

Specification for Small Bore Tubing and Fittings

Revision history

VERSION	DATE	PURPOSE
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Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

Table of Contents

	Foreword	1
	Introduction	3
1	Scope	5
2	Normative references	5
3	Terms and Definitions	7
4	Design	7
	4.1 General.....	7
	4.2 Sizing.....	8
	4.3 Small bore tubing	9
	4.4 Small bore tubing system components	10
	4.5 Instrument nipples	12
	4.6 Insulation	12
	4.7 Vibration and thermal effects	12
5	Material selection.....	12
6	Installation	16
	6.1 General.....	16
	6.2 Small bore tubing system installation.....	17
	6.3 Small bore piping components installation specific to instruments	19
	6.4 Thread Sealing	19
7	Inspection and testing	20
8	Marking	21
9	Preservation and packing	21
	Bibliography.....	22

List of Tables

Table 1 — Tube size.....	8
Table 2 — Material Selection	13
Table 3 — Material Compatibility.....	16
Table 4 — Spacing for supports	18

List of Figures

Figure 1 — Parallel runs of tubing runs	19
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Introduction

The purpose of this specification is to define a minimum common set of requirements for the design, material selection, installation, testing and inspection, marking of small bore tubing, small bore tubing system components and small bore piping for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the three documents as shown below, which together with the purchase order define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents Technical Specification

This specification is to be applied in conjunction with the quality requirements specification (QRS) and information requirements specification (IRS) as follows.

IOGP S-716: Specification for Small Bore Tubing and Fittings

This specification defines the technical requirements for the supply of the equipment.

IOGP S-716Q: Quality Requirements for Small Bore Tubing and Fittings

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the purchase order.

IOGP S-716L: Information Requirements for Small Bore Tubing and Fittings

The IRS defines the information requirements, including contents, format, timing and purpose, to be provided by the supplier. It may also define specific conditions which invoke information requirements.

The terminology used within this specification and the supporting QRS and IRS is in accordance with ISO/IEC Directives, Part 2.

The IRS is published as an editable document for the purchaser to specify application specific requirements. The specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) purchaser defined requirements (QRS and IRS);
- d) this specification.

1 Scope

This specification provides the requirements for the design, material selection, installation, inspection, testing and marking of the following items covering offshore and onshore environments:

- a) Small bore tubing sizes up to 50 mm (2 in) for:
 - 1) process impulse lines, pneumatic lines, hydraulic lines, analyzer and sample take off tubing;
 - 2) trace heating.
- b) Small bore tubing system components for use with ASME B31.3 piping systems up to class 2500 in accordance with ASME B16.5 (42.5 Mpa @ < 38 °C (6170 psig @ < 100 °F) based on carbon steel systems):
 - 1) tube fittings;
 - 2) instrument air manifolds;
 - 3) instrument tubing valves;
 - 4) miscellaneous items such as tube clamps and valves for flushing rings or bleed rings.
- c) Instrument nipples.

This specification excludes the following items:

- subsea small bore tubing and fittings;
- welded tube and tube fittings for welded tubes, Joint Industry Council fittings, flexible hoses;
- piping systems designed in accordance with ASME B31.1 and ASME B31.3;
- non-metallic multi tubes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the references document (including any amendments) applies.

ANSI/NACE MR0103/ISO 17945, Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments

ANSI/NACE MR0175/ISO 15156, Parts 1 to 3, Petroleum, petrochemical, and natural gas industries — Materials for use in H₂S-containing environments in oil and gas production

API Standard 598:2016, *Valve Inspection and Testing*

ASME B1.20.1:2013, *Pipe Threads, General Purpose (Inch)*

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ Through NPS 24 Metric/Inch Standard*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ASME B31.3, *Process Piping*

ASTM A269/A269M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A479/A479M, *Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels*

ASTM A632, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service*

ASTM A789/A789M, *Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service*

ASTM B68/B68M, *Standard Specification for Seamless Copper Tube, Bright Annealed*

ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*

ASTM B165, *Standard Specification for Nickel-Copper Alloy Seamless Pipe and Tube*

ASTM B338, *Standard Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers*

ASTM B423, *Standard Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloy (UNS N08825, N08221, and N06845) Seamless Pipe and Tube*

ASTM B444, *Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625 and UNS N06852) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Pipe and Tube*

ASTM B622, *Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube*

ASTM B677, *Standard Specification for UNS N08925, UNS N08354, and UNS N08926 Seamless Pipe and Tube*

ASTM B706, *Standard Specification for Seamless Copper Alloy (UNS No. C69100) Pipe and Tube*

ASTM B729, *Standard Specification for Seamless Nickel-Iron-Chromium-Molybdenum-Copper Nickel Alloy Pipe and Tube*

ASTM F1387:2019, *Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings*

ISO 5208:2015, *Industrial valves — Pressure testing of metallic valves*

ISO 8573-1:2010, *Contaminant and purity classes*

ISO 21457, *Petroleum, petrochemical and natural gas industries - Materials selection and corrosion control for oil and gas production systems*

MSS SP-99, *Instrument Valves*

3 Terms and Definitions

For the purpose of this document, the following terms and definitions apply.

3.1

direct-mount

supported directly by the process pipe

3.2

interchanging

replacing of any individual component of a tube fitting, i.e. body, nut, front ferrule and back ferrule with another tube fitting

3.3

intermixing

mixing of a single part, i.e. a body or a group of parts together

Note to entry: Nut, front ferrule and back ferrule from a tube fitting to another tube fitting.

3.4

marine

offshore

nearshore

installations sited in oceans, seas, bays, estuaries and other high salinity water bodies including land up to 1 kilometre (0,6 miles) from shore

3.5

onshore

inland installations sited more than 1 kilometre (0,6 miles) from shore

4 Design

4.1 General

4.1.1

The tubing system shall be designed for the following:

- process fluid;
- process pressure (design range);
- process temperature (design range);
- environmental conditions in accordance with project-specific requirements.

4.1.2

Compression fittings shall be from a single manufacturer.

4.1.3

Intermixing of tube fittings from different manufacturers shall not be acceptable.

4.1.4

Interchanging of tube fittings from different manufacturers shall not be acceptable.

4.1.5

Mixing of different wall thickness tubing within the same diameter tubing run shall not be acceptable.

4.2 Sizing

4.2.1

A project shall not mix metric and imperial tubing sizes.

4.2.2

The minimum wall thickness for tubing shall be in accordance with Table 1.

Table 1 — Tube size

Metric units ^c		Imperial units ^c	
Tube outside diameter ^d (mm)	Minimum nominal wall thickness ^{a, b} (mm)	Tube outside diameter ^d (in)	Minimum nominal wall thickness ^{a, b} (in)
3	0,8	$\frac{1}{8}$	0,028
—	—	$\frac{3}{16}$	0,049
6	1,2 e	$\frac{1}{4}$	0,049 e
8	1,2	$\frac{5}{16}$	0,049
10	1,2	$\frac{3}{8}$	0,049
12	1,2	$\frac{1}{2}$	0,049
14	1,5	—	—
16	1,5	$\frac{5}{8}$	0,065
18	1,5	$\frac{3}{4}$	0,065
22	2,2	$\frac{7}{8}$	0,083
25	2,2	1	0,083
30	2,8	1 $\frac{1}{4}$	0,109
38	3,5	1 $\frac{1}{2}$	0,134
50	5,0	2	0,180

^a Pressure ratings of different wall thicknesses shall be determined based on the design criteria defined in ASME B31.3.

^b Higher wall thicknesses can be specified by the user or can be selected by the package supplier or contractor where required.

^c Tube sizes indicated for imperial and metric shall not be treated as a direct conversion from imperial to metric.

^d The tube sizes indicated are commonly available for SS 316 or SS 316L tubes. Some tube sizes may not be available for other materials such as 6 Mo, 25 Cr. Duplex, Alloy 625, Alloy 825 and Titanium Gr. 2.

^e For pneumatic signal lines, 6 mm tubing diameter with 1 mm WT ($\frac{1}{4}$ in tubing diameter with 0,035 in WT) is acceptable.

4.3 Small bore tubing

4.3.1 Tubes

4.3.1.1

Tubing shall be seamless, i.e. coiled or stick form.

4.3.1.2

Tubing shall be fully annealed.

4.3.1.3

Tubing shall not exceed the maximum acceptable hardness specified by the fittings manufacturer.

4.3.1.4

The tubing material, material grade and wall thickness shall be the same from source to destination.

NOTE The wall thickness of branch tubing may be less than the wall thickness of the main header tubing if the branch tubing size is less than the main header size.

4.3.1.5

Analyzer sample tubing to and from the sample conditioning system shall use continuous, single-run, i.e. without splices of pre-insulated tubing bundle or tubing with insulation.

4.3.2 Trace heated tube bundles

4.3.2.1

The tubing bundle outer jacket shall be flame retardant, ultraviolet resistant, hydrolytically stabilized, low smoke-halogen free, chloride free and abrasion resistant.

4.3.2.2

The tubing bundle outer jacket shall be selected for the operating temperature.

4.3.2.3

Tubing bundle insulation shall be non-hygroscopic.

4.3.2.4

Heat traced tubing, ends of pre-insulated tubing bundles into boxes, cabinets and bulkheads shall:

- be installed using the manufacturer's approved heat shrink boot and procedures; or
- utilize heat shrink entry seals for penetrations.

4.3.2.5

Tubing bundle ends shall:

- be installed using the manufacturer's approved heat shrink boot and procedures; or
- utilize heat shrink entry seals for penetrations.

4.4 Small bore tubing system components

4.4.1 General

4.4.1.1

Compression tube fittings shall be flareless, double-ferrule type.

4.4.1.2

Compression tube fittings for the selected tube size and wall thickness combination shall be used up to design pressures not exceeding ASME B16.5 class 2500 pressure ratings.

4.4.1.3

Tubing shall be de-rated in accordance with the tube manufacturer's charts or formula for the service design pressure and temperature limits.

4.4.1.4

NPT (national taper pipe thread) thread engagement shall conform to ASME B1.20.1:2013, Table 2, column 7.

4.4.1.5

In panels, elbow fittings shall only be used:

- for tubing terminations where the tubing manufacturer's recommended minimum bending radius is not achievable; or
- to facilitate component removal.

4.4.1.6

Compression fitting nut or body threads shall have an anti-galling coating.

4.4.1.7

Polytetrafluoroethylene or graphite packing shall be used for design temperatures up to 232 °C (450 °F) for instrument tubing valves.

4.4.1.8

Graphite packing shall be used for design temperatures greater than 232 °C (450 °F) for instrument tubing valves.

4.4.1.9

Unused vent and drain ports shall be fitted with design-rated plugs or caps.

4.4.1.10

Plugs and caps shall be the same material as the tubing.

4.4.2 Instrument air manifolds

4.4.2.1

Air manifolds shall be fabricated using at least 25 mm (1 in) diameter pipe.

4.4.2.2

The material of air manifolds and their valves and plugs shall be minimum SS 316L.

4.4.2.3

Air manifolds shall have a ball valve at least 12 mm ($\frac{1}{2}$ in) in size for each individual air consumers.

4.4.2.4

Individual air consumers shall be sized to meet the required response time and pressure drop.

4.4.2.5

Air manifolds shall have a drain valve at least 12 mm ($\frac{1}{2}$ in) in size.

4.4.2.6

Air manifold drain valves shall be fitted with a rated plug for condensate draining.

4.4.2.7

Valves for air consumers shall be lockable.

4.4.2.8

Spare taps installed on the instrument air manifolds shall be fitted with a rated valve and rated plug.

4.4.3 Instrument tubing valves

4.4.3.1

Instrument tubing valves shall be ball or needle type.

4.4.3.2

The instrument tubing valves maximum allowable leakage rates for closure tests shall be in accordance with API Standard 598:2016, Table 5 or ISO 5208:2015, Table 4, Rate A.

4.4.3.3

In addition to primary isolation (e.g. provided by piping, others), a separate block and bleed arrangement shall be provided using either an instrument tubing valves or an instrument manifold.

NOTE Primary isolation is achieved by piping primary isolation valves.

4.4.3.4

Instrument tubing valves or manifold valves shall not be used for piping or process primary isolation purposes.

4.4.4 Miscellaneous items

4.4.4.1 Tube clamps

4.4.4.1.1

Tubing clamps shall use ultraviolet resistant and flame-retardant polymer with SS 316 mounting hardware.

4.4.4.1.2

Tubing clamps design shall prevent the trapping of liquid within the clamp body.

4.4.4.1.3

Tubing clamps shall be an anti-corrosion design.

4.4.4.2 Instrument valves for flushing or bleed rings

When a flushing ring is used, the ring shall be provided with one valve in the 12 o'clock position and one valve in the 6 o'clock position.

4.5 Instrument nipples

4.5.1

Stainless steel nipples shall be manufactured from seamless pipe in accordance with ASTM A312/A312M or from wrought bar in accordance with ASTM A479/A479M.

4.5.2

Close nipples without a hex head shall not be used.

4.5.3

Nipples used for direct-mount installations shall be minimum ½ in, Sch 80.

4.6 Insulation

4.6.1

Where steam tracing is used, the tubing and tubing bundle shall be insulated.

4.6.2

Prefabricated traced and insulated tubing bundles shall be used for heat tracing applications.

4.7 Vibration and thermal effects

The tubing system shall be designed to withstand the stresses due to vibration, thermal variation or the movement of the attached equipment.

5 Material selection

5.1

The tubing material shall be selected from Table 2.

Table 2 — Material Selection

Tube				
Material	ASTM grade	UNS number	Recommended tube hardness ^b	Typical applications and limitations ^c
316 or 316L	A269/A632	S31600/S31603	HRB 80	1) Locations where chloride build up do not occur or use in indoor conditioned environment for services such as air, hydraulic, nitrogen, hydrocarbons, fresh water, and glycol 2) Maximum temperature limits (internal/external) to be limited 60 °C (140 °F) where chloride induced stress corrosion cracking may occur 3) Maximum temperature limits can be extended up to 450 °C (842 °F) for non-marine, non-corrosive environments and without use of clamps 4) Instrument air, HVAC and inert gases 5) Dual certified tubes can also be used 6) Tubing with minimum 2,5 % Molybdenum content can be used to minimize chloride induced stress corrosion cracking and pitting corrosion
317 or 317L	A269/A632	S31700/S31703	HRB 80	1) Dual certified 317/317L in lieu of 316/316L can be used to enhance resistance to stress corrosion cracking
Alloy 254 (6Mo)	A269	S31254	HRB 80	1) External marine atmospheric environments: maximum operating temperature limits: 100 °C to 120 °C (212 °F to 248 °F) 2) External corrosive environment, chloride stress corrosion cracking, pitting and crevice corrosion 3) Aerated chlorinated seawater system with crevices: maximum operating temperature limit: 20 °C (68 °F) 4) Sour service ^a
Alloy 6HN	A269	N08367	HRB 80	1) External marine atmospheric environments: maximum operating temperature limits: 100 °C to 120 °C (212 °F to 248 °F) 2) Severe corrosive environment, chloride stress corrosion cracking, pitting and crevice corrosion 3) Chlorinated seawater system with crevices: maximum operating temperature limit: 20 °C (68 °F) 4) Increased resistance to pitting, crevice corrosion and chloride-induced stress cracking when compared to Alloy 254 5) Sour service ^a
25Cr Super Duplex SS	A789/A789M	S32750/S32760	HRC 32	1) Marine environment 2) Sour service ^a 3) Severe corrosive environment 4) Chlorinated seawater system with crevices: maximum operating temperature 20 °C (68 °F) 5) External marine atmospheric environments: maximum operating temperature limits: 90 °C to 110 °C (194 °F to 230 °F)

Table 2 (continued)

Tube				
Material	ASTM grade	UNS number	Recommended tube hardness ^b	Typical applications and limitations ^c
Alloy 400	B165	N04400	HRB 75	1) Resistance to acid, alkali, seawater, organic intermediates 2) Marine environment 3) Chemical plants, including environments using sulfuric acid and hydrofluoric acid 4) Severe internal/external corrosive environment 5) Maximum operating temperature limits: 150 °C (302 °F) for external chloride stress corrosion cracking
Copper Alloy	B706	C69100	HRB 80	1) Marine environment 2) Gas pipework systems (oxygen and inert gases) 3) Cryogenic applications 4) Not to be used when fluids are contaminated with H ₂ S & mercury, acetylene, ammonia 5) Sensitive to chlorine containing environments
Alloy 625	B444	N06625	HRB 93	1) Marine environment 2) Chlorinated seawater system with crevices: maximum operating temperature 30 °C (86 °F) 3) Sour service ^a 4) Chlorides on external environments 5) Glycol
Alloy 825	B423	N08825	HRB 90	1) Analyzer sample transport tubing with the exception of continuous emission monitoring systems, moisture analyzer 2) Treated sea water 3) Phosphoric acid, sour gas and oil wells 4) Sour service ^a 5) No restriction on external chloride stress corrosion cracking
Titanium Gr.2	B338	R50400	HRB 85	1) Sodium hypochlorite application for operating temperature up to 50 °C (122 °F) 2) Chlorinated seawater system with crevices maximum operating temperature 85 °C (185 °F) 3) Sour service ^a 4) External marine atmospheric environments maximum operating temperature limits: 100 °C to 120 °C (212 °F to 248 °F)

Table 2 (continued)

Tube				
Material	ASTM grade	UNS number	Recommended tube hardness ^b	Typical applications and limitations ^c
Alloy C276	B622	N10276	HRB 90	1) Marine environment 2) HF Acid non-aerated 3) Corrosive conditions 4) Oxidizing and reducing chemicals (e.g. ferric/cupric chlorides, chlorine, formic acids, and hypochlorite solution) 5) Sour service ^a 6) Chlorinated seawater system with crevices: maximum operating temperature 50 °C (122 °F) 7) No restriction on external chloride stress corrosion cracking
Alloy 904L	A269/B677	N08904	HRB 80	1) Marine environment (maximum ambient temperature limits up to 30 °C (86 °F) ^c 2) Chlorinated seawater system with crevices: maximum operating temperature 10 °C (50 °F) 3) Sour service ^a
Alloy 20	B729	N08020	HRB 95	1) Sulfuric acid, caustic, sour gas, acid gas, organic acids, chlorinated hydrocarbons, sludge acids 2) Sour service ^a
Copper	B68/B75	C12200	60 on Rockwell 15T scale	1) Steam tracing 2) HVAC tubing
^a The definition of sour service remains the responsibility of the end user. Tubes used in sour service, shall meet the requirements in accordance with ANSI/NACE MR0103 or ISO 17945 or ANSI/NACE MR0175/ISO 15156, Parts 1 to 3. ^b If hardness compatibility between tubing and tube fittings can be demonstrated, higher tubing hardness above the recommended hardness can be used. ^c Tubing clamp design must be selected based on maximum operating temperature limits of the tube to avoid corrosion.				

5.2

The tubing system components material shall be selected from Table 3.

5.3

For sour service, tubing system components materials shall be in accordance with ANSI/NACE MR0103 or ISO 17945 or ANSI/NACE MR0175/ISO 15156, Parts 1 to 3.

5.4

Operating and ambient temperature limits of the applications shall be in accordance with ISO 21457 for the selected tubing material.

Table 3 — Material Compatibility

Tube			Compatible material	
Material ^a	ASTM grade	UNS number	Tube fitting ^{a, b}	Instrument isolation valves ^{a, b}
316/316L	A269/A632	S31600/S31603	SS 316	SS 316
317/317L	A269/A632	S31700/S31703	SS 316	SS 316
Alloy 254 (6Mo)	A269/A632	S31254	6Mo or SS 316	6Mo or SS 316
Alloy 6HN	A269/A632	N08367	Alloy 6HN or SS 316	Alloy 6HN or SS 316
25Cr Super Duplex SS	A789/A789M	S32750/S32760	25Cr Super duplex SS	25Cr Super duplex SS
Alloy 400	B165	N04400	Alloy 400	Alloy 400
Copper Alloy	B706	C69100	SS 316	SS 316
Alloy 625	B444	N06625	Alloy 625 or Alloy C 276	Alloy 625 or Alloy C 276
Alloy 825	B423	N08825	Alloy 825 or SS 316	Alloy 825 or SS 316
Titanium Gr.2	B338	R50400	Titanium Gr. 2	Titanium Gr. 5
Alloy C276	B622	N10276	Alloy C276	Alloy C276
Alloy 904L	A269/B677	N08904	SS 316	SS 316
Alloy 20	B729	N08020	Alloy 20	Alloy 20
Copper	B68/B75	C12200	Brass B16/B453 or SS 316	Brass B16/B453 or SS 316
^a SS 316 material shall not be used in Middle East marine environments. ^b Temperature and environmental limits of the lower grade material shall be applied for material selection when dissimilar material combination is selected within a tubing run.				

6 Installation

6.1 General

6.1.1

Tubing shall not be used as a support.

6.1.2

Tubing and tubing bundles shall be supported using tube clamps or alternate methods recommended by the manufacturer.

6.1.3

Threads shall not be seal welded.

6.1.4

Instrument tubing shall be removable without disassembly of pipes or equipment.

6.1.5

Impulse line tubing shall have a minimum gradient of 1:12 towards the instrument for liquid service.

6.1.6

Impulse line tubing shall have a minimum gradient of 1:12 towards the process for gas service.

6.2 Small bore tubing system installation

6.2.1 Tube routing

6.2.1.1

Tubing containing hydrocarbons, toxic and corrosive fluids shall not be routed to electrical buildings, equipment rooms or control rooms.

6.2.1.2

Tubing and tubing bundles shall be routed separately from cables.

6.2.1.3

Tubing system installation shall not prevent the removal of instruments, maintenance of equipment or calibration of instruments.

6.2.1.4

Where impulse tubing length is more than 6 m (20 ft), a dynamic analysis shall be performed to measure the response time.

6.2.1.5

Where impulse tubing length is more than 6 m (20 ft), a risk assessment shall be performed for potential leaks.

6.2.1.6

Tubing shall be routed using tray, angle or channel.

6.2.1.7

Tubing shall be routed through grating or chequer plate if the removal of the grating or chequer plate does not require isolation or disassembly of tubing installation.

6.2.1.8

If tubing or tubing bundles are pre-insulated, tubing runs shall be continuous between:

- tubing junction boxes and shelters; or
- tubing junction boxes and field enclosures.

6.2.2 Supports

6.2.2.1

Tubing shall be supported in accordance with Table 4.

Table 4 — Spacing for supports

Spacing for tubing supports	
Tube outside diameter mm (in)	Maximum span between supports mm (in)
< 6 (<1/4)	400 (16)
6 to 10 (1/4 to 3/8)	600 (24)
12 to 22 (1/2 to 7/8)	900 (35)
25 to 32 (1 to 1 1/4)	1400 (55)
38 (1 1/2)	2100 (83)
50 (2)	2100 (83)

6.2.2.2

Tubing shall not be supported from handrails or ladders.

6.2.3 Tubing installation

6.2.3.1

The tubing system shall be installed by personnel who have been certified by the fittings manufacturer's approved product training program or equivalent industry training program including hands-on assembly.

6.2.3.2

Tubing and fittings make-up shall be prepared and marked in accordance with the fittings manufacturer's recommendations.

6.2.3.3

Marking pens containing chloride or sulfur shall not be used.

6.2.3.4

Parallel runs of tubing shall be installed in accordance with the example method shown in Figure 1.

6.2.3.5

Tubing and fittings shall be assembled using the tools recommended by the tube fittings manufacturer.

6.2.3.6

The tubing manufacturer's recommended bending radius shall be followed.

6.2.3.7

Installed spare tubes in tube bundles shall be capped.

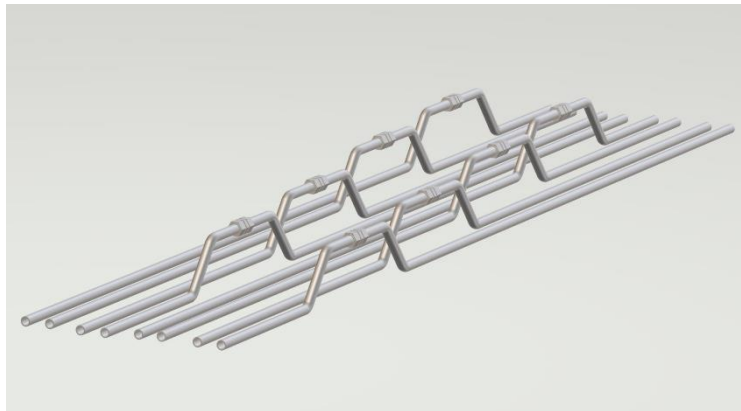


Figure 1 — Parallel runs of tubing runs

6.2.4 Tube bundles

6.2.4.1

Spacing between multiple traced tube bundles shall follow the tube bundle manufacturer's recommendation.

6.2.4.2

Clamps or tie-wraps that exert point pressures shall not be used.

6.3 Small bore piping components installation specific to instruments

6.3.1

Fittings and nipples used at piping-instrument interfaces shall comply with ASME B16.11.

6.3.2

ASME B16.11 hex-style bushings and flush bushings shall not be used.

6.3.3

Flush or hollow hex pipe plugs shall not be used.

6.4 Thread Sealing

6.4.1

Sealant, lubricant or tape for threaded instrument connections shall be in accordance with the requirements of the process service.

6.4.2

Thread sealant or tape applied on stainless steel fittings shall have anti-seize properties.

6.4.3

Polytetrafluoroethylene tape shall not be used on hydraulic or air supply connections.

6.4.4

Sealants shall be applied and cured in accordance with the manufacturer's instructions.

7 Inspection and testing

7.1

A visual inspection and dimensional check shall be performed on the assembled tubing installations.

7.2

Positive material identification shall be performed on the assembled tubing installations.

7.3

Pneumatic leak testing for tubing installations shall be carried out in accordance with ASME B31.3.

7.4

If specified, hydrostatic leak testing for tubing installations shall be carried out in accordance with ASME B31.3.

7.5

Assembly testing using the tube fittings manufacturer's recommended tools e.g. gap inspection gauge (Go / No Go gauge, if applicable) and depth insertion marking gauge shall be performed.

7.6

Dismantling and re-assembly testing shall be performed on the assembled tubing installations.

7.7

Compression fittings for each tubing material and size combination shall be type test qualified for the standard performance tests in accordance with ASTM F1387:2019, 13.1 and ASTM F1387:2019, Table 3.

7.8

Instrument tubing valves shall be type test qualified in accordance with MSS SP-99.

7.9

The sample size for the inspection and testing specified in 7.1 to 7.6 shall be confirmed prior to commencement of inspection.

7.10

Instrument air tubing systems shall be flushed and dried as follows:

- remove water from the tubing system;
- flush the system with clean, dry air with a particle size of class 2 in accordance with ISO 8573-1:2010.

8 Marking

8.1

Analyzer sample, pneumatic and hydraulic tubing shall be tagged at a span of 25 m (82 ft).

8.2

Tag plates shall be affixed at entry and exit locations of the penetrations when the tubes are passing through a deck or wall.

8.3

Tag plates shall be SS 316.

8.4

Tag plates shall be tied using SS 316 zip ties or wires.

8.5

Tubing shall be marked in accordance with the selected tubing ASTM material standards.

8.6

In addition to 8.5, tubing shall be marked with the following as a minimum:

- tube outside diameter;
- tube wall thickness;
- material;
- manufacturer's name;
- lot number;
- heat treatment number, if heat treated.

8.7

Fitting bodies and nuts shall be marked with either the manufacturer's name, material, size and heat code traceability or with the manufacturer's part number.

8.8

Front and rear ferrules shall be marked with the manufacturer's name and material unless the marking is not feasible due to the size.

9 Preservation and packing

9.1

Incomplete tubing runs or ship loose components and fittings shall be protected using caps or plugs.

9.2

Ship loose tubes shall be packaged together in a protective sleeve.

Bibliography

- [1] ASME B31.1, *Power Piping*

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