



For ASME B16.49 Related Information

Specication for Factory-made wrought steel, buttwelding induction bends for
transportation and distribution systems

Zhengzhou Huitong Pipeline Equipment Co.,Ltd.

www.htpipe.com
www.htpipe.es
info@htpipe.com
86 19339900201

ASME B16.49 specifies the design, materials, manufacturing, testing, and marking requirements for induction bending pipes to ensure their structural integrity and long-term reliability under high pressure and high temperature environments.

Compared to **ASME B16.9** (General Weld-to-Butt Fittings), **B16.49** focuses more on the induction bending process and explicitly excludes its application in process piping and power piping.

HT PIPE is a well-known stockist and exporter. We are a **ASME B16.49** stainless steel ,alloy material supplier with 15+ export experience. We not only provide pipes, plate, round bars, but also pipe fittings, flanges, etc. Contact us for more information and prices for free.

ASME B16.49, ASME B16.49 Specification, ASME B16.49 Butt Welding Bends, ASME B16.49 Production Standards, ASME B16.49 BW Pipe Bend, ASME B16.49 Stainless Steel Pipe Bend, ASME B16.49 Nickel Alloy Pipe Bend, ASME B16.49 Carbon Steel Pipe Bend.

Core Geometric Parameters

1. Angles

-**ASME B16.49** Standard angles: 30° , 45° , 60° , 90° , customizable $15^{\circ} \sim 135^{\circ}$ non-standard angles.

-Special requirements: $\leq 30^{\circ}$ small angles require 2 additional measuring points; transition zone ($\geq 2D$) angle change rate $\leq 0.5^{\circ}/\text{mm}$.

2. Bending Radius

-Common specifications: $3D$, $5D$, $7D$ (D is nominal diameter); customizable $2D \sim 10D$.

-Special requirements: $\geq 7D$ large radii require centerline straightness measurement; offset $\leq 0.5D$ And $\leq 0.1D$ per meter.

3. Other key parameters

-Ellipticity: Bending section $\leq 2.5\%$, weld end $\leq 1\%$ (measured by outer diameter in 4 directions).

-Wall thickness deviation: Outer arc thinning $\leq 12.5\%$, inner arc thickening $\leq 20\%$ (measured by ultrasonic wall thickness gauge at 5 points).

-End face perpendicularity: $\leq 0.5\text{mm/m}$ (measured by right angle ruler + feeler gauge).

ASME B16.49 Tolerance

The **ASME B16.49** Production Standard defines the permissible tolerances for dimensions of pipe elbows, including:

1. Wall Thickness:

- The minimum wall thickness shall be as specified for the pipe material or elbow size.

- Tolerances must ensure the ASME B16.49 BW Pipe Bend does not fall below the specified thickness.

2. Length and Radius:

- Bend radius tolerance is typically limited to $\pm 1\%$ of the specified radius.

- Angular tolerance for the bend angle must be within ± 1 degree.

- Ovality (out-of-roundness) should be controlled to prevent excessive distortion during bending and ensure consistent internal pressure ratings.

- End Preparation: Tolerances for the ASME B16.49 Stainless Steel Pipe Bends are specified to ensure proper fit-up for welding.

Manufacture Process

Induction bends manufactured to ASME B16.49 can be either made from seamless or welded pipes with or without tangent length by cold- or heat-forming process. Generally, ASME B16.49 Nickel Alloy Pipe Bend heat-forming process is applied which utilizes the mid-frequency induction-bending machine.

This process utilizes induction heating to heat a narrow band 360° around a pipe or cylinder at the point of bending as the pipe or cylinder is being pushed through the inductor coil at a constant velocity.

After the material passes through the coil, it may be cooled by forced air or water spray, or it may be allowed to cool in still air. Bends in any producible wall thickness and diameter are covered.

Control Link	Control Points	Specific Requirements
Induction Heating & Bending	Heating Temperature	$850 \pm 50^{\circ} \text{C}$ (adjustable by material, e.g., $830 \sim 880^{\circ} \text{C}$ for X65 steel)
	Heating Width	$\geq 2D$ for 3D bends. $\geq 3D$ for 5D bends. $\geq 4D$ for 7D bends
	Bending Speed	$5^{\circ} \sim 10^{\circ} / \text{min}$ for 3D bends. $10^{\circ} \sim 15^{\circ} / \text{min}$ for 5D~7D bends (with real-time angle monitoring)
Heat Treatment Control	Inspection Requirements	Measure angle, radius, and ovality before and after heat treatment
	Over-tolerance Handling	Cold straightening allowed (deformation $\leq 0.5\%$ for carbon steel)

Core Differences of B16.49 and B16.9

Angle range

ASME B16.49 covers bend radii of 2D to 10D and angles of 15° to 135° , and allows customization. ASME B16.9 mainly focuses on 1.5D long radius elbows, with angles concentrated at 45° , 90° , and 180° , and does not support customization of large radii ($\geq 5D$). ASME B16.28 is only for 1.0D short radius elbows, with angles limited to 45° and 90° , and no customization space.

Tolerance control perspective

The angular tolerance ($\pm 1.5^{\circ}$) of ASME B16.49 is consistent with ASME B16.9, but the bending radius tolerance ($\pm 1.5\%$) is stricter than that of ASME B16.9 ($\pm 2\%$) and ASME B16.28 ($\pm 2.5\%$).

Regarding ellipticity requirements, the bending section ($\leq 2.5\%$) of ASME B16.49 is slightly wider than that of ASME B16.9 ($\leq 2\%$), but the weld end ($\leq 1\%$) is consistent with both.

Geometric compatibility perspective

The large radius (5D, 7D) bends of ASME B16.49 are suitable for high-velocity ($\geq 3\text{m/s}$) fluid transport, reducing fluid resistance, the 1.5D bends of ASME B16.9 are suitable for conventional process piping, balancing space and resistance, the 1.0D bends of ASME B16.28 are only suitable for scenarios with extremely limited space, requiring acceptance of higher fluid resistance losses.

Comparative Standard	Core Differences of B16.49
ASME B16.9	1. Supports large radii (2D~10D) + custom angles. 2. Tighter radius tolerance ($\pm 1.5\%$); 3. Suitable for high-flow-rate scenarios
ASME B16.28	1. ASME B16.28 only covers short radii (1.0D) and fixed angles ($45^{\circ} / 90^{\circ}$). 2. ASME B16.49 has better spatial adaptability

Fig. 1 Bend Dimensional Terms

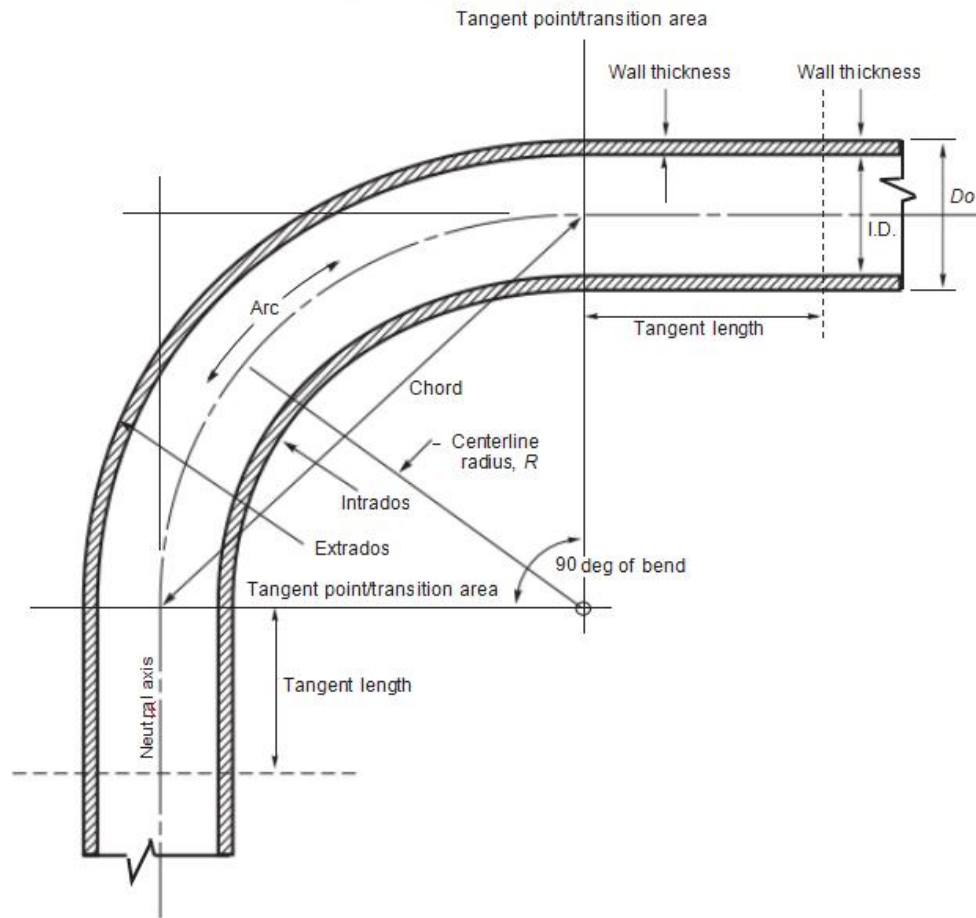


Table 1 Tensile Properties

Grade (Symbol)	Minimum Tensile Properties			Maximum Hardness	
	Yield Strength, MPa (ksi)	Tensile Strength, MPa (ksi)	Elongation, %	HBW [Note (1)]	HRC [Note (2)]
P241 (X241)	241 (35)	414 (60)	20	238	22
P290 (X290)	290 (42)	414 (60)	20	238	22
P317 (X317)	317 (46)	434 (63)	20	238	22
P359 (X359)	359 (52)	455 (66)	20	238	22
P386 (X386)	386 (56)	490 (71)	20	238	22
P414 (X414)	414 (60)	517 (75)	20	238	22
P448 (X448)	448 (65)	531 (77)	18	238	22
P483 (X483)	483 (70)	565 (82)	16	247	24
P552 (X552)	552 (80)	621 (90)	16	247	24

GENERAL NOTE: Intermediate grades may be purchased subject to agreement between the purchaser and manufacturer. NOTES:

(1) HBW (Hardness Brinell) is the primary number.

(2) HRC (Hardness Rockwell C) is an approximation based on ASTM E140 hardness conversion.

ASME B16.49 Material Requirements

ASME B16.49 Carbon Steel Pipe Bend Grades

- ASTM A234 WPB
- ASTM A420 WPL3 WPL6 (low-temperature service)
- Applications: Suitable for general service conditions, including oil, gas, and water pipelines, where toughness and strength are required.

ASME B16.49 Alloy Steel Pipe Bend Grades

- ASTM A234 WP11, WP22, WP9 WP91
- ASTM A860 WPHY 42, WPHY 46, WPHY 52, WPHY 60, WPHY 65, WPHY 70 (High-yield strength materials)
- Applications: Used in high-temperature and high-pressure environments, such as power plants, refineries, and chemical plants.

ASME B16.49 Stainless Steel Pipe Bend Grades

- ASTM A403 WP304, WP304L, WP316, WP316L, WP321, WP347
- Applications: Ideal for corrosive environments, including food processing, pharmaceuticals, and chemical industries.

ASME B16.49 Duplex Stainless Steel Pipe Bend Grades

- ASTM A815 UNS S31803 (Duplex 2205)
- ASTM A815 UNS S32750 (Super Duplex 2507)
- Applications: Provides higher strength and corrosion resistance, used in oil and gas, marine, and chemical processing industries.

ASME B16.49 Nickel Alloy Pipe Bend Grades

- ASTM B366 UNS N06600 (Inconel 600), UNS N06625 (Inconel 625), UNS N08825 (Incoloy 825)
- ASTM B366 UNS N10276 (Hastelloy C276)
- ASTM B366 UNS N04400 (Monel 400)
- ASTM B366 UNS N06022 (Hastelloy C22)
- Applications: Used in applications requiring specific resistance to certain chemicals or environments, such as sulfuric acid plants, chemical processing, and pollution control equipment.

Table 2 Maximum Limits of Chemical Elements That May Be Used

Element	Symbol	Maximum, %
Carbon	C	0.30
Manganese	Mn	1.60 [Note (1)]
Phosphorus	P	0.025
Sulfur	S	0.015
Silicon	Si	0.50
Chromium	Cr	0.30
Molybdenum	Mo	0.25
Vanadium	V	0.10
Copper	Cu	0.50
Nickel	Ni	1.00
Niobium	Nb (Cb)	0.10

GENERAL NOTE: The chemical requirements of this Table are not intended to represent the composition of any heat of steel, but to record the maximum permissible amounts of individual elements.

NOTE:

- (1) For Grades P483 (X483) and higher for each reduction of 0.01% below the specified maximum carbon content, an increase of 0.05% above the maximum manganese content is permissible, up to a maximum of 2.00%.

ASME B16.49 Pressure Rating

Pressure-Temperature Ratings: Pipe elbows must withstand the pressure ratings specified by the connected piping system, ensuring that the elbow's pressure rating matches the same rating as the pipe.

- **ASME B16.49** Pressure Ratings are based on the class of pipe, material, and wall thickness.

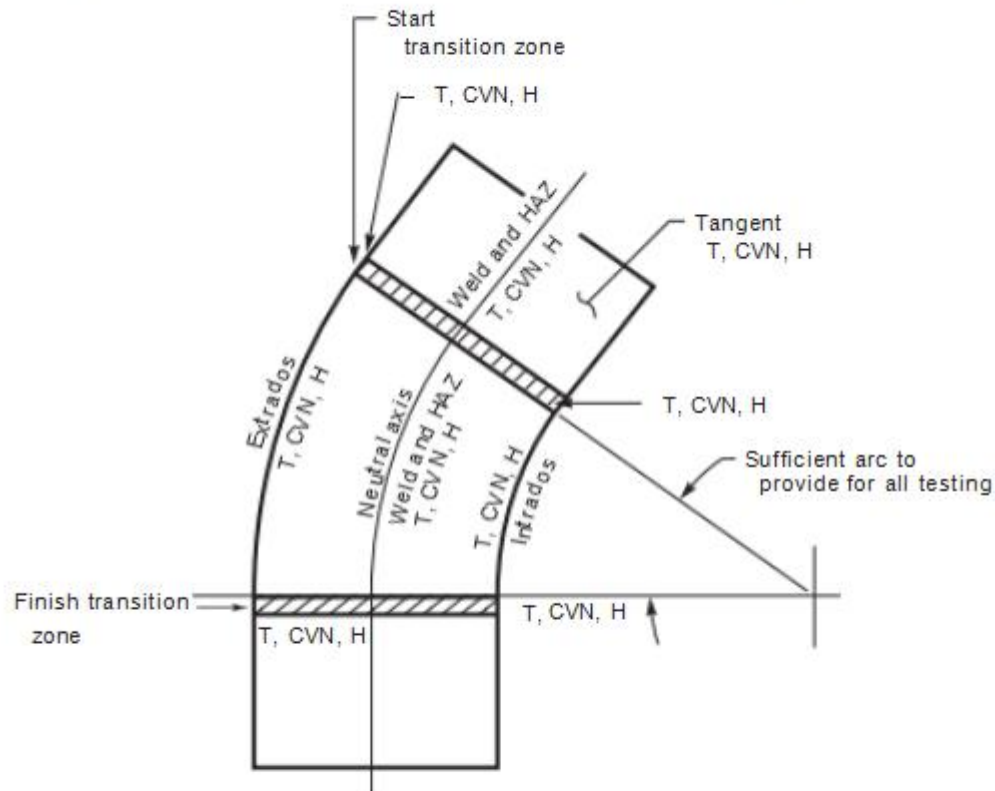
- Wall Thickness and Pressure Relationship: For a given NPS, the elbow's wall thickness must meet the design pressure requirements at the specified operating temperature.

ASME B16.49 Specification Marking

The marking requirements ensure traceability and compliance with the standard:

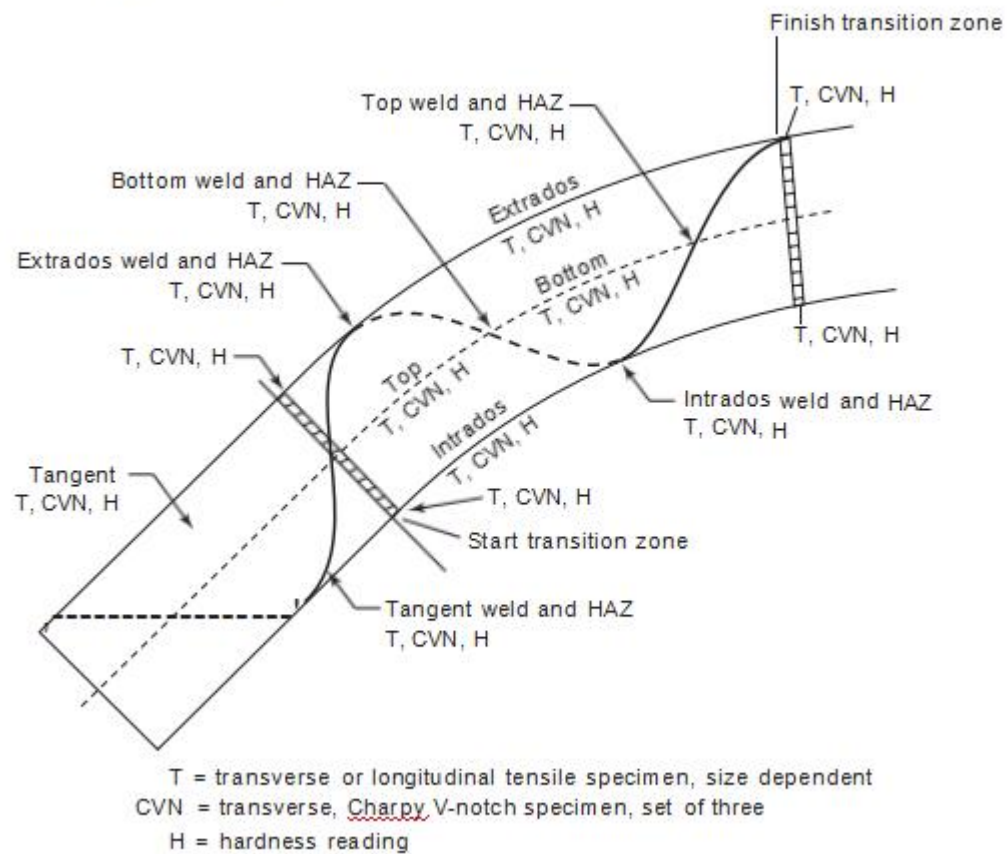
- Manufacturer's Identification: Includes the manufacturer's name or trademark.
- Material Grade: Denotes the steel grade or material type.
- Pipe Size and Radius: Includes the nominal pipe size, bend radius, and wall thickness.
- Pressure Rating: Specifies the pressure class or schedule of the pipe elbow.
- **ASME B16.49** Standard Designation: Marking the part as per ASME B16.49, ensuring compliance with the specification.

Fig. 2 Test Specimen Locations and Orientations — Longitudinal Seam



T = transverse or longitudinal tensile specimen, size dependent
 CVN = transverse Charpy V-notch specimen, set of three
 H = hardness reading

Fig. 3 Test Specimen Locations and Orientations — Helical Seam



Testing Requirements

ASME B16.49 Pipe Bend Normalizing. Heat above the transformation temperature range and hold at temperature for a minimum of 20 min per 25 mm (1 in.) of thickness, but not less than 20 min, and allow to cool in still air.

ASME B16.49 Pipe elbows must undergo various testing procedures to verify their compliance with the standard:

Non-Destructive Testing (NDT): Includes methods such as:

- ASME B16.49 SS Pipe Bend Ultrasonic Testing (UT) or Radiographic Testing (RT) to detect internal flaws.
- Magnetic Particle Inspection (MPI) or Dye Penetrant Testing (DPT) to detect surface cracks or imperfections.
- Hydrostatic Testing: A pressure test is performed to ensure the elbow can withstand specified internal pressures without failure or leaks. The test pressure is usually 1.5 times the design pressure of the system.
- ASME B16.49 CS Pipe Bend Dimensional Inspection: A detailed dimensional inspection is performed to verify that the bend radius, wall thickness, and end dimensions meet the tolerance requirements.

Conclusion

ASME B16.49 governs the manufacturing, testing, and quality assurance of factory-made wrought steel pipe elbows for high-pressure systems. The ASME B16.49 Pipe Bend Specification ensures that pipe elbows maintain appropriate tolerances, material strength, pressure ratings, and undergo thorough testing to guarantee integrity in service. This helps to provide consistent performance in high-pressure environments like oil and gas pipelines, chemical processing, and other critical industries.