

ASTM A182 F321 Forging Specification

ASTM A182 – Standard Overview

ASTM A182 is a specification covering **forged or rolled alloy and stainless steel flanges, fittings, valves, and parts for high-temperature service.**

- Typical applications:
 - Pressure vessels
 - Petrochemical piping
 - Heat exchangers
 - Nuclear & power plant systems

ASTM A182 F321 – Stabilized Austenitic Stainless Steel

F321 corresponds to **AISI 321 stainless steel**, stabilized with **titanium (Ti)**.

Materials shall comply with the specifications provided in the bid documents.

Applicable Standards

- **ASTM A370** – Standard test methods and definitions for mechanical testing of steel products
- **ASTM E112** – Standard test methods for determining average grain size
- **ASTM A262** – Practices for detecting susceptibility to intergranular attack in austenitic stainless steels

Raw Material Requirements

a. Steel for forgings shall be produced by **electric furnace melting, vacuum degassing, or electroslag remelting (ESR)** to ensure high-quality fine-grain steel. A **Mill Test Certificate (MTC)** shall be provided.

b. The manufacturer shall conduct **100% chemical analysis** of the raw material. Chemical composition shall conform to **Table 1**.

Forging Requirements

1. Steel ingots or billets used for forging flanges and rings shall be from the **same heat number**. After heating, sufficient crop ends shall be removed to ensure no shrinkage cavity or severe segregation.
 2. The **forging reduction ratio** of the main cross-section shall be ≥ 3 .
 3. **Carbon steel and alloy steel shall not be heated together**. The furnace shall be cleaned before forging to prevent contamination or carburization of stainless steel.
 4. Forging shall be fully worked with adequate deformation. Final forging dimensions shall be as close as possible to drawing dimensions.
Final forging temperature shall not be lower than 850 ° C.
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Heat Treatment Requirements

1. Forgings shall undergo **solution heat treatment** at 1050 ° C – 1150 ° C, with complete original records retained.
 2. **Stabilization heat treatment** shall be carried out at 815 ° C – 870 ° C, with proper records maintained.
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Mechanical Properties

Finished forgings shall be subjected to mechanical testing.

- **Grade IV forgings**: test samples taken from each forging
- **Grade III forgings**: one sample taken from the same heat number and same heat treatment batch

Test results shall comply with **Table 2**.

Grain Size Measurement

- Average grain size shall be measured in accordance with **ASTM E112**
- Acceptance criteria shall comply with the specified standard

Intergranular Corrosion Test

- When required, testing shall be conducted in accordance with **ASTM A262**, and test samples shall be retained.
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Ultrasonic Testing (UT)

a. Products classified as **Grade III or Grade IV forgings** shall undergo **100% ultrasonic testing**.

b. When specified by purchase order or owner requirements, UT shall be conducted as follows:

- Testing standard: **JB/T 4730.3-2005** or **ASTM E94**
 - Acceptance criteria shall comply with the applicable standard.
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Liquid Penetrant Testing (PT)

- All stainless steel forgings shall undergo **liquid penetrant testing**, except where ultrasonic testing is specified.
 - Testing standard: **JB/T 4730.5-2005**
 - Acceptance level: **PT I**
 - PT may be performed after machining or prior to final protection.
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Visual Inspection

Surface quality shall be visually inspected.

- No visible cracks, laps, folds, inclusions, or other harmful defects
 - Surface roughness shall not exceed **Ra 6.3**
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Positive Material Identification (PMI)

All products shall undergo **100% PMI testing** using **SPECTRO TEST spectrometer**.
All requirements shall comply with engineering specifications.

Quality Documentation

For all accepted forgings, the following documents shall be provided:

1. Raw material Mill Test Certificate
2. Manufacturer's material re-inspection report (chemical analysis)
3. Heat treatment report and original records
4. Mechanical test report
5. NDT reports
6. Metallographic analysis report
7. Intergranular corrosion test report
8. Dimensional inspection records

Table 1 – Chemical Composition of ASTM A182 F321

Element	C	Si	Mn	S	P	Cr	Ni	Ti
A182 F321 (%)	≤0.08	≤1.00	≤2.00	≤0.030	≤0.045	17.00 – 19.00	9.00 – 12.00	$5 \times C$ – 0.70

Table 2 – Mechanical Properties of ASTM A182 F321 (After Heat Treatment)

Property	Requirement
Yield Strength (YS, $\sigma_{0.2}$)	≥205 MPa
Tensile Strength (TS)	≥515 MPa
Elongation (EL)	≥30 %
Reduction of Area (RA)	≥50 %
Impact Test	Not required
Hardness	Not specified

ASTM A182 F321H – High-Carbon Version

F321H is the **high-carbon (H-grade)** version of F321.

Differences vs F321

Item	F321	F321H
Carbon content	≤0.08%	0.04 – 0.10% (controlled)
Strength at high temperature	Standard	Higher creep & tensile strength
Service temperature	High	Higher temperature service

Typical Applications

- High-temperature pressure vessels
- Steam piping
- Refinery furnace components

Summary Comparison

Grade	Key Advantage	Typical Use
A182 F321	Stabilized, corrosion-resistant	General high-temperature service
A182 F321H	Higher strength at elevated temp	High-pressure & high-temp systems