PIP PNSC0035
Steam Tracing Specification
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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1. **Scope**

This Practice provides requirements and details for the design and installation of steam tracing systems.

This Practice describes minimum requirements for design, materials of construction, installation, leak testing, and inspection of steam tracing systems for process fluids that require heating to prevent condensation, freezing, unacceptable viscosity, crystallizing, separation, or temperature control. This Practice provides requirements for equipment, piping, and instruments for steam tracing including steam supply piping, steam tracers, tracer traps, and condensate collection.

*Comment:* Use of this Practice for contractual purposes requires the purchaser to make specific choices and assemble additional supporting documents. Listing of or reference to supporting documents within this Practice does not imply suitability for specific designs.

2. **References**

Applicable parts of the following Practices and industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 **Process Industry Practices (PIP)**

- PIP INSH1000 - *Hot Service Insulation Materials and Installation Specification*
- PIP PN50SD0L01 - *Piping Material Specification 50SD0L01, 316/316L Stainless Steel, 0.000” C.A., Process Tubing*
- PIP PNF0200 - *Vents, Drains, and Instrument Connection Details*

2.2 **Industry Code and Standards**

- ASTM B68 - *Standard Specification for Seamless Copper Tube, Bright Annealed*
- ASTM B75 - *Standard Specification for Seamless Copper Tube*
- ASME B31.3 - *Process Piping*

3. **Definitions**

- **air convection tracing:** Tracers attached to the pipe without the use of heat-transfer compounds. Tubing may be bare or have a polymer jacket. A tracer is attached to the pipe with high-temperature tape, tie-wires, or bands. Heat transfer is by means of air convection movement of heat in the annular space between the thermal insulation and the heated pipe.

- **ambient temperature:** The temperature of the air in the surrounding atmosphere

- **condensate:** Water that is formed in the steam tracer tube if latent heat from the steam is given up to the heated pipe or equipment

- **conduction tracing:** Tracer tube that is thermally bonded to the heated pipe or equipment by heat-transfer compound if the primary heat transfer means is by conduction directly into the metal wall of the pipe or equipment being heated

- **dry steam:** Steam containing no moisture; either saturated or superheated
heat loss: The rate at which heat flows from a hot surface, such as a process pipe to a cooler atmosphere, usually stated in Btu/h feet (kcal/m) of length of pipe. The heat loss is typically from the pipe through the pipe insulation to the cooler atmosphere, but can also be from conduction through hangers and supports.

heatsink: A surface or mass such as a flange or valve that is at a lower temperature than the warm pipe

heat tracing: The application of hot liquid, vapor, steam tracing tubes, electric heating cables, or tapes to pipes, fittings, valves, pumps, tanks, instruments, or instrument lines to offset the heat loss through thermal insulation

heat-transfer compound: A heat-conductive material with highly efficient thermal characteristics for use on any steam or fluid tracer tube. The heat-transfer compound is used to establish a broad, heat-conductive contact surface, for heat-transfer purposes, between the tracer tube and the surface to be heated.

isolated tracing: Tracing for sensitive piping and processes where the tracer tube is separated from the pipe or equipment by a low conductive material. This tracing includes preinsulated tubing with a polymer protective jacket. Heat transfer is primarily by air-convection movement of heat in the annular space between the thermal insulation and the heated pipe.

owner: The party who owns the facility wherein the steam tracing system will be used

saturated steam: Steam at the temperature and pressure at which vaporization takes place for that pressure and is free of moisture

steam and condensate manifolds: Modular prefabricated steam supply and condensate collection units designed specifically for steam tracing circuits

steam tracing: A tube or small pipe carrying steam, which is placed parallel and attached to the surface of the pipe or equipment to be heated. The tube is referred to as the “tracer,” “tracer tube,” or simply “tracing.”

supplier: The party responsible for designing, providing the materials for, and installing the insulation system

4. Requirements

4.1 Design

4.1.1 Tracing System Temperature Control

Proper temperature control based on an assessment of the actual system shall be evaluated.

4.1.2 Steam Supply Design/Layout

4.1.2.1 Steam used to supply steam tracing shall be from a constant source that can be maintained independently of plant operations.

4.1.2.2 If possible, the steam supply shall be taken from a source that is continuously available even during normal shutdown periods.

4.1.2.3 Steam shall be distributed at the highest pressure and reduced to the design requirements of the tracer system using a pressure-reducing valve.
4.1.2.4 To help ensure the quality of the tracing steam, all steam supply manifolds and tracer circuits shall have a separate steam trap station installed.

4.1.2.5 Tracing steam shall be dry saturated steam at a pressure that provides the tracing design heat input requirements.

4.1.2.6 The tracing supply header shall be adequately sized to provide the maximum tracer design load (steam pounds per hour) and trapped at its low points.

4.1.2.7 The number of tracer connections on a manifold shall be 12 maximum. A minimum of two of these connections shall be designated as spares.

4.1.2.8 If possible, vertical type manifolds shall be provided.

4.1.3 Steam Trap Selection

Comment: Effective removal of condensate and air is essential to achieving uniform temperatures and maximum heat-transfer rates from steam tracing circuits.

4.1.3.1 Steam trap manufacturers shall be consulted regarding the selection and sizing of the steam traps as well as for sizing and proper installation techniques to provide trouble-free winter performance.

4.1.3.2 Preassembled steam trapping stations with universal connectors are preferred.

4.1.3.3 The type of traps selected shall be in accordance with the design and efficiency requirements of the tracing system.

4.1.4 Steam Pressure Selection

The following criteria shall be considered when selecting the steam pressure that can be utilized to meet the steam tracing design requirements:

a. Desired maximum allowable number of tracers on a line

b. Desired maximum allowable length of the tracer tubing that is connected to the line

c. Elevation differences between the location of the steam manifold and traced piping

d. Sensitivity of process fluid or piping material to conduction or localized heating

e. Plant site environmental design criteria (summer and winter design temperatures and mean wind velocity)

f. Pressure differential between steam trap discharge and the condensate return header including any static pressure head

g. Pressure of plant steam that is dedicated for steam tracing

h. Required maintenance temperatures (allowable minimum/maximum temperature range for traced piping)

i. Safety factor for drops in steam pressure

j. Size and desired maximum length of all steam supply and condensate return leads
k. Traced piping size (outside diameter [OD]) and material of construction
l. Tracing size and type (air convection, conduction, or isolated tracing)
m. Type and thickness of the insulation system

### 4.1.5 Selection of Tracer Type

#### 4.1.5.1
The selection of the steam tracer for each heated pipe and piece of equipment shall be based on the process sensitivity and the temperature to be maintained along with the heat load demand, tracer capability, and the results of the design scenarios.

#### 4.1.5.2
Isolated tracing shall be considered for the following operating conditions:

a. Reduced thermal risk is important to aid in compliance with applicable safety standards
b. A controlled, predictable heat-transfer rate shall be maintained to prevent corrosion or other unacceptable temperature-related conditions
c. For sensitive products (e.g., caustics, acids, amines, resins, and aqueous fluids) that require low uniform heat for freeze protection

#### 4.1.5.3 Convection Tracing

1. Convection tracing shall be provided for the following operating conditions:

a. Only one convection tracer is needed to hold the required temperature
b. Winterization is required for lines carrying material such as air, water, gases, or other noncorrosive aqueous solutions
c. Low heat density and flexibility is required for high-maintenance valves, pumps, and other such equipment
d. For process lines in which ambient temperature fluctuations or emergency shutdown and heat-up requirements do not require more heat than the convection tracer supplies

2. Multiple convection tracers usually cannot be economically justified if one tracer with heat-transfer compound can suffice because of the additional steam supply connections and trap assemblies required.

3. A convection tracer may be doubled back if allowable pressure drops are not exceeded. The use of doubled-back tracers should be minimized.

4. Unless otherwise specified, spiraled convection tracers shall not be permitted 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 on horizontal runs requires more frequent trapping.
4.1.5.4 Tracers with heat-transfer compound may be utilized for the following operating conditions:
   a. More than one convection tracer is required
   b. Fast heat-up is essential after an emergency or a planned shutdown
   c. A more even temperature distribution is required
   d. High heat density and flexibility is required at valves, pumps, and other such equipment
   e. It is desirable to keep the required number of tracers to a minimum

4.1.5.5 Preinsulated instrument tubing bundles and high-density polyurethane instrument enclosures shall be provided for the following situations:
   a. Closely predicted thermal characteristics are required for pressure and differential pressure transmitters, process analyzers, emissions analyzers, and other such applications
   b. Space is limited, pretraced and insulated bundles can be shaped to allow layout by way of the shortest distance with simple supports in locations where field-fabricated lines are not practical
   c. Factory-applied polymer weather protection is preferred on critical lines

4.1.5.6 Tracing with self-acting, off-on, or pressure-reducing control valves with sensors that respond to the pipe wall or ambient temperature shall be considered for:
   a. Piping that operates intermittently
   b. Prevention of overheating the product
   Comment: If the process fluid is sensitive to over heating, self-acting off-on in steam tracers may not be suitable.
   c. Constant viscosity is required for instrumentation
   d. Energy efficiency is a key requirement
   e. Piping requires process heat-up
   f. Piping requires freeze protection during shutdown periods

4.1.6 Size and Number of Tracers

4.1.6.1 To facilitate designing a cost-effective tracing system, the number of tracer circuits shall be minimized.

4.1.6.2 The following factors shall be considered in the design:
   a. Fixed factors furnished by the purchaser:
      (1) Nominal pipe size
      (2) Desired pipe temperature
      (3) Lowest ambient temperature and highest wind speed
b. Variable factors that shall be balanced to establish an appropriate design:
   (1) Tracer type, size, and number
   (2) Steam inlet pressure and temperature
   (3) Insulation type and thickness

4.1.6.3 All flow diagrams shall be reviewed to determine the steam tracing requirements for each line.

4.1.6.4 Isometric drawings identifying steam supply headers, tracer supply manifolds, tracer routing, tracer trap stations, and condensate return lines shall be provided to facilitate proper design and installation of the tracing system.

4.1.6.5 The tracer size and number of tracer circuits required to supply the heating requirement on a line or equipment item shall be determined by calculation, manufacturer’s data, or the use of a computer program developed for steam tracing design.

4.1.6.6 The maximum trapping length and the maximum vertical rise for each tracer circuit shall be determined from calculation, manufacturer’s data, or the use of a computer program developed for steam tracing design.

4.1.6.7 The maximum length of the tracing circuit shall not exceed the calculated maximum trapping length for the tracer including the supply and return leads.

4.1.6.8 Maximum tracer length shall be applicable to the length of the tracer attached to the line. The tracer length shall be measured from the point where the tracer first contacts the line to be heated to the point where it connects to the return lead routed to the trap station.

4.1.6.9 Pressure losses for preinsulated tubing that runs from the steam manifold to the tracer circuit, from the tracer to the condensate manifold, and from the manifold to the condensate return header shall be calculated separately if the length of these runs is greater than 30 m (100 feet) total.

4.2 Materials

4.2.1 General

4.2.1.1 All materials used to construct steam tracing components shall be new and in accordance with this Practice.

4.2.1.2 See PIP Piping Material Specifications as required for piping details.

4.2.1.3 Steam supply, condensate return, and tracer tubing wall thickness shall be in accordance with ASME B31.3.

4.2.1.4 Steam supply subheaders and tracing steam distribution manifolds shall be of the same materials as the steam header.

4.2.1.5 Condensate return subheaders and tracing condensate collection manifolds shall be of the same materials as the condensate return header.
4.2.2 Preinsulated Leads

4.2.2.1 Tubing shall be insulated with approved purchaser thermal insulation and jacketed with plastic rated for 40°C (105°F) or greater.

4.2.2.2 Sufficient insulation shall be provided for a maximum surface temperature of 60°C (140°F) during operation. The sensible temperature and wind speed for the location and the maximum steam temperature and pressure expected for the particular application should be considered.

4.2.3 Tracer Material

4.2.3.1 The tracer in a steam tracing system shall be sufficiently flexible for ease of installation and conformance to the shape and layout of the pipes and equipment being heated.

4.2.3.2 The tracer shall act as a leak-proof carrier of the heating media.

4.2.3.3 If possible, tubing shall be used rather than pipe for tracing.

4.2.3.4 The tracer shall be selected in accordance with the thermal and installation requirements as determined by the process pipe material, temperature of the process pipe and tracer, pressure of the heating media, and the environment.

4.2.3.5 The tracer material shall be galvanically compatible with the process pipe.

4.2.4 Copper Tubing

4.2.4.1 Bare copper tubing tracers shall be in accordance with or exceed ASTM B68 and ASTM B75 soft-annealed grade 122.

4.2.4.2 Unless corrosion or other deterrents exist, copper tubing shall be used if the saturated steam pressure or the item being traced does not exceed 204°C (400°F).

4.2.4.3 Tubing wall thicknesses shall be as follows for the tubing sizes shown:
   a. 9.52 mm (3/8-inch) OD: 0.89-mm (0.035-inch)
   b. 12.7-mm (1/2-inch) OD: 0.89 mm (0.035-inch)
   c. 19-mm (3/4-inch) OD: 1.24-mm (0.049-inch)

4.2.4.4 6.35-mm (1/4-inch) OD tubing tracers shall be used only if absolutely required for heating small tubes or other similar applications.

4.2.5 Stainless Steel Tubing

4.2.5.1 Bare stainless steel tubing shall be type 316/316L stainless steel in accordance with PIP PN50SD0L01.

4.2.5.2 Unless corrosion or other deterrents exist, stainless steel tubing shall be used if the saturated steam pressure or the item being traced has a maximum temperature between 204°C (400°F) and 427°C (800°F).

4.2.5.3 Tubing wall thicknesses shall be as follows for the tubing sizes shown:
   a. 9.52-mm (3/8-inch) OD: 0.89-mm (0.035-inch) minimum
4.2.6 Preinsulated Tracers

4.2.6.1 The material requirements for preinsulated tracer tubing shall be the same as specified in this Practice for bare tracers.

4.2.6.2 Preinsulated tracers shall be covered with a flexible insulation and a weather-tight flexible jacket.

4.2.6.3 The jacket shall be flexible enough to permit bending the preinsulated tracer to fit typical installations.

4.2.7 Tracer Tubing Fittings

4.2.7.1 Tracer tubing fittings shall be suitable for the pressure of the contained steam.

4.2.7.2 Fittings shall be compression type.

4.2.7.3 Fittings shall be made of material compatible with the tracer construction material.

4.2.8 Steam Traps

4.2.8.1 Steam traps shall be sized for the maximum calculated condensate load in the expected operating pressure range.

4.2.8.2 Steam traps shall be provided with an integral strainer, air vent, and blow-off valve.

4.2.9 Insulation System

4.2.9.1 The next largest pipe-size rigid insulation (e.g., calcium silicate, expanded Perlite, cellular glass, etc.) shall be provided; however, insulation of the actual pipe-size may be used if board sections are cut to fit the longitudinal joint to compensate for the steam tracer.

4.2.9.2 The insulation material shall be selected carefully in accordance with PIP INSH1000.

4.2.9.3 The following important selection aspects shall be considered:

a. Thermal insulating characteristics
b. Mechanical strength characteristics
c. Chemical stability characteristics under both normal and abnormal conditions
d. Moisture absorption characteristics
e. Personnel health and safety
f. Installed cost

4.2.10 Heat-Transfer Compounds

Various formulations of heat-transfer compounds are available to cover a wide range of tracing applications. Selection of the proper formulation shall include consideration of all the following:
a. Minimum and maximum temperatures to which heat-transfer compounds shall be exposed under both normal and abnormal operating conditions
b. Ambient conditions under which heat-transfer compounds shall be installed
c. Piping and equipment size and configuration
d. Total installed cost for the heat-transfer compounds
e. Feasibility of performing start-up curing procedures if required
f. Solubility resistance of the heat-transfer compounds

4.3 Installation

4.3.1 Tracer Tube Cutting and Shaping

4.3.1.1 Tracer tube bends shall be free of kinks, wrinkles, or flattening.
4.3.1.2 Bends shall be made with a mechanical tubing bender.
4.3.1.3 Bend radii should typically be from four to ten times the outside diameter of the tube. The largest functional radius should be used.
4.3.1.4 A tube cutter or hacksaw shall be used to cut the tracer tubes.
4.3.1.5 Guide blocks shall be used with a hacksaw cutting to assure a square cut.
4.3.1.6 Outside diameter deburring shall be performed using a file.
4.3.1.7 Inside diameter deburring shall be performed using a deburring tool.

4.3.2 Tubing Unions

4.3.2.1 Tubing unions shall be installed in tracers where required for removal of equipment (e.g., pumps, relief valves, instruments, control valves, and strainers).
4.3.2.2 Tubes shall be formed to join with true alignment to the centerline of the unions without distortion or tension.

4.3.3 Steam Supply Layout

4.3.3.1 The tracing supply header shall be located as close as possible to the point of use.
4.3.3.2 If three or more tracers are supplied from a common header, prefabricated manifolds shall be considered.
4.3.3.3 Each tracer supply line (subheader) from the steam header shall be:
   a. Equipped with an isolation valve located where the valve is accessible to the plant operation personnel.
   b. Routed from the top of the tracer supply header at the highest point possible and shall slope downward to the tracer steam supply distribution manifold subheader avoiding pockets if possible.

4.3.3.4 Preinsulated Tubing

1. Preinsulated tubing with factory-applied insulation and a polymeric weather-protective jacket may be used for steam supply and condensate return leads.
2. Preinsulated tubing leads shall be routed as follows:
   a. From the distribution manifold block valve outlet to where the tracer that is attached to the piping enters the insulation.
   b. From the point of connection where the tracer piping exits the insulation to the inlet connection of the steam trap station located on the condensate collection manifold.
3. If possible, all leads should be routed symmetrically and run together to maintain a neat appearance.
4. If possible, pockets shall not be permitted.
5. To ensure a cost-effective design, the length of the supply and return leads shall be kept to a minimum, preferably from 7.6 m (25 feet) to 21 m (70 feet) in length.

4.3.3.5 Steam supply manifolds shall be strategically located along the tracing route and shall be accessible from grade, platform, or permanent ladder.

4.3.3.6 Steam supply manifolds shall be provided with an isolation valve.

4.3.3.7 If condensate is not returned, supply manifolds shall be drained using a trap and discharged to the atmosphere directed to a safe location.

4.3.4 Trap and Condensate Return Systems

4.3.4.1 Steam trap condensate manifold assemblies shall be provided with the following:
   a. Internal siphon tube for freeze protection of traps that are shut off
   b. Freeze protection valve that senses condensate temperature to drain the manifold if the condensate cools to a given set point

4.3.4.2 If possible, steam trap manifold assemblies shall be placed in an accessible location to facilitate maintenance.

4.3.4.3 Manufactured steam trap, steam distribution, and condensate collection manifolds designed specifically for steam tracing applications are preferred.

4.3.5 Tracer Location and Routing

4.3.5.1 Tracers serving the same or adjacent items shall be grouped and supplied from a common manifold to facilitate maintenance. Condensate shall be returned to a common return manifold.

4.3.5.2 The steam supply should start at the highest point of the lines to be traced, and the tracers shall be arranged to slope downward avoiding pockets if possible.

4.3.5.3 Unless otherwise approved by owner, the accumulated vertical tracer rise (pocket height) in feet should not be greater than 15% of the steam supply pressure.

4.3.5.4 Each tracer shall be continuous from the supply manifold to the trap without vents, drains, or dead-end extensions at intermediate points.
4.3.5.5 In general, branch connections shall be avoided. If branches are required, each branch shall have its own trap.

4.3.5.6 All tracers shall be installed parallel to and against the heated pipe or equipment and shall be placed on the most accessible surface location in regard to supports, ease of installation, connection, and thermal insulation.

4.3.5.7 Multiple tracers shall be equally spaced around the circumference of the pipe.

4.3.5.8 If possible, expansion of bare (convection) tracer tubes shall be absorbed at elbows and flanges.

4.3.5.9 For long straight runs, 0.305-m (12-inch) diameter horizontal loops shall be provided at 18-m to 30-m (60-feet to 100-feet) intervals, preferably midway between fittings.

4.3.5.10 Tracer loops provided specifically for expansion shall not contain unions.

4.3.5.11 Tracer loops around flanges shall be horizontal to permit drainage during shutdown, and unions shall be provided so tracers can be disconnected at valves, pumps, tanks, or other flange-connected equipment.

4.3.5.12 Tracing shall be included on dead legs and similar heatsinks along the traced line.

4.3.5.13 Each tracer circuit shall have a separate trap station installed at the end of the tracer circuit.

4.3.5.14 Slots shall be provided in the thermal insulation to accommodate expansion of the tracer where it joins and leaves the traced line. See detail PIP PNSC0035-17 appended to this Practice for arrangement details.

4.3.5.15 Extra Tracer Lengths

1. Typically, extra tracer lengths shall not be required at pipe hangers, piping tees, and ells.
2. Extra tracer lengths shall be provided for valves or large pieces of equipment.
3. Extra tracer lengths for pipe supports or flanges in critical service shall be provided.

4.3.5.16 Insulated pipe supports shall be considered for critical temperature maintenance situations.

4.3.5.17 All tracers should be arranged to accommodate maintenance and removal of traced valves, instruments, and other equipment.

4.3.6 Trap Stations

4.3.6.1 If possible, a steam trap shall be installed below the tracer circuit and at a condensate manifold located to not interfere with the operation and maintenance of equipment or obstruct access ways.

4.3.6.2 Each tracer circuit shall be trapped individually at the tracer termination point determined from the circuit design information.

4.3.6.3 A new tracer shall be installed for continuing the tracing if the pipe-run exceeds the specified maximum trapping length.
4.3.6.4 Isolation valves shall be installed to accommodate servicing of the trap.

4.3.6.5 Discharge to Overhead Return Line

1. If condensate is to be discharged to an overhead return line or against a lift, a swing check valve shall be installed in the discharge line just beyond the trap at the bottom of the lift if the trap does not have an integral check valve or is not otherwise designed to prevent back flow.

2. The discharge line from the trap shall feed into the top of the return main.

3. The pressure due to the lift shall be added to the pressure in the overhead return line to determine the total back pressure against which the trap shall discharge.

4. A value of 3.44 kPa per vertical meter (0.5 psi/ft) of lift shall be used to calculate the pressure from lift.

5. The back pressure shall not be greater than the allowable limit of the selected trap.

4.3.6.6 A test tee should be installed just downstream of the trap to permit checking of trap performance.

4.3.7 Tracing Identification

4.3.7.1 Each tracer circuit shall be identified by two corrosion-resistant identification tags. One tag shall be installed on the steam supply valve at the steam distribution manifold and the other tag shall be installed on the isolation valve located on the steam trap assembly.

4.3.7.2 Steam tracer supply stations and condensate trap stations shall be given line numbers. An isometric piping erection drawing shall be made for each station. These stations shall be assigned numbers that shall be located on the plot plan and the model to indicate unit number, station number, and whether they are supply or trap stations.

4.3.7.3 The identification tags shall be fabricated from 16-gauge corrosion-resistant material suitable for the environment and attached to the supply valve and steam trap assembly valve with No. 16 gauge corrosion-resistant wire.

4.3.7.4 Identification tags shall be stamped with 6-mm (1/4-inch) numbers and letters using the identification system established for the project.

4.3.7.5 See details PIP PNSC0035-09 through PNSC0035-12 appended to this Practice for identification tags for tracing lines and manifolds.

4.3.8 Tracers on Valves and Pumps

4.3.8.1 Tracing for valves and pumps shall be tubing in the form of hairpin loops so that the tracer makes the least amount of complete circles.

4.3.8.2 The number of feet of tracer to surface area of valve or pump shall be sufficient to obtain the same ratio or greater of feet of tracer per unit of surface area as on the straight pipe surface area.
4.3.8.3 Unless otherwise specified, hairpin tubing loops shall be attached to the valve or pump surface with 12-mm by 0.5-mm (1/2-inch by .020-inch) stainless steel bands, high-temperature fiberglass tape, or No. 16 gauge stainless steel wire.

4.3.8.4 See details PIP PN3C0035-20, PN3C0035-21, and PN3C0035-25 appended to this Practice for arrangement details.

4.3.9 Tracers on Vessels

4.3.9.1 Unless otherwise specified, external tracing for vessels shall be either prefabricated stainless steel heating panels formed to the required radius, or hairpin loop tubing panels.

4.3.9.2 See details PIP PN3C0035-24 and PN3C0035-25 appended to this Practice for arrangement details for tracing on vessels.

4.3.9.3 Prefabricated stainless steel heating panels may have a layer of factory-applied nonhardening heat-transfer compound between the vessel surface and the back of the heating panel.

4.3.9.4 Small equipment with an outside radius of curvature less than 178 mm (7 inches) and vessel bottoms with compound curved surfaces may be traced with tubing in the form of hairpin loops in lieu of heating panels.

4.3.9.5 Unless otherwise specified, hairpin circuits shall be embedded in heat-transfer compound.

4.3.9.6 Each tracing panel shall have a separate steam trap station.

4.3.9.7 Tracing systems on equipment shall be separate from tracing systems dedicated for piping.

4.3.10 Tracing on Instruments

4.3.10.1 Tracing for instruments and instrument impulse lines shall be in accordance with details PIP PN3C0035-26 through PN3C0035-35 appended to this Practice.

4.3.10.2 Tracing shall be installed so that instruments can be removed for maintenance without interrupting or removing the tracing.

4.3.10.3 Tracing shall be applied only to the process-wetted parts of instruments, not to electronic or pneumatic parts.

4.3.10.4 Tracer sizes shall be as follows for the applications shown:
   a. Gauge glass and external displacer level instruments: 12-mm (1/2-inch) OD tubing
   b. Meter leads: 10-mm (3/8-inch) or 12-mm (1/2-inch) OD tubing

4.3.11 Heating Systems for Instrument Enclosures

4.3.11.1 Pressure gauge enclosures shall be heated with the heat from the process line by installing heat conservation insulation up to the enclosure or by continuing the tracer at the gauge connection.
4.3.11.2 Differential pressure transmitters with partial enclosures shall be heated by a steam heater block installed under the instrument. The heater shall have its own flexible thermal insulation cover and be installed where it will not interfere with removal of the transmitter.

4.3.11.3 Preinsulated tubing bundles may be used in lieu of field-traced and insulated instrument lead lines.

4.3.11.4 Transmitters, controllers, recorders, etc., with complete polyurethane enclosures shall be heated with a separate finned steam heater connected by tube fittings to the steam tracer.

4.3.12 Preinsulated Lead Supports

4.3.12.1 The installation and support of preinsulated instrument tubing bundles and preinsulated steam supply and condensate return lines shall be in accordance with the manufacturer’s specifications.

4.3.12.2 Routing and support shall be determined in the field.

4.3.12.3 If possible, preinsulated tubing lines shall be run together for common support.

4.3.12.4 Preinsulated tubing shall be spaced and located in accordance with the following considerations:
   a. Ability to place a durable support at some desired location
   b. Keep sag in the line within limits that permit drainage
   c. Avoid bends that are less than the minimum bend radius as recommended by the manufacturer
   d. Allow for heat dissipation by keeping a minimum 12-mm (1/2-inch) space between the preinsulated lines

4.3.13 Tracing Installation Sequence

After the process pipe has been installed with proper supports and hangers to permit correct application of tracers and insulation, the following major steps for installation of the tracer system shall be performed in the sequence shown:

a. Ensure that all leak testing of the piping has been completed.

b. Ensure that all the required coatings have been applied on the pipe.

c. Perform surface preparation of process piping.

d. Perform surface preparation of tracer.

e. Perform installation of tracer and its securement.

f. Perform pressure testing of tracer.

g. Perform application of heat-transfer compound if required.

h. Ensure curing of heat-transfer compound if required.

i. Inspect the tracer system in accordance with the requirements specified in this Practice.
j. Perform application of thermal insulation system in accordance with 
   *PIP INSH1000*

k. Perform inspection of insulation system in accordance *PIP INSH1000*.

### 4.3.14 Surface Preparation of Piping

4.3.14.1 All tracer tubes and pipes or equipment to be traced shall be reasonably 
   clean before installation of steam tracers.

4.3.14.2 For non-coated surfaces, dirt, rust, and scale may be removed with a 
   wire brush.

4.3.14.3 Oil and grease films on coated or noncoated surfaces may be removed 
   with a rag and suitable solvent.

4.3.14.4 For coated surfaces, clean compressed air, brushes, or rags shall be used 
   to remove all loose dirt or dust.

4.3.14.5 Preparation for the application of heat-transfer compounds shall be 
   performed in accordance with the manufacturer’s instructions.

### 4.3.15 Surface Preparation of Tracers

All tracers shall be free of dirt, grease, oil, loose scale, or any other nonspecified 
material before installation on piping and equipment and before application of 
heat-transfer compound if applicable.

### 4.3.16 Tracer Securement to Process Lines

4.3.16.1 The tracer shall be properly secured to the process pipe where required 
   to prevent stress in the tracer tubing because of expansion.

4.3.16.2 Tracers shall be fastened to piping and equipment with wire, bands, or 
   high-temperature tapes.

4.3.16.3 Covering the tracer with galvanized or stainless steel channels before 
   final attachment may be required to protect the tracer from impacts.

4.3.16.4 Each method of tracing in this Practice shall be installed in accordance 
   with details *PIP PNSC0035-01* through *PNSC0035-35* appended to this 
   Practice.

4.3.16.5 Fastening materials shall be galvanically compatible with the pipe and 
   tracer materials.

4.3.16.6 High-temperature tapes used to secure stainless steel pipe or tubing 
   shall be free of chlorides or halides.

### 4.3.17 Pressure Testing and Cleaning

4.3.17.1 Steam supply headers and pipe or tubing runs to tracers shall be blown 
   clean with steam or air before connection to trap assemblies.

4.3.17.2 After all tracer connections to the supply header and trap have been 
   completed, a circuit shall be tested for leaks using steam pressure equal 
   to or greater than the system pressure or an appropriate hydrostatic test.

4.3.17.3 All leaks shall be repaired and the system retested before the installation 
   of heat-conducting compound (if used) and insulation.
4.3.17.4 Performance of traps, gauges, pressure-relief valves, and pressure- and/or temperature-controlling devices shall be periodically checked.

4.3.18 Insulation

Installation of the insulation system shall be in accordance with the requirements of PIP INSH1000.

4.4 Inspection

4.4.1 The purchaser’s inspector and the tracing and/or insulation manufacturer’s representative shall be given full access to all stages of the work upon request.

4.4.2 Inspections shall be performed to ensure that all phases of the installation are in accordance with the materials and application specifications.

4.4.3 The following checklist items shall be included in the inspections:

a. All materials used are as specified and in good condition.

b. All materials are stored in accordance with recommendations.

c. Surface preparations are as specified.

d. Tracer systems are installed in accordance with the design.

e. All tracing supply headers, preinsulated supply and condensate tubing runs, tracer tubes, and manifolds are cleaned before they are connected to trap assemblies.

f. All tracer circuits and process pipe runs are pressure tested after all connections are completed.

h. Heat-transfer compounds are installed in accordance with specifications and this Practice.

i. Water-soluble heat-transfer compounds are protected from rain and other moisture before installing the thermal insulation and weather barrier.

j. High-temperature insulation is of proper thickness and installed in accordance with specifications.

k. Insulation was dry when installed and protected from rain and moisture until weather barrier was installed.

l. All insulation on vessels is properly supported.

m. Suitable insulation expansion joints are installed.

n. Weather protection is of type specified, installed in accordance with specifications and recommendations, and dry thickness of mastic is of specified dimension.

o. All weather barriers are watertight, and projections and terminations are properly sealed.
NOTE: SEE PIP PNF0200 FOR SPECIFIC DETAILS OF INSTRUMENT CONNECTIONS.
NOTE: DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
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5/8" DIA. x 1 1/2" LG SLOT AS REQUIRED BY FIELD (TYP. 4 PLACES)
FLOW

BLOW DOWN

TRAP WITH SEPARATE STRAINER
TRAP WITH INTEGRAL STRAINER
XX-XXX-XXXXX-XXXX-XXXXXXX
(UNIT/AREA-SERVICE-SEQUENCE-SIZE-LINE-CLASS)
STEAM SUPPLY LINE NUMBER

SP NUMBER → MANIFOLD NUMBER

XXXX-XX

STEAM DISTRIBUTION MANIFOLD NUMBER

TYPICAL TAG NUMBERING SYSTEM

SECURE WIRE TO TAG

14" (360) LONG S.S.
WIRE (22 BWG)

3/32" (2.5) HOLE

3/16"

STEAM DISTRIBUTION MANIFOLD NUMBER

SP-XXX-01

XX-XXX-XXXXX-
XXXX-XXXXXXX

STEAM SUPPLY LINE NUMBER

1/8" (3) HIGH
LETTERING & SPACING

2 1/4" (60) DIA. ALUMINUM
DISC (20 GAGE) WITH
STAMPED LETTERING

TRACING IDENTIFICATION TAG

NOTES:
1. ATTACH TAG TO BLOCK VALVE ON STEAM SUPPLY LINE TO STEAM
   DISTRIBUTION MANIFOLD.
2. DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES
   ARE IN MILLIMETERS.
XX-XXX-XXXXX-XXXX-XXXXXXXXXXXX
(UNIT AREA SERVICE SEQUENCE SIZE LINE CLASS)
CONDENSATE RETURN LINE NUMBER
SP NUMBER MANIFOLD NUMBER
XXX-XX
CONDENSATE RETURN MANIFOLD NUMBER

TYPICAL TAG NUMBERING SYSTEM

SECURE WIRE TO TAG
14" (360) LONG S.S. WIRE (22 BWG)
3/32" (2.5) HOLE
3/16"
CONDENSATE RETURN MANIFOLD NUMBER
SPXXX-01
1/8" (3) HIGH LETTERING & SPACING
XX-XXX-XXXXX-
XXXX-XXXXXXXXXXXX
CONDENSATE RETURN LINE NUMBER

2 1/4" (60) DIA. ALUMINUM DISC (20 GAGE) WITH STAMPED LETTERING

TRACING IDENTIFICATION TAG

NOTES:
1. ATTACH TAG TO BLOCK VALVE ON CONDENSATE RETURN LINE FROM TRACING CONDENSATE RETURN MANIFOLD.
2. DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
XX-XXX-XXXXX-XXXX-XXXXXXXXXXXXX
(UNIT/AREA-SERVICE-SEQUENCE-SIZE-LINE-CLASS)
TRACED LINE NUMBER
MANIFOLD NUMBER
STEAM TRACER NUMBER
XX-SXX
STEAM TRACER NUMBER
SP NUMBER
MANIFOLD NUMBER
XXXXX-XX
STEAM DISTRIBUTION MANIFOLD NUMBER
TYPICAL TAG NUMBERING SYSTEM
SECURE WIRE TO TAG
14” (360) LONG S.S. WIRE (22 BWG)
3/32” (2.5) HOLE
3/16”
STEAM DISTRIBUTION MANIFOLD NUMBER
SPXXX-01
XX-XXX-XXXXX-
XXXX-XXXXXXXXX
STEAM TRACER NUMBER
1/8” (3) HIGH LETTERING & SPACING
2 1/4” (60) DIA. ALUMINUM DISC (20 GAGE) WITH STAMPED LETTERING
TRACING IDENTIFICATION TAG
NOTES:
1. ATTACH TAG TO EACH TRACER BLOCK VALVE ON STEAM DISTRIBUTION MANIFOLD AND EACH PREINSULATED TUBING ATTACHED TO THE BLOCK VALVE.
2. DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
XX-XXX-XXXXX-XXX-XXXXXXXXXXXXX
(UNIT/AREA-SERVICE-SEQUENCE-SIZE-LINE-CLASS)
TRACED LINE NUMBER
MANIFOLD NUMBER

XX-RXX
CONDENSATE RETURN NUMBER

CONDENSATE RETURN TRACER NUMBER
SP NUMBER

XXXX-XX
MANIFOLD NUMBER

CONDENSATE RETURN MANIFOLD NUMBER

TYPICAL TAG NUMBERING SYSTEM

SECURE WIRE TO TAG

14” (360) LONG S.S.
WIRE (22 BWG)

3/32” (2.5) HOLE

3/16”

CONDENSATE RETURN MANIFOLD NUMBER

SPXXX-01

1/8” (3) HIGH LETTERING & SPACING

XX-XXX-XXXXX-

XXXX-XXXXXXXXX

CONDENSATE RETURN TRACER NUMBER

2 1/4” (60) DIA. ALUMINUM
DISC (20 GAGE) WITH
STAMPED LETTERING

TRACING IDENTIFICATION TAG

NOTES:
1. ATTACH TAG TO EACH TRAP STATION BLOCK VALVE ON CONDENSATE RETURN MANIFOLD AND TO THE PREINSULATED TUBING ATTACHED TO THE BLOCK VALVE.
2. DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
TYPICAL CONVECTION TRACER

TYPICAL ISOLATED TRACER

TYPICAL CONDUCTIVE TRACER

NOTE:
DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
TYPICAL TRACER ARRANGEMENTS

TYPICAL TRACER WITH CEMENT AND CHANNEL

TYPICAL TRACER WITH PRE-FORMED CEMENT

TYPICAL ISOLATED TRACER WITH PRE-INSULATED

NOTE: DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
1 TRACER
HORIZONTAL PIPE

2 TRACERS
HORIZONTAL PIPE

3 TRACERS
HORIZONTAL PIPE

1 TRACER
VERTICAL PIPE

2 TRACERS
VERTICAL PIPE

3 TRACERS
VERTICAL PIPE
TYPICAL CONNECTION ON PROCESS PIPING

TYPICAL EXPANSION LOOP

TYPICAL CONNECTION ON PIPE FLANGES

NOTE: LARGER PIPE ELLS MAY REQUIRE ADDITIONAL WIRE OR BANDING TO SECURE WIRE OR BANDING PER STANDARD

TYPICAL CONNECTION ON PIPE ELBOWS

ELBOW OPTION FOR ALL CONNECTIONS
PIPE LINE TRACER
INSULATION PENETRATIONS

SLIT INSULATION TO PROVIDE FOR THERMAL EXPANSION. FILL WITH INSULATION MASTIC.

STEAM

CONDENSATE

INSULATION MASTIC

WRAP EXPOSED TUBE WITH INSULATING TAPE

TUBE UNION DETAIL

SECTION A-A

SECTION B-B
BANDING AT ELBOW

TIE WIRES (TYP. 3 PLACES)

BANDING AT STRAIGHT PIPE

TIE WIRES ON 24” (600) CENTERS

NOTE: DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
EXAMPLES OF ACCUMULATED RISE

(SEE PIP PNSC0035–21 FOR SPECIFIC RECOMMENDED ARRANGEMENTS)

AR = A + B + C
AT FLANGES

AR = SUM OF "X" DIMENSION
AT VALVES

AT PIPING

NOTE: THE SUM OF THE RISERS, EXPRESSED IN FEET, SHALL NOT BE GREATER THAN:

\[ A + B + C + D \leq \frac{(P_1 - P_2)}{3} \times (2.31) \]
3/8" TUBING – MAY BE USED FOR WRAPPING NPS 3 VALVES

NOTE: PROVIDE THREE INSULATING SPACES ON VALVES FOR ISOLATED TRACING ONLY

TUBE UNION – LOCATE OUTSIDE INSULATION

NPS 3 & SMALLER FLANGED VALVES

SECTIONS A–A & B–B
(OPPOSITE HAND)

USE MAXIMUM NUMBER OF HAIRPINS AS PERMITTED BY BEND RADIUS

PLAN VIEW LAYOUT BEFORE WRAPPING AROUND A VALVE

LINES NPS 8 & LARGER REQUIRE TWO TRACERS. 2ND TRACER SHALL BE WRAPPED AROUND END FLANGES AND ALSO WRAPPED ONCE AROUND BONNET ON BONNETED VALVES.

NPS 4 & LARGER VALVES

LOCATE TUBE UNIONS AT HIGH POINT TO PREVENT CONDENSATE BUILD-UP OUTSIDE OF INSULATION

NOTE: ALL TUBING TO BE ½” O.D.
A—JACKETED VALVE

B—JACKETED VALVE
WITH BLEED RING

NOTES:
1. SINGLE 1/2” TRACER.
2. APPLY HEAT TRANSFER CEMENT. TYPICALLY DONE ON SMALLER DIAMETER LINES ONLY.
3. DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
1/2" O.D. TUBING

NOTE: AVOID USE OF UNIONS IF POSSIBLE.

TRACER
NOTE: DIMENSIONS ARE GIVEN IN INCHES. METRIC DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
TYPICAL TRACING OF PUMPS, VALVES & CONE BOTTOMS

TYPICAL INSTALLATION ON PUMPS

TYPICAL CROSS SECTION OF PUMPS, VALVES AND OTHER IRREGULAR SURFACES

TYPICAL INSTALLATION ON CONE BOTTOM OF TANK
TYPICAL TRACING OF PRESSURE TRANSMITTER IN LIQUID OR STEAM SERVICE

STANDARD TRANSMITTER

HYDROSTATIC LEG

STEAM SUPPLY

INSTRUMENT AIR SUPPLY

TO RECEIVER

TO TRAP

JACKETED TRANSMITTER
FLANGED D/P LEVEL TRANSMITTER
**JACKETED LEVEL GLASS**

**TRACED LEVEL GLASS**
EXTERNAL FLOAT LEVEL INSTRUMENT

NOTE: FOR COLD AMBIENT CONDITION, WRAP OR COIL TUBING AROUND INSTRUMENT.
D/P LEVEL INSTRUMENT ON VESSEL
LIQUID REMOTE PRESSURE GAUGE

NOTE: TRACING MAY CONTACT PIPE BUT NOT GAUGE.
REMOTE MOUNTED D/P INSTRUMENT
TYPICAL TRACING OF LINE MOUNTED D/P INSTRUMENT

STEAM

TO STREAM TRAP

INSULATING COVER

TUBING UNION (TYP.)

INSULATING COVER

TO STREAM TRAP

STEAM

LINE MOUNTED D/P INSTRUMENT
TYPICAL TRACING OF PRESSURE TRANSMITTER

TUBING UNION (TYP.)

STEAM TRACER

INSULATING COVER

TO STEAM TRAP

PRESSURE TRANSMITTER DETAIL
PRESSURE SWITCH OR PRESSURE GAUGE IN STEAM TRACED LINES

NOTE: TRACING MAY CONTACT PIPE BUT NOT GAUGE.