

SampleSpec for “Heated Sample Lines¹”
For Extractive Analyzers (CEMS or Process Analyzers)
(May 29, 2009)

1.0 SCOPE

This specification outlines the minimum requirements for electrically traced or steam/fluid traced instrument tubing. Acceptable suppliers are Cellex, Thermon, or their authorized agents.

2.0 CONSTRUCTION

2.1 The process tube(s) and heat tracing (steam/fluid tracer tube and/or electric heat tracing) shall be “cabled” together using no greater than an 18” (55cm) “lay” to insure tube and/or heat tracing contact is maintained throughout the length of the finished product. Exceptions to this will be pre-insulated tube products containing a single tube, a thermally isolated tracer tube, and/or nonmetallic tube(s).

2.2 In bundles with multiple tubes, each tube shall be identified by a paint or dye mark along its entire length. The paint or dye shall be compatible with the tube and insulation materials. The only exception will be bundles containing tubes made of fluoropolymer.

2.3 The tube(s) and electric heat tracing shall be wrapped with a combination of non-hygroscopic glass fiber insulation tape and heat-reflective tape containing less than 50-ppm chloride.

2.4 The standard outer jacket material shall be black UV resistant Arctic Thermo-Plastic (ATP) compound with a maximum temperature rating 221°F (105°C) and suitable for installation in conditions as low as -40°F (-40°C). The outer jacket shall have a nominal thickness of .080”. Acceptable materials are polyvinyl chloride (PVC), polyether urethane elastomer compound (TPU), or adequate thermoplastic elastomer.

2.5 The finished product shall be labeled its entire length with the manufacturer’s name, catalog number, and country of origin. Products containing electrical heat tracing shall also be labeled “caution electric” along its entire length. Long lengths of product shall be coiled and level wound on a wooden spool. Lengths less than 25’ may be shipped as straight lengths in a wooden crate.

¹ These may also be known as “Tubing Bundle”, Heated Sample Line (HSL), “Heated Umbilical”, “Sample Transport Bundles” (STB), “Heat Traced Tubing”, “Pre-insulated Tubing” (which may or may not be heated). This specification is not intended to consider “Heated Hose” to be acceptable for these applications.

3.0 MATERIALS OF CONSTRUCTION

3.1 Tubing

The following tubing specifications shall apply to the process and/or sample tube(s), as well as any tube(s) for calibration gases and/or purging gases, and those to carry heating media such as steam, glycol or other heat transfer fluid. (Also addressed in section 3.7 of this specification.)

3.1.1 Welded stainless steel tubing shall be Type 316 continuous TIG welded, cold drawn and fully annealed. It shall meet or exceed ASTM Standard A-269. Tube hardness shall be RB90 or less, suitable for bending and flaring. The heated and pre-insulated stainless steel tubing shall be available in continuous coils of 500 feet for 1/8" O.D. through 3/4" O.D. and .028", .035", or .049" wall thickness.

3.1.2 Seamless stainless steel tubing shall be Type 316 cold drawn and fully annealed. It shall meet or exceed ASTM Standards A-269 and A213. Long length coils are preferred for sizes 1/8" O.D. through 3/4" O.D. and .028", .035", .049", or .065" wall thickness. Tube hardness shall be RB90 or less, suitable for bending and flaring. "Semi-conductor-industry" grade coiled tubing which is for "Ultra-High Purity" applications. After manufacturing, prior to special treatment, it can have a surface of 20 Ra ("roughness average" measured in micro-inches), or less.

3.1.3 Specialty Finishes and Coatings on Stainless or Exotic tubing materials, including Hastelloy, Inconel (Alloy 600), Incoloy (Alloy 825) and others can be treated as follows:

3.1.3.1 "EP" Electropolished: refers to a particular process common for stainless steel, in our case applied to the inside surface of tubing. For coiled tubing there is presently a max length limit of 100m (328 ft) that can be electropolished. To some customers, EP simply implies a highly polished surface, while others require a specific surface Ra. The primary issue is how quickly a sample line can be flushed with de-ionized water, and then dried before introducing another gas sample. The "smoothest" finish (lowest Ra) will result from applying the EP process to the "best" raw tubing finish.

3.1.3.2 "CP" Chemical Passivated: (Sometimes referred to incorrectly as chemical polished.) Chemical passivation is a process that removes iron from a stainless steel surface by using a 20% nitric acid-water flush in accordance with established ASTM standards. It results in a "chromium enriched oxide layer" on the treated surface. Following the passivation the tubing is rinsed with DI water and blown dry with a filtered nitrogen gas purge. Chemical passivation does not appreciably improve the surface finish of a tube, but rather creates an inert surface to reduce any tendency for gas molecules to adhere to the tube. It is

routinely the final procedure following the EP process mentioned above.

3.1.3.3 Amorphous silicone “Passivation Coatings” applied to stainless steel surfaces. To reduce tendencies for gas molecules to be attracted to a stainless tube surface, coatings can be applied to stainless steel tubing. Acceptable treatments include SilcoNert1000 (previously known as Silcosteel) and SilcoNert 2000 (formerly known as Siltek or Sulfinert). SilcoNert is a trade name of SilcoTek, using technologies and processes previously performed by Restek High Performance Coatings

3.1.4 Copper tubing shall be grade 122 soft annealed and shall meet or exceed ASTM Standards B-68 and B-75. The tubing shall be in continuous coils minimum 500’ for sizes 1/4” O.D. through 3/4” O.D.

3.1.5 “Teflon” process tubing shall be an extruded² fluoropolymer resin. The fluoropolymer resin shall be PFA or FEP Grade. Tubing shall be in continuous coils for sizes 3/8” O.D. through 3/4” O.D. minimum wall thickness shall be .062”. Minimum wall thickness for 1/4” O.D. tubing is .047” and 1/8” O.D. is .030”.

3.2 Thermal Insulation System

The following insulation specifications shall apply to all heated and pre-insulated tubing bundles.

3.2.1 For tubing and heaters <400°F (204°C). The insulation system shall consist of non-hygroscopic (non-wicking) glass-fiber insulation and heat-reflective tape with total chloride content less than 50 ppm. The insulation shall be applied in sufficient thickness as to limit the outer jacket surface temperature to 140°F (60°C) maximum with an 80°F (27°C) ambient with no wind and 400°F (204°C) tube temperature.

3.2.2 For tube or heater temperatures between 400°F (204°C) and 500°F (260°C) increased insulation thickness shall be provided to ensure the 140°F (60°C) limit for the outer jacket surface temperature is not exceeded.

3.2.3 For tube or heater temperatures above 500°F (260°C) woven fiberglass insulation shall be provided to avoid deterioration of the binders in the standard fiberglass insulation wrap. In no case shall the 140°F (60°C) limit for the outer jacket surface temperature be exceeded.

3.3 Electrical Heat Tracing

The type of electrical heat tracing used in the tubing bundles shall be determined by the applications described by below. Primary concern shall be

² PTFE tubing can be considered if allowed in the project or facility specifications.

given to system safety and reliability. Heat tracing methods not covered in this specification may only be considered as an alternate where temperature and/or watt density are outside the capabilities described.

3.3.1 Freeze Protection & Low Temperature Maintenance up to 150°F (65°C). Heat tracing shall be self-regulating, capable of maintaining process temperatures up to 150°F (65°C) and withstanding continuous exposure to tube temperatures of 185° F (85°C) while heat tracing is de-energized. Heat tracing shall be capable of being cut to length without changing its power output per unit length, and heat output shall respond to temperature change. Long-term stability as established by the service life performance test per IEEE 515 Std-2004, with Thermon BSX self-regulating heat tracing preferred.

3.3.2 Freeze Protection & Medium Process Maintenance up to 250°F (121°C). All heat tracing shall be self-regulating, capable of maintaining process temperatures up to 250°F (121°C) and continuous exposure to tube temperatures of 400°F (205°C) while heat tracing is de-energized. Heat tracing shall be capable of being cut to length without changing its power output per unit length, and heat output shall respond to temperature change. Long-term stability as established by the service life performance test per IEEE 515 Std-2004, with Thermon HTSX self-regulating heat tracing preferred.

3.3.3 Freeze Protection & High Process Maintenance up to 300°F (149°C)³. All heat tracing shall be self-regulating, capable of maintaining process temperatures up to 300°F (149°C) and intermittent exposure to tube temperatures of 450°F (232°C) while heat tracing is de-energized. Heat tracing shall be capable of being cut to length without changing its power output per unit length, and heat output shall respond to temperature change. Long-term stability as established by the service life performance test per IEEE 515 Std-2004, with Thermon VSX self-regulating heat tracing preferred.

3.3.4 Freeze Protection & Process Maintenance up to 400°F (204°C)³. All heat tracing shall be power-limiting and capable of maintaining process temperatures up to 400°F (204°C) and withstand continuous exposure to tube temperatures of 500°F (260°C) while heat tracing is de-energized. Heat tracing shall be capable of being cut to length without changing its power output per unit length, and heat output shall respond to temperature change. Long-term stability as established by the service life performance test per IEEE 515 Std-2004, with Thermon HPT power-limiting heat tracing preferred.

3.4 Control and Monitoring for Electrically Traced Tubing

3.4.1 For freeze protection applications where elevated process temperature excursions and/or steam-outs do not exceed the heat tracing exposure rating of

³ Above 250°F (121°C) parallel constant wattage electrical heat tracing shall NOT be used. The risk of heater failure increases with wattage and maintain temperature. No parallel constant wattage heat tracing shall be allowed to operate above 10 W/ft (33 W/m).

the while energized, ambient sensing control is acceptable. For energy conservation, “ambient proportional control” is recommended.

3.4.2 Where elevated excursions are expected and/or where accurate temperatures are to be maintained, tube sensing control is required. Depending on the application, electronic controls or mechanical thermostats can be considered.

3.4.3 Care shall be taken to ensure the temperature sensor is not in contact with the electrical heat tracing to create a false reading. The placement of an RTD-type sensor on the tube can be arranged by the tubing bundle manufacturer, or applied in the field.

3.4.4 The RTD sensor shall be connected to a microprocessor-based control and monitoring device such as the Thermon TC device. Note that the TC-101, TC-201, TC-202, and TC-1818 also provide ground leakage equipment protection functions required by most electrical codes.

3.5 Circuit Protection for Electrically Traced Tubing

3.5.1 All pertinent electrical codes shall be observed in the installation, operation, and maintenance of all electrical heat tracing installations, including heated instrument tubing.

3.5.2 No more than five (5) instrument lines can be connected in parallel with a common electrical circuit protection device, (i.e. circuit breaker).

3.5.3 If approved by the manufacturer of the tubing bundle manufacturer, a heated instrument enclosure may be powered from the electrical heat tracing within the tubing bundle.

3.5 Auxiliary Conductors and Temperature Sensors

Where required, additional insulated conductors can be added within a pre-insulated and heat traced tubing bundle. This includes, but is not limited to, temperature sensor leads, communications wiring, and/or conductors intended to supply power to other electrical heat tracing segments or other equipment requiring from power feed within the tubing bundle. The manufacturer of the tubing bundle shall demonstrate expertise in the application of all pertinent electrical codes and standards, independent of whether the installation is to be in a hazardous (classified) area, or not.

3.6 Accessories for Connections, Terminations, and Sealing Kits

All electrical heat tracing circuits within the tubing bundle(s) shall be fabricated with the appropriate kits designed specifically for power connections and end terminations. Where the tube sample line is to be electrically heated, the manufacturer of the pre-insulated and heat traced tubing bundle shall also be the manufacturer of the electrical heat tracing.

3.7 Steam and Fluid Heat Tracing

Steam/Fluid traced tubing bundles shall have a tracer tube of copper or stainless steel. The heat tracing shall be 3/8" or 1/2" O.D. (or 8mm or 12 mm), and shall meet this specification section 3.1.

***Also See:**

"Specification for Heated Instrument Tubing in Process Applications", and

"Specification for Freeze Protecting Super-heated Steam Sample Tubing"