1½ (40)	.88	.85	.77	.52	.36	.29
	2 (50)	.85	.82	.72	.47	.31	.24
	3 (75)	.80	.77	.65	.39	.26	.20
18 (450)	1½ (40)	--	.87	.78	.54	.38	.31
	2 (50)	.86	.84	.74	.49	.33	.26
	3 (75)	.82	.78	.68	.42	.27	.27
20 (500)	1½ (40)	--	.88	.80	.57	.40	.32
	2 (50)	.88	.85	.76	.51	.35	.28
	3 (75)	.83	.80	.69	.44	.29	.22
24 (600)	1½ (40)	--	--	.82	.60	.44	.35
	2 (50)	--	.87	.79	.54	.38	.30
	3 (75)	.85	.82	.76	.47	.31	.24
30 (750)	1½ (40)	--	--	--	.65	.49	.39
	2 (50)	--	--	--	.59	.42	.32
	3 (75)	--	--	--	.51	.35	.28



Design Guide For Steam Tracing Applications

Table 4.2 Insulation Material Adjustment Factors Process Temperature Change for Other Insulants of Equal Thickness

Pipe Size in (mm)	Tracer Type	Number of Tracers	Insulation Type							
			Cellular Glass		Fiberglass		Mineral Wool		Expanded Perlite	
			°F	(°C)	°F	(°C)	°F	(°C)	°F	(°C)
1½ (40)	HTC	1	+1	(+0.5)	+5	(+2.8)	+6	(+3.3)	-4	(-2.2)
		2-4	--	--	--	--	--	--	--	--
	BTS	1	+4	(+2.2)	+23	(+12.8)	+26	(+14.4)	-12	(-6.7)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
2 (50)	HTC	1	+2	(+1.1)	+7	(+3.9)	+8	(+4.4)	-4	(-2.2)
		2-4	+1	(+0.5)	+4	(+2.2)	+4	(+2.2)	-2	(-1.1)
	BTS	1	+6	(+3.3)	+24	(+13.3)	+27	(+15.0)	-13	(-7.0)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+29	(+16.1)	+35	(+19.4)	-15	(-8.3)
3 (80)	HTC	1	+2	(+1.1)	+9	(+5.0)	+10	(+5.6)	-6	(-3.3)
		2-4	+1	(+0.5)	+5	(+2.8)	+6	(+3.3)	-3	(-1.6)
	BTS	1	+7	(+3.9)	+26	(+14.4)	+31	(+17.2)	-14	(-7.8)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+28	(+15.6)	+34	(+18.9)	-14	(-7.8)
4 (100)	HTC	1	+2	(+1.1)	+12	(+6.7)	+13	(+7.0)	-7	(-3.9)
		2-4	+1	(+0.5)	+7	(+3.9)	+8	(+4.4)	-3	(-1.6)
	BTS	1	+8	(+4.4)	+28	(+15.6)	+33	(+18.3)	-14	(-7.8)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+27	(+15.0)	+33	(+18.3)	-13	(-7.0)
6 (150)	HTC	1	+2	(+1.1)	+15	(+8.3)	+15	(+8.3)	-9	(-5.0)
		2-4	+1	(+0.5)	+7	(+3.9)	+9	(+5.0)	-7	(-3.9)
	BTS	1	+8	(+4.4)	+29	(+16.1)	+35	(+19.4)	-14	(-7.8)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+27	(+15.0)	+32	(+17.8)	-12	(-6.7)
8 (200)	HTC	1	+3	(+1.6)	+16	(+8.9)	+18	(+10.0)	-9	(-5.0)
		2-4	+1	(+0.5)	+7	(+3.9)	+10	(+5.6)	-5	(-2.8)
	BTS	1	+8	(+4.4)	+29	(+16.1)	+36	(+20.0)	-14	(-7.8)
	SLS-IT, DLS-IT	1	+8	(+4.4)	+26	(+14.4)	+32	(+17.8)	-11	(-6.0)
10 (250)	HTC	1	+4	(+2.2)	+20	(+11.1)	+23	(+12.8)	-11	(-6.0)
		2-4	+2	(+1.1)	+11	(+6.0)	+14	(+7.8)	-6	(-3.3)
	BTS	1	+8	(+4.4)	+29	(+16.1)	+35	(+19.4)	-14	(-7.8)
	SLS-IT, DLS-IT	1	+7	(+3.9)	+24	(+13.3)	+29	(+16.1)	-10	(-5.6)
12 (300)	HTC	1	+6	(+3.3)	+25	(+13.9)	+29	(+16.1)	-13	(-7.0)
		2-4	+3	(+1.6)	+14	(+7.8)	+19	(+10.6)	-8	(-4.4)
	BTS	1	+8	(+4.4)	+28	(+15.6)	+35	(+19.4)	-13	(-7.0)
	SLS-IT, DLS-IT	1	+6	(+3.3)	+21	(+11.7)	+27	(+15.0)	-9	(-5.0)
14 (350)	HTC	1	+6	(+3.3)	+27	(+15.0)	+31	(+17.2)	-14	(-7.8)
		2-4	+3	(+1.6)	+16	(+8.9)	+23	(+12.8)	-10	(-5.6)
	BTS	1	+9	(+5.0)	+28	(+15.6)	+34	(+18.9)	-12	(-6.7)
	SLS-IT, DLS-IT	1	+6	(+3.3)	+21	(+11.7)	+26	(+14.4)	-9	(-5.0)
16 (400)	HTC	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
		2-4	+3	(+1.6)	+19	(+10.6)	+27	(+15.0)	-11	(-6.0)
	BTS	1	+9	(+5.0)	+27	(+15.0)	+33	(+18.3)	-12	(-6.7)
	SLS-IT, DLS-IT	1	+6	(+3.3)	+19	(+10.6)	+25	(+13.9)	-9	(-5.0)
18 (450)	HTC	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
		2-4	+4	(+2.2)	+20	(+11.1)	+28	(+15.6)	-12	(-6.7)
	BTS	1	+9	(+5.0)	+26	(+14.4)	+32	(+17.8)	-12	(-6.7)
	SLS-IT, DLS-IT	1	+6	(+3.3)	+18	(+10.0)	+23	(+12.8)	-8	(-4.4)
20 (500)	HTC	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
		2-4	+4	(+2.2)	+21	(+11.7)	+28	(+15.6)	-12	(-6.7)
	BTS	1	+9	(+5.0)	+26	(+14.4)	+32	(+17.8)	-11	(-6.0)
	SLS-IT, DLS-IT	1	+6	(+3.3)	+17	(+9.4)	+21	(+11.7)	-8	(-4.4)
24 (600)	HTC	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
		2-4	+5	(+2.8)	+23	(+12.8)	+28	(+15.6)	-12	(-6.7)
	BTS	1	+9	(+5.0)	+24	(+13.3)	+30	(+16.7)	-10	(-5.6)
	SLS-IT, DLS-IT	1	--	--	--	--	--	--	--	
30 (750)	HTC	1	+8	(+4.4)	+30	(+16.7)	+35	(+19.4)	-15	(-8.3)
		2-4	+5	(+2.8)	+23	(+12.8)	+28	(+15.6)	-12	(-6.7)
	BTS	1	--	--	--	--	--	--	--	--
	SLS-IT, DLS-IT	1	--	--	--	--	--	--	--	

Note . . . These 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 minimize the number of supply lines, valves and trapping stations required. Table 5.1 is based on 1½" calcium silicate insulation, maximum pipe size grouping, 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 optimal 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 feet does not exceed 15% 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 15% of the inlet steam pressure. For example, with an inlet steam pressure of 50 psig, the AVTR should not exceed 7.5 feet. The approximate multiplier for pressure in kilopascals is 0.0066 to arrive at allowable AVTR in meters (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 charts 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 8" (200 mm).
2. For SLS-IT and DLS-IT, distance is based on maximum pipe size that can be held at 50°F (10°C) or above.
3. Maximum pipe size 24" (600 mm).
4. Maximum pipe size 30" (750 mm).

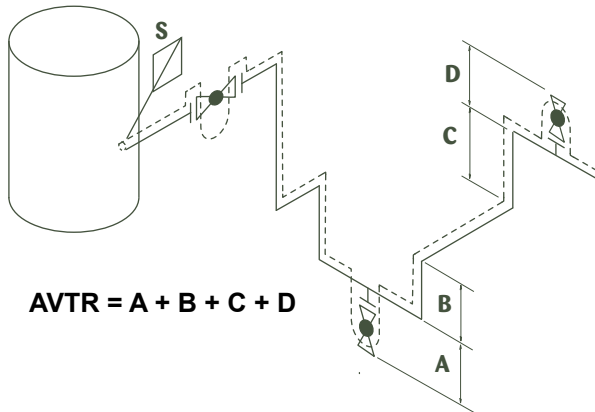
Table 5.1 Trapping Distances

Based on 1½" (50 mm) Calcium Silicate Insulation

Steam Pressure psig (kPa Absolute)	Tracer Type	Number of Tracers	Tubing Size					
			3/8" O.D. (10 mm) ^{1,2}		1/2" O.D. (12 mm) ³		3/4" O.D. (20 mm) ⁴	
			ft	(m)	ft	(m)	ft	(m)
15 (205)	HTC	1	50	(15)	75	(23)	135	(41)
		2	65	(20)	95	(29)	170	(52)
		3	75	(23)	110	(34)	195	(59)
	BT or BTS	1	75	(23)	110	(34)	--	--
		DLS-IT	1	125	(38)	--	--	--
		SLS-IT	1	115	(35)	--	--	--
30 (308)	HTC	1	60	(18)	100	(30)	185	(56)
		2	90	(27)	125	(38)	230	(70)
		3	105	(32)	145	(44)	265	(81)
	BT or BTS	1	100	(30)	151	(46)	--	--
		DLS-IT	1	170	(52)	--	--	--
		SLS-IT	1	150	(46)	--	--	--
50 (446)	HTC	1	80	(24)	130	(40)	230	(70)
		2	115	(35)	160	(49)	290	(88)
		3	135	(41)	185	(56)	335	(102)
	BT or BTS	1	125	(38)	190	(58)	--	--
		DLS-IT	1	215	(66)	--	--	--
		SLS-IT	1	185	(56)	--	--	--
75 (618)	HTC	1	95	(29)	155	(47)	280	(85)
		2	135	(41)	195	(59)	350	(107)
		3	165	(50)	225	(69)	405	(123)
	BT or BTS	1	150	(46)	235	(72)	--	--
		DLS-IT	1	260	(79)	--	--	--
		SLS-IT	1	225	(69)	--	--	--
100 (791)	HTC	1	110	(34)	180	(55)	320	(98)
		2	155	(47)	225	(69)	400	(122)
		3	190	(58)	255	(78)	465	(142)
	BT or BTS	1	175	(53)	270	(82)	--	--
		DLS-IT	1	300	(91)	--	--	--
		SLS-IT	1	380	(116)	--	--	--
150 (1136)	HTC	1	130	(40)	220	(67)	390	(119)
		2	190	(58)	270	(82)	490	(149)
		3	230	(70)	310	(94)	500	(152)
	BT or BTS	1	215	(66)	325	(99)	--	--
		DLS-IT	1	355	(108)	--	--	--
		SLS-IT	1	315	(96)	--	--	--
200 (1480)	HTC	1	150	(46)	250	(76)	450	(137)
		2	215	(66)	310	(94)	500	(152)
		3	260	(79)	360	(110)	500	(152)
	BT or BTS	1	245	(75)	375	(114)	--	--
		DLS-IT	1	405	(123)	--	--	--
		SLS-IT	1	355	(108)	--	--	--
250 (1825)	HTC	1	170	(52)	280	(85)	500	(152)
		2	240	(73)	345	(105)	500	(152)
		3	290	(88)	395	(120)	500	(152)
	BT or BTS	1	270	(82)	415	(126)	--	--
		DLS-IT	1	450	(137)	--	--	--
		SLS-IT	1	390	(119)	--	--	--



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$$AVTR = A + B + C + D$$

Figure 5.1

Table 5.2 Circuit Length Allowances

Type of Bend or Fitting	Equivalent Length ft (m)
45°	0.7 (0.2)
90°	1.0 (0.3)
180°	1.6 (0.49)
Gate Valve	0.7 (0.2)
Globe Valve	17.0 (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 Supplying Steam Tracer Lines				
Header Size in (mm)	Number of Tracers			
	3/8" (10 mm)	1/2" (12 mm)	3/4" (20 mm)	
3/4 (20)	3	2	--	
1 (25)	4 to 8	3 to 5	2	
1½ (40)	9 to 24	6 to 15	3 to 6	
2 (50)	25 to 48	16 to 30	7 to 13	

Recommended Header Size for Condensate Lines				
Header Size in (mm)	Number of Tracers			
	3/8" (10 mm)	1/2" (12 mm)	3/4" (20 mm)	
1 (25)	Up to 8	Up to 5	Up to 2	
1½ (40)	9 to 16	6 to 10	3 to 4	
2 (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-vulcanizing 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.

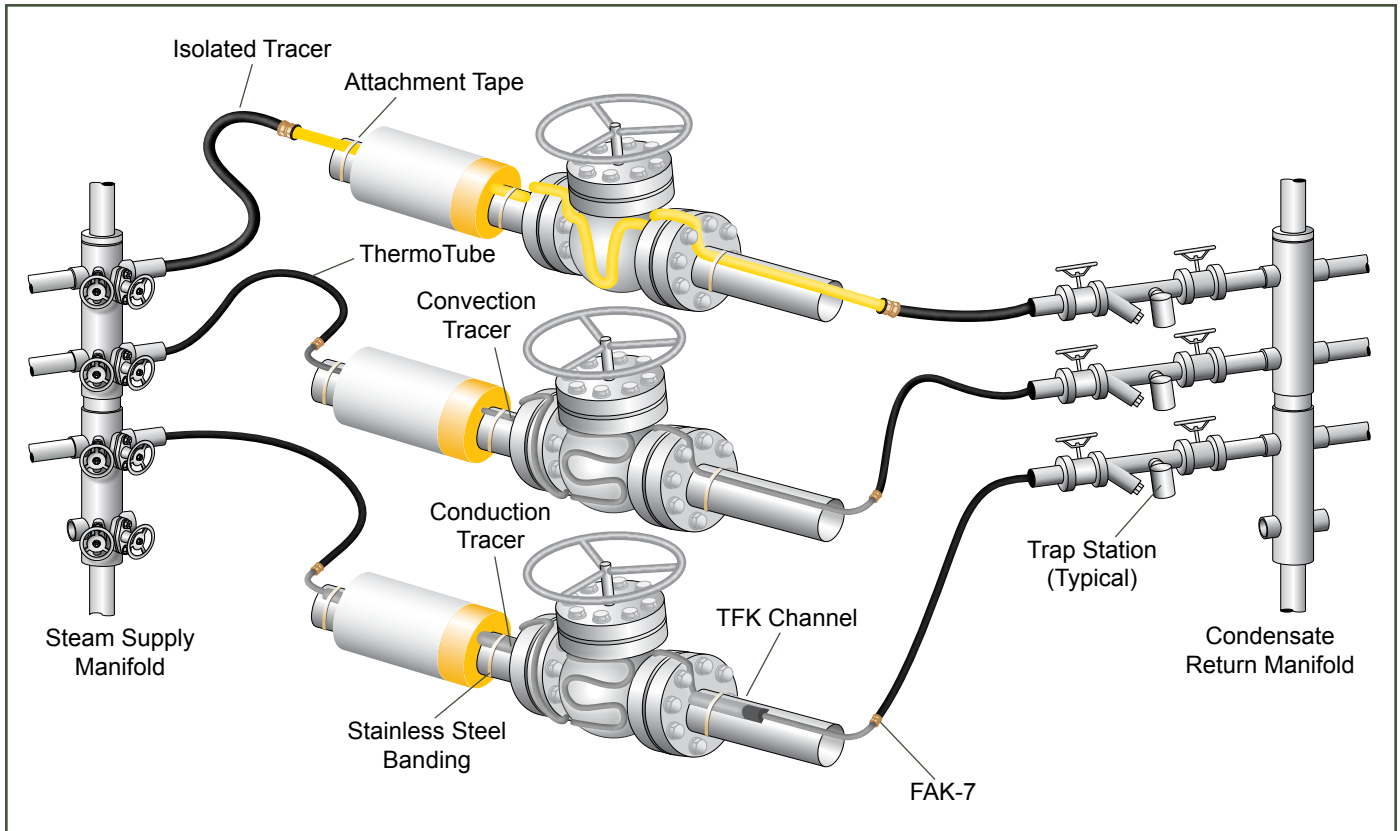
Conduction Tracers . . . Accessories to install Thermon heat transfer compounds include stainless steel banding, crimp seals, banding tools and galvanized steel channel.

Steam Supply and Condensate Return . . . Every steam tracing circuit requires a method to move the steam medium from the supply header to the tracer's starting point and from the tracer's 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, utilize nonhygroscopic glass fiber 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-insulated materials. For additional product information, refer to Thermon Form TSP0009.



Figure 6.1 Typical Steam Tracing System



Basic Accessories . . .



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

- **T2SSB** (.50" x .020") for 3/8" and 1/2" O.D. tube tracers.
- **T3SSB** (.50" x .030") for 3/4" and 1" O.D. tube tracers and NPS 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 . . . fixing tape for circumferential banding of SafeTrace tracer to piping every 12" (300 mm) or as required by code or specification.

Product Rating:
Maximum Exposure Temperature 500°F (260°C)
Minimum Installation Temperature -40°F (-40°C)



FAK-7 . . . each kit contains a roll of self-vulcanizing silicone rubber tape and RTV sealant. The kit contains sufficient materials to waterproof approximately six terminations. No heat gun or special tools are needed for installation.

Product Rating:
Maximum Exposure Temperature 400°F (204°C)
Minimum Application Temperature -64°F (-54°C)



TFK-4 . . . galvanized steel channel covers heat transfer compound applied to 3/8" or 1/2" O.D. tube tracers.

TFK-7 . . . galvanized steel channel covers heat transfer compound applied to 3/4" O.D. tube or 1/2" NPS pipe tracers.

TFK-9 . . . galvanized steel channel covers heat transfer compound applied to 1" O.D. tube and 3/4" or 1" NPS pipe tracers.



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Design Optimization 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 250 psig, 1825 kPa) where possible to decrease the use of pressure-reducing valves and increase 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 installation costs.
 - b. Eliminates maintenance of omitted materials.
4. Use conduction tracers rather than steam-jacketed pipe where possible.
 - a. Significantly reduces material and labor costs.
 - b. Provides flexibility for maintenance.
 - c. Greatly reduces 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 labor cost due to ease of installation.
 - b. Reduces number of fittings required, lowering 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. Reduces the number of trap stations and isola-

tion valves and thus material and installation costs.

- b. Eliminates maintenance of omitted materials.

8. Use preinsulated steam supply and condensate return lines.
 - a. Reduces labor 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. Provides centralized location for steam distribution and condensate collection.
 - b. Minimizes 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. Minimizes installation and labor costs.
 - b. Standardized design reduces maintenance and inventory.

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.
- 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 (Inch-Pound, °F Units)

Gauge Pressure psig	Temp. °F	Heat Btu/lb			Specific Volume cu ft/lb	Gauge Pressure psig	Temp. °F	Heat Btu/lb			Specific Volume cu ft/lb
		Sensible	Latent	Total				Sensible	Latent	Total	
0	212	180	970	1150	26.8	105	341	312	878	1190	3.74
1	215	183	968	1151	25.2	110	344	316	875	1191	3.59
2	219	187	966	1153	23.5	115	347	319	873	1192	3.46
3	222	190	964	1154	22.3	120	350	322	871	1193	3.34
4	224	192	962	1154	21.4	125	353	325	868	1193	3.23
5	227	195	960	1155	20.1	130	356	328	866	1194	3.12
6	230	198	959	1157	19.4	135	358	330	864	1194	3.02
7	232	200	957	1157	18.7	140	361	333	861	1194	2.92
8	233	201	956	1157	18.4	145	363	336	859	1195	2.84
9	237	205	954	1159	17.1	150	366	339	857	1196	2.74
10	239	207	953	1160	16.5	155	368	341	855	1196	2.68
12	244	212	949	1161	15.3	160	371	344	853	1197	2.60
14	248	216	947	1163	14.3	165	373	346	851	1197	2.54
16	252	220	944	1164	13.4	170	375	348	849	1197	2.47
18	256	224	941	1165	12.6	175	377	351	847	1198	2.41
20	259	227	939	1166	11.9	180	380	353	845	1198	2.34
22	262	230	937	1167	11.3	185	382	355	843	1198	2.29
24	265	233	934	1167	10.8	190	384	358	841	1199	2.24
26	268	236	933	1169	10.3	195	386	360	839	1199	2.19
28	271	239	930	1169	9.85	200	388	362	837	1199	2.14
30	274	243	929	1172	9.46	205	390	364	836	1200	2.09
32	277	246	927	1173	9.10	210	392	366	834	1200	2.05
34	279	248	925	1173	8.75	215	394	368	832	1200	2.00
36	282	251	923	1174	8.42	220	396	370	830	1200	1.96
38	284	253	922	1175	8.08	225	397	372	828	1200	1.92
40	286	256	920	1176	7.82	230	399	374	827	1201	1.89
42	289	258	918	1176	7.57	235	401	376	825	1201	1.85
44	291	260	917	1177	7.31	240	403	378	823	1201	1.81
46	293	262	915	1177	7.14	245	404	380	822	1202	1.78
48	295	264	914	1178	6.94	250	406	382	820	1202	1.75
50	298	267	912	1179	6.68	255	408	383	819	1202	1.72
55	300	271	909	1180	6.27	260	409	385	817	1202	1.69
60	307	277	906	1183	5.84	265	411	387	815	1202	1.66
65	312	282	901	1183	5.49	270	413	389	814	1203	1.63
70	316	286	898	1184	5.18	275	414	391	812	1203	1.60
75	320	290	895	1185	4.91	280	416	392	811	1203	1.57
80	324	294	891	1185	4.67	285	417	394	809	1203	1.55
85	328	298	889	1187	4.44	290	418	395	808	1203	1.53
90	331	302	886	1188	4.24	295	420	397	806	1203	1.49
95	335	305	883	1188	4.05	300	421	398	805	1203	1.47
100	338	309	880	1189	3.89						



Design Guide

For Steam Tracing Applications

Properties of Saturated Steam (SI Metric Units)

Pressure kPa Absolute	Temp. °C	Heat kJ/kg			Specific Volume m ³ /kg	Pressure kPa Absolute	Temp. °C	Heat kJ/kg			Specific Volume m ³ /kg
		Sensible	Latent	Total				Sensible	Latent	Total	
101.3	100	419	2257	2674	1.67	650.2	162	684	2076	2760	0.293
108.8	102	428	2251	2679	1.57	683.6	164	693	2069	2762	0.279
116.7	104	436	2245	2681	1.47	718.3	166	702	2062	2764	0.266
125.0	106	444	2241	2685	1.37	754.5	168	711	2056	2667	0.254
133.9	108	453	2235	2688	1.29	792.0	170	719	2050	2769	0.243
143.3	110	461	2230	2691	1.21	831.1	172	728	2043	2771	0.232
153.2	112	470	2224	2694	1.14	871.6	174	737	2036	2773	0.222
163.6	114	478	2219	2697	1.07	913.7	176	746	2029	2774	0.212
174.6	116	487	2213	2700	1.01	957.4	178	754	2022	2776	0.203
186.3	118	495	2208	2703	0.947	1002.7	180	763	2015	2778	0.194
198.5	120	504	2202	2706	0.892	1049.7	182	772	2008	2780	0.186
211.4	122	512	2197	2709	0.841	1098.4	184	781	2000	2781	0.178
225.0	124	521	2191	2712	0.793	1148.8	186	790	1993	2783	0.170
239.3	126	529	2186	2715	0.749	1201.1	188	799	1986	2784	0.163
254.3	128	538	2180	2718	0.707	1255.3	190	808	1979	2786	0.156
270.1	130	546	2174	2721	0.668	1311.2	192	816	1971	2787	0.150
286.7	132	555	2168	2723	0.632	1369.2	194	825	1964	2789	0.144
304.1	134	563	2162	2725	0.598	1429.1	196	834	1956	2790	0.138
322.2	136	572	2156	2728	0.566	1491.0	198	843	1949	2792	0.133
341.4	138	580	2125	2731	0.537	1555.1	200	852	1941	2793	0.127
361.4	140	589	2145	2734	0.509	1621.2	202	862	1932	2794	0.122
382.3	142	598	2139	2737	0.482	1689.5	204	871	1924	2795	0.117
404.2	144	606	2133	2739	0.458	1760.1	206	880	1917	2797	0.113
419.2	146	615	2127	2742	0.435	1832.9	208	889	1908	2797	0.108
451.0	148	623	2121	2744	0.413	1908.0	210	898	1900	2798	0.104
476.0	150	632	2114	2746	0.393	1985.5	212	907	1892	2799	0.100
502.0	152	641	2108	2749	0.373	2065.4	214	916	1884	2800	0.0965
557.6	156	658	2096	2754	0.338	2147.7	216	925	1875	2800	0.0929
587.2	158	667	2089	2756	0.322	2232.7	218	935	1867	2802	0.0894
618.0	160	676	2082	2758	0.307	2320.1	220	944	1858	2802	0.0861



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