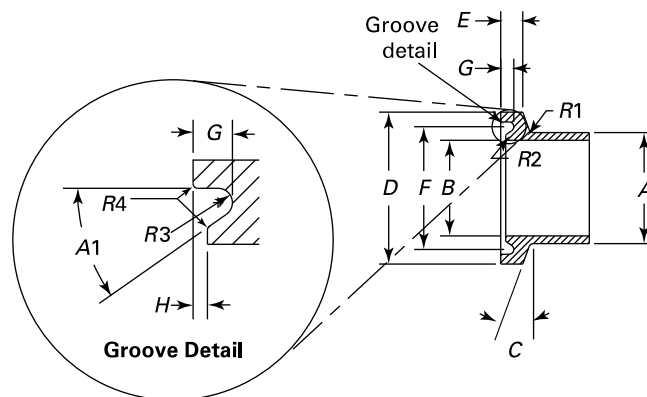


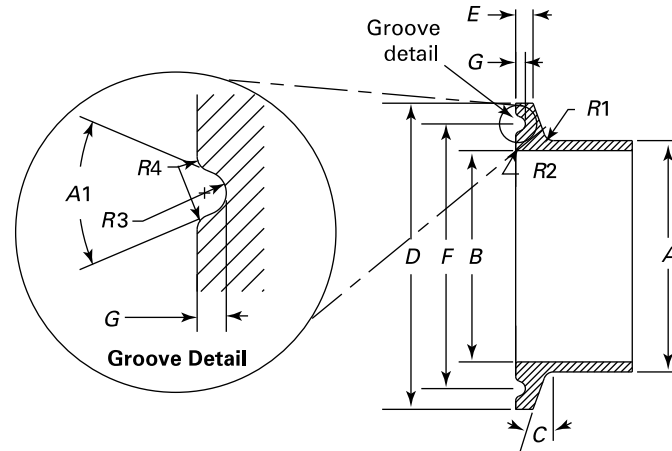
Table DT-7-1 Metallic Hygienic Clamp Ferrule Standard Dimensions and Tolerances

Type A



Nominal Size, in.	Type	Tube Diameter, <i>A</i>								I.D. Bore, <i>B</i>		Flange Diameter, <i>D</i>				Flange Thickness, <i>E</i> , ref.		Groove Diameter, <i>F</i>							
		Tolerance, ±				Tolerance, ±				Flange Angle, <i>C</i> , deg	Tolerance, ±		Dimension	Dimension	Dimension	Dimension	Tolerance, ±								
		Dimension		Dimension		Dimension		Dimension																	
		in.	mm	in.	mm	in.	mm	in.	mm		in.	mm													
1/4	A	0.250	6.35	0.005	0.13	0.180	4.57	0.005	0.13	20	0.5	0.984	25.0	0.005	0.13	0.143	3.63	0.800	20.32	0.005	0.13				
3/8	A	0.375	9.53	0.005	0.13	0.305	7.75	0.005	0.13	20	0.5	0.984	25.0	0.005	0.13	0.143	3.63	0.800	20.32	0.005	0.13				
1/2	A	0.500	12.70	0.005	0.13	0.370	9.40	0.005	0.13	20	0.5	0.984	25.0	0.005	0.13	0.143	3.63	0.800	20.32	0.005	0.13				
3/4	A	0.750	19.05	0.005	0.13	0.620	15.75	0.005	0.13	20	0.5	0.984	25.0	0.005	0.13	0.143	3.63	0.800	20.32	0.005	0.13				
1	A	1.000	25.40	0.005	0.13	0.870	22.10	0.005	0.13	20	1.0	1.339	34.0	0.005	0.13	0.143	3.63	1.160	29.46	0.005	0.13				
Nominal Size, in.	Type	Groove Depth, <i>G</i>				Face Offset, <i>H</i>				Groove Detail, <i>R3</i>				Groove Detail, <i>R4</i>				Radius, <i>R2</i>							
		Tolerance, ±				Tolerance, ±				Tolerance, ±				Tolerance, ±				Groove Detail, <i>A1</i> , deg	Radius, <i>R1</i> , max.	Maximum	Minimum				
		Dimension		Dimension		Dimension		Dimension		Dimension		Dimension													
		in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm										
1/4	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
3/8	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
1/2	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
3/4	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
1	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13

Table DT-7-1 Metallic Hygienic Clamp Ferrule Standard Dimensions and Tolerances (Cont'd)

Type B

																						Flange Thickness, E, ref.			
		Tube Diameter, A				I.D. Bore, B						Flange Diameter, D						Groove Diameter, F							
Nominal Size,		Dimension		Tolerance, ±		Dimension		Tolerance, ±		Flange Angle, C, deg		Dimension		Tolerance, +		Tolerance, −		Dimension		Dimension	Tolerance, ±				
		in.	mm	in.	mm	in.	mm	in.	mm			in.	mm	in.	mm	in.	mm	in.	mm						
		Type	Tolerance,																						
1	B	1.000	25.40	0.005	0.13	0.870	22.10	0.005	0.13	20	1.0	1.984	50.39	0.008	0.20	0.005	0.13	0.112	2.84	1.718	43.64	0.005	0.13		
1½	B	1.500	38.10	0.008	0.20	1.370	34.80	0.005	0.13	20	1.0	1.984	50.39	0.008	0.20	0.005	0.13	0.112	2.84	1.718	43.64	0.005	0.13		
2	B	2.000	50.80	0.008	0.20	1.870	47.50	0.005	0.13	20	1.0	2.516	63.91	0.008	0.20	0.008	0.20	0.112	2.84	2.218	56.34	0.005	0.13		
2½	B	2.500	63.50	0.010	0.25	2.370	60.20	0.005	0.13	20	1.0	3.047	77.39	0.008	0.20	0.008	0.20	0.112	2.84	2.781	70.64	0.005	0.13		
3	B	3.000	76.20	0.010	0.25	2.870	72.90	0.005	0.13	20	1.0	3.579	90.91	0.010	0.25	0.010	0.25	0.112	2.84	3.281	83.34	0.005	0.13		
4	B	4.000	101.60	0.015	0.38	3.834	97.38	0.005	0.13	20	1.0	4.682	118.92	0.015	0.38	0.015	0.38	0.112	2.84	4.344	110.34	0.005	0.13		
6	B	6.000	152.40	0.030	0.76	5.782	146.86	0.005	0.13	20	1.0	6.570	166.88	0.030	0.76	0.030	0.76	0.220	5.59	6.176	156.87	0.005	0.13		
		Groove Depth, G								Groove Detail, R3				Groove Detail, R4						Radius, R2					
Nominal Size,		Dimension		Tolerance, ±		Face Offset, H				Dimension		Tolerance, ±		Dimension		Tolerance, ±		Groove Detail, A1, deg		Radius, R1, max.		Maximum		Minimum	
		in.	mm	in.	mm	Dimen- sion	Tolerance, ±	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	Dimen- sion	Tolerance, ±	in.	mm	in.	mm	in.	mm
		Type																							
1	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13		
1½	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13		
2	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13		

(19)

Table DT-7-1 Metallic Hygienic Clamp Ferrule Standard Dimensions and Tolerances (Cont'd)

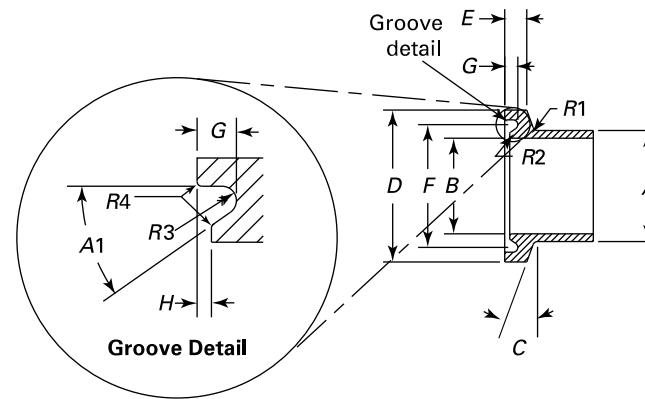
Nominal Size, in.		Groove Depth, <i>G</i>						Groove Detail, <i>R3</i>				Groove Detail, <i>R4</i>				Radius, <i>R2</i>								
		Tolerance, ±				Face Offset, <i>H</i>		Tolerance, ±				Tolerance, ±				Groove Detail, <i>A1</i> , deg		Radius, <i>R1</i> , max.		Maximum Minimum				
		Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension
Type	in.	mm	in.	mm	in.	mm	Dimension	±	in.	mm	in.	mm	in.	mm	in.	mm	Dimension	±	in.	mm	in.	mm	in.	mm
2½	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13	
3	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13	
4	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13	
6	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13	

GENERAL NOTES:

(a) Dimensions and tolerances apply to machined finishes only.

(b) I.D. bore dimension *B* should be measured on the ferrule face side only.

Type A

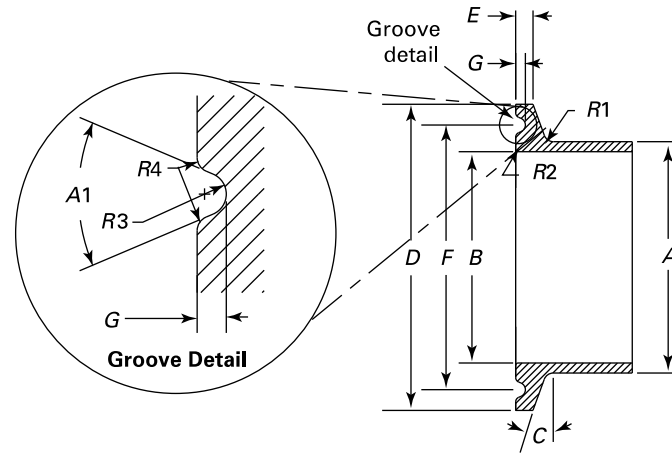


Groove Dimensions																			Flange Dimensions					
Nominal Size, in.	Type	Tube Diameter, <i>A</i>		I.D. Bore, <i>B</i>				Flange Angle, <i>C</i> , deg			Flange Diameter, <i>D</i>				Flange Thickness, <i>E</i> , ref.		Groove Diameter, <i>F</i>							
		Dimension		Dimension		Tolerance, ±					Dimension		Tolerance, ±		Dimension		Dimension		Tolerance, ±					
		Tolerance																						
		in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm			
1/4	A	0.250	6.35	0.180	4.57	0.010	0.25	20	1.0	3.0	0.984	25.0	0.010	0.25	0.143	3.63	0.800	20.32	0.010	0.25				
3/8	A	0.375	9.53	0.305	7.75	0.010	0.25	20	1.0	3.0	0.984	25.0	0.010	0.25	0.143	3.63	0.800	20.32	0.010	0.25				
1/2	A	0.500	12.70	0.370	9.40	0.010	0.25	20	1.0	3.0	0.984	25.0	0.010	0.25	0.143	3.63	0.800	20.32	0.010	0.25				
3/4	A	0.750	19.05	0.620	15.75	0.010	0.25	20	1.0	3.0	0.984	25.0	0.010	0.25	0.143	3.63	0.800	20.32	0.010	0.25				
1	A	1.000	25.40	0.870	22.10	0.010	0.25	20	1.0	3.0	1.339	34.0	0.010	0.25	0.143	3.63	1.160	29.46	0.010	0.25				

Groove Dimensions																			Flange Dimensions						
Nominal Size, in.	Type	Groove Depth, <i>G</i>				Face Offset, <i>H</i>				Groove Detail, <i>R3</i>				Groove Detail, <i>R4</i>				Radius, <i>R2</i>							
		Tolerance, ±		Tolerance, ±		Tolerance, ±		Tolerance, ±		Tolerance, ±		Tolerance, ±													
		Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Dimension	±	Groove Detail, <i>A1</i> , deg	Radius, <i>R1</i> , max.	Maximum	Minimum								
		in.	Type	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm				
1/4	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
3/8	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
1/2	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
3/4	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13
1	A	0.085	2.16	0.005	0.13	0.031	0.79	0.005	0.13	0.031	0.79	0.005	0.13	0.020	0.51	0.005	0.13	35	1	0.031	0.79	0.031	0.79	0.005	0.13

Table DT-7-2 Polymeric Hygienic Clamp Ferrule Standard Dimensions and Tolerances (Cont'd)

Type B



											Flange Thickness, E, ref.									
Tube Diameter, A								I.D. Bore, B			Flange Angle, C, deg			Flange Diameter, D				Groove Diameter, F		
Nominal Size,	Type	Dimension		Dimension		Tolerance, ±					Dimension		Tolerance, ±		Dimension		Dimension		Tolerance, ±	
		Tolerance																		
		in.	mm	in.	mm	in.	mm	Dimension	±	–	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
1	B	1.000	25.40	0.870	22.10	0.010	0.25	20	1.0	3.0	1.984	50.39	0.010	0.25	0.112	2.84	1.718	43.64	0.010	0.25
1½	B	1.500	38.10	1.370	34.80	0.010	0.25	20	1.0	3.0	1.984	50.39	0.010	0.25	0.112	2.84	1.718	43.64	0.010	0.25
2	B	2.000	50.80	1.870	47.50	0.010	0.25	20	1.0	3.0	2.516	63.91	0.010	0.25	0.112	2.84	2.218	56.34	0.010	0.25
2½	B	2.500	63.50	2.370	60.20	0.010	0.25	20	1.0	3.0	3.047	77.39	0.010	0.25	0.112	2.84	2.781	70.64	0.010	0.25
3	B	3.000	76.20	0.010	0.25	2.870	72.90	20	1.0	3.0	3.579	90.91	0.010	0.25	0.112	2.84	3.281	83.34	0.010	0.25
4	B	4.000	101.60	3.834	97.38	0.010	0.25	20	1.0	3.0	4.682	118.92	0.015	0.38	0.112	2.84	4.344	110.34	0.010	0.25

Groove Depth, G								Groove Detail, R3				Groove Detail, R4				Radius, R2							
Nominal Size,	Type	Dimension		Tolerance, ±		Face Offset, H		Dimension		Tolerance, ±		Dimension		Tolerance, ±		Groove Detail, A1, deg		Radius, R1, max.		Maximum		Minimum	
		Tolerance																					
		in.	mm	in.	mm	Dimension	Tolerance, ±	in.	mm	in.	mm	in.	mm	in.	mm	Dimension	Tolerance, ±	in.	mm	in.	mm	in.	mm
1	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13
1½	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13
2	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13
2½	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13
3	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13

Table DT-7-2 Polymeric Hygienic Clamp Ferrule Standard Dimensions and Tolerances (Cont'd)

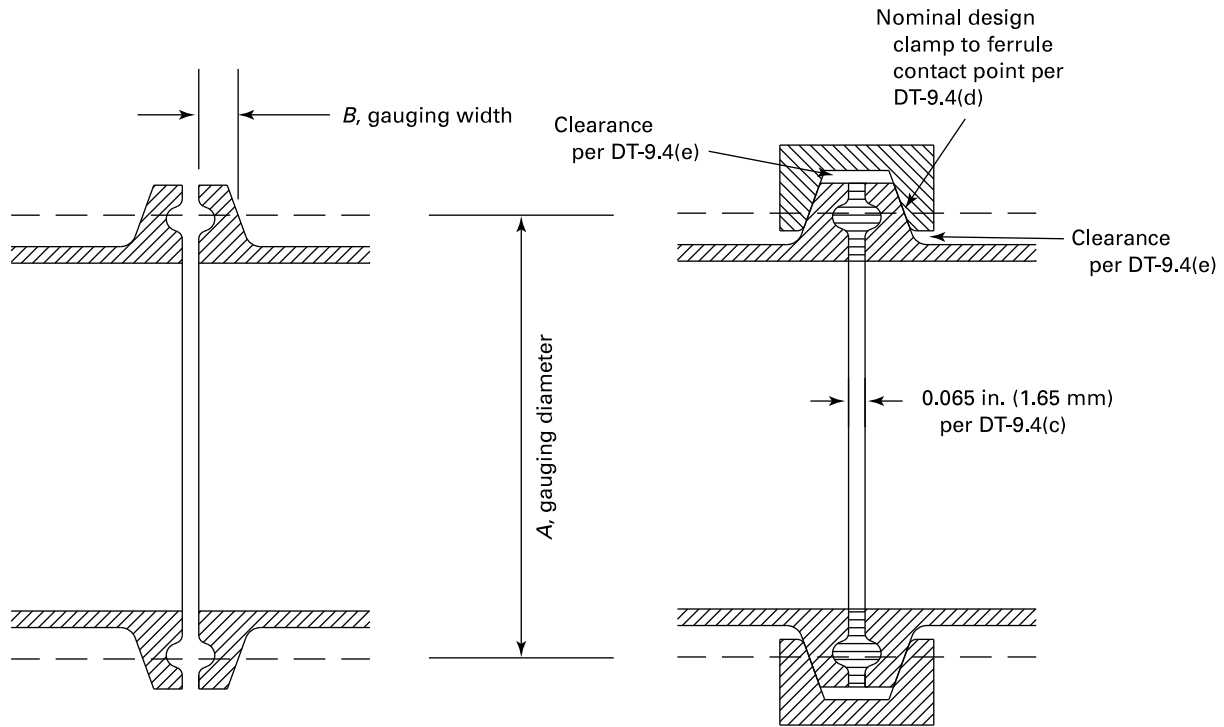
Nominal Size, in.		Groove Depth, <i>G</i>				Face Offset, <i>H</i>				Groove Detail, <i>R3</i>				Groove Detail, <i>R4</i>				Groove Detail, <i>A1</i> , deg		Radius, <i>R1</i> , max.		Radius, <i>R2</i>			
		Dimension		Tolerance, ±						Dimension		Tolerance, ±		Dimension		Tolerance, ±						Maximum		Minimum	
				Dimension		Tolerance, ±		Dimension				Tolerance, ±				Dimension		Tolerance, ±							
		Type	in.	mm	in.	mm	Dimension	Tolerance, ±	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	
4	B	0.063	1.60	0.005	0.13	N/A	N/A	0.047	1.19	0.005	0.13	0.020	0.51	0.005	0.13	46	1	0.063	1.60	0.031	0.79	0.005	0.13		

GENERAL NOTES:

- (a) Dimensions and tolerances apply to molded polymer materials only.
 (b) I.D. bore dimension *B* should be measured on the ferrule face side only.
 (c) Ferrules should only be used with elastomeric gaskets.

(19) **Table DT-7-3 Transfer Panel and Jumper Tolerances**

Connection Nominal Size, in.	Flatness Tolerance Maximum Gap Allowed		Center-to-Center Dimensional Tolerance, ±	
	in.	mm	in.	mm
$\frac{1}{2}$	0.010	0.25	0.015	0.38
$\frac{3}{4}$	0.010	0.25	0.015	0.38
1	0.020	0.51	0.015	0.38
$1\frac{1}{2}$	0.020	0.51	0.015	0.38
2	0.025	0.64	0.015	0.38
$2\frac{1}{2}$	0.025	0.64	0.015	0.38
3	0.030	0.76	0.015	0.38
4	0.040	1.02	0.015	0.38

Table DT-9.3-1 Hygienic Clamp Ferrule: Design Criteria

Basic Gauging and Contact								
Diameter, <i>A</i> (ref.)				Gauging Width, <i>B</i>				Hygienic Clamp Size, in.
Nominal Size, in.	Type	Dimension		Dimension		Tolerance, ±		
		in.	mm	in.	mm	in.	mm	
1/4	A	0.867	22.02	0.164	4.17	0.004	0.10	3/4
3/8	A	0.867	22.02	0.164	4.17	0.004	0.10	3/4
1/2	A	0.867	22.02	0.164	4.17	0.004	0.10	3/4
3/4	A	0.867	22.02	0.164	4.17	0.004	0.10	3/4
1	A	1.222	31.04	0.164	4.17	0.004	0.10	ISO DN15
1	B	1.748	44.39	0.155	3.94	0.005	0.13	1 1/2
1 1/2	B	1.748	44.39	0.155	3.94	0.005	0.13	1 1/2
2	B	2.280	57.91	0.155	3.94	0.005	0.13	2
2 1/2	B	2.811	71.39	0.155	3.94	0.005	0.13	2 1/2
3	B	3.264	82.91	0.169	4.30	0.005	0.13	3
4	B	4.288	108.92	0.184	4.66	0.005	0.13	4
6	B	6.255	158.88	0.277	7.04	0.005	0.13	6

PART PI

PROCESS INSTRUMENTATION

PI-1 PURPOSE AND SCOPE

The purpose of this Part is to provide requirements for process instrumentation. This Part defines the minimum requirements for the application of process contact instrumentation in hygienic systems. This Part applies to instrument components that are in contact with the process.

PI-2 PROCESS INSTRUMENTATION GENERAL REQUIREMENTS

Process instrumentation includes sensors, transmitters, analyzers, controllers, recorders, transducers, final control elements, signal converting or conditioning devices, and supporting components (e.g., light sources and sight glasses).

Final control elements such as control valves or variable-speed pumps are covered in other Parts of this Standard.

PI-2.1 General Considerations

PI-2.1.1 Installation. All process instrumentation should be installed per the manufacturer's instructions for proper operation.

Indicating devices shall be oriented and located such that they can be easily viewed for maintenance and operation purposes. Instruments shall be located and oriented so connections can be easily made and adequate space is provided for calibration, maintenance, and replacement.

Instruments, connecting tubing, and systems shall be supported by mounting brackets as necessary to prevent potential stresses on the instrument and tubing system, and to allow for ease of removal without disturbing the adjacent components.

Remote-mounted devices (transmitters, etc.) shall be mounted with appropriate supports to a permanent structure. Ladders, handrails, guardrails, etc., shall not be acceptable mounting supports. If necessary, dedicated instrument supports shall be provided.

PI-2.1.2 Internal Design and Process Connections

(a) Sensors shall be designed in such a way that a failure will not cause contamination hazards to the process and environment.

(b) Liquid-filled elements in measuring devices should not contain materials that can potentially impact product quality.

(c) The internal volume of the liquid-filled elements should be minimized.

(d) Instruments should have integral hygienic fittings. Threaded ferrules are not acceptable to convert standard instrumentation to hygienic standards. Process connections shall be of hygienic design, per the requirements of [Parts SD](#) and [SG](#), in order to ensure cleanability of the system.

(e) Gauge siphons (pigtailed) shall not be used. Isolation valves should be used if required by the owner/user for routine maintenance or calibration.

(f) Where required for proper operation, all instruments, valves, and in-line devices shall be permanently marked for proper installation (flow direction or orientation).

PI-2.1.3 Exterior Design. Material selection shall consider all intended uses, ambient conditions, and cleaning agents as specified by the owner/user. Sensors and transmitters shall be housed in an enclosure with an appropriate protection rating as specified by the owner/user and shall comply with [Parts SD](#) and [SG](#).

PI-2.2 Instrumentation Categories

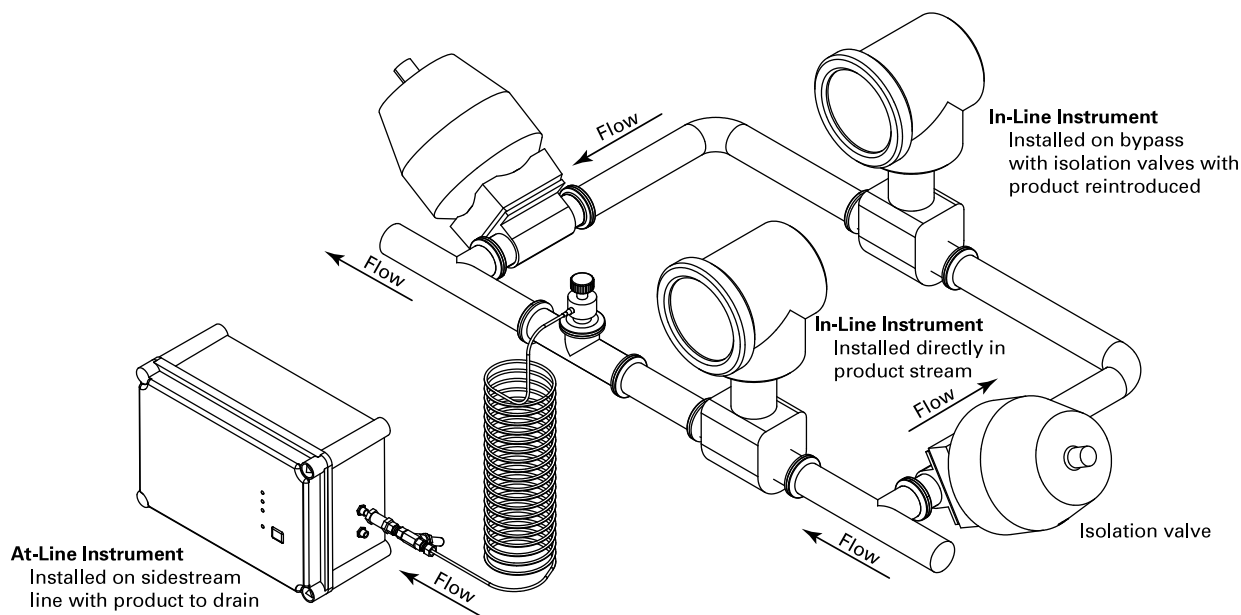
Process instrumentation may be broadly categorized by process installation type as in-line, insertion, at-line, and off-line devices. Process instruments within these categories share some basic installation recommendations for hygienic design and in-process performance.

PI-2.2.1 In-Line Devices. In-line process instruments are self-contained devices installed directly into the process tubing system similar to a standard fitting. Basic installation requirements for hygienic operation as found in [Part SD](#) pertain to in-line process instrumentation.

In-line devices may be installed directly in the process stream or in a bypass line to facilitate periodic services (see [Figure PI-2.2.1-1](#)). Device-specific recommendations are defined later in this Part.

PI-2.2.2 Insertion Devices. Insertion devices are instruments that are inserted directly into the process tubing system or process vessel to measure a parameter.

Figure PI-2.2.1-1 In-Line and At-Line Instrument Installation Examples



Insertion devices generally require proper immersion in the process fluid for optimal performance. Installation of insertion devices must balance performance requirements and hygienic design. Refer to later sections of this Part and/or the manufacturer's recommended guidelines for specific recommendations (see [Figure PI-2.2.2-1](#)).

PI-2.2.3 At-Line Devices. At-line devices are instruments that measure various parameters by the means of a sidestream sampling loop, which is generally not reintroduced back into the process. Connection of the sampling stream shall be compliant with [Part SD](#) and designed to ensure continuous sampling flow to maintain hygienic operation for optimal measurement (see [Figure PI-2.2.1-1](#)).

PI-2.2.4 Off-Line Devices. Off-line devices are instruments located away from the main process and are not covered in this Part.

PI-3 INSTRUMENT RECEIVING, HANDLING, AND STORAGE

PI-3.1 Introduction

Material compatibility and environmental storage conditions shall be considered when receiving, handling, and storing process instrumentation. All instruments shall have markings such as labels, tags, barcodes, or radio-frequency identification (RFID) to ease identification.

PI-3.2 Instrument Receiving

The instrument(s) shall be identified by part/model numbers.

PI-3.2.1 Original Packaging. The integrity of the original packaging of any component, with cleaning certifications such as passivated, cleaned for oxygen service, or hydrocarbon free, shall be maintained during inspection and storage.

PI-3.3 Instrument Handling: Protection of Process Connections and Surface Finish

Care shall be taken to protect the process connection(s) and surface finish of the instrument during receiving, handling, calibration, and storage.

PI-3.4 Instrument Storage

PI-3.4.1 Special Considerations. Special considerations for storage shall be made for certain instrumentation, such as analytical instruments, according to the manufacturer's recommendations.

PI-3.4.2 Instrument Shelf Life and Environmental Requirements. Instruments with limited shelf lives or environmental requirements (temperature, humidity, etc.) shall be identified.

Additional information regarding instrument receiving, handling, and storage is contained in [Nonmandatory Appendix R](#).

PI-4 FLOWMETERS

PI-4.1 Coriolis Flowmeter

PI-4.1.1 General Considerations. This section provides the requirements for installation and operation of Coriolis flowmeters specific to bioprocessing and

Figure PI-2.2.2-1 Accepted Insertion Device Installation Examples

