



TECHNICAL DATA / ENGINEERING REFERENCE

15-5 PH Stainless Steel

Properties, precipitation-hardening conditions, corrosion behavior and material specifications

Common Grade	UNS	EN Material No.	Common Type
15-5 PH	S15500	1.4545	XM-12

Purpose Concise technical reference for preliminary material selection, aging-condition selection, machining planning and purchasing. Final design and production requirements should be verified against the applicable product standard, specified heat-treatment condition and actual service environment.

NAITE TECH

www.naitetech.com

naiteservice@naitetech.com

+86 18018270716

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1. Grade Overview

15-5 PH is a martensitic precipitation-hardening stainless steel developed for high-strength precision components where strength, toughness and controlled aging response must be combined with useful stainless corrosion resistance. It is closely related to 17-4 PH but is commonly selected where improved transverse toughness and a more uniform microstructure are important.

Property	15-5 PH Stainless Steel
Material family	Precipitation-hardening stainless steel
Grade designation	15-5 PH / UNS S15500 / EN 1.4545
Main advantage	High strength + improved toughness
Performance requirement	High strength / corrosion resistant / dimensional stability*
Machinability	Good; generally best before final aging
Corrosion resistance	Good general corrosion resistance
Heat treatable	Yes - precipitation hardening
Relative cost	\$\$\$ - High

Engineering note: Mechanical properties depend strongly on aging condition. 15-5 PH offers high strength with good toughness and relatively controlled aging distortion, but it is not a specialist chloride- or seawater-resistant grade.

Typical applications

Aerospace structural components / shafts / high-strength fasteners / valve and pump components / gears / structural fittings / actuator parts / precision mechanical components / highly loaded CNC parts

Aging-condition selection summary

Condition / Decision	Guidance
Condition A	Solution-treated starting condition; commonly used for machining or forming before final aging.
H900	Highest commonly specified strength and hardness; reduced toughness compared with overaged conditions.
H1025	High strength with improved toughness; strong general engineering balance.
H1075 / H1100	Progressive shift toward greater toughness and ductility with lower strength.
H1150	Lower strength with higher toughness and ductility.
Consider 17-4 PH when	A closely related, widely available PH grade meets the required strength and toughness balance.
Consider 2205 when	High strength must be combined with stronger chloride pitting and SCC resistance.

2. Chemical Composition & Mechanical Properties

Composition limits below are representative for UNS S15500 / XM-12. Exact chemistry and mechanical-property requirements vary by product standard, size and condition; the purchasing specification remains controlling.

UNS S15500 - representative chemical composition

Element	Representative Limit
Carbon (C)	<= 0.07%
Manganese (Mn)	<= 1.00%
Phosphorus (P)	<= 0.040%
Sulfur (S)	<= 0.030%
Silicon (Si)	<= 1.00%
Chromium (Cr)	14.0-15.5%
Nickel (Ni)	3.5-5.5%
Copper (Cu)	2.5-4.5%
Niobium + Tantalum (Nb + Ta)	0.15-0.45%
Iron (Fe)	Balance

Alloying note: Copper provides the principal precipitation-hardening response. Chromium supplies stainless corrosion resistance, while nickel and Nb/Ta support the martensitic matrix, toughness and aging behavior.

Representative minimum mechanical properties - aged bar reference

Condition	Tensile	0.2% Yield	Elongation	Typical intent
H900	>= 1310 MPa	>= 1170 MPa	>= 10%	Maximum common strength / hardness
H925	>= 1170 MPa	>= 1070 MPa	>= 10%	High strength, slightly improved toughness
H1025	>= 1070 MPa	>= 1000 MPa	>= 12%	High strength + toughness balance
H1075	>= 1000 MPa	>= 860 MPa	>= 13%	Balanced strength / toughness
H1100	>= 965 MPa	>= 795 MPa	>= 14%	Greater toughness / ductility
H1150	>= 930 MPa	>= 725 MPa	>= 16%	Higher toughness / lower strength

Engineering note: These values are representative of commonly specified 15-5 PH aged bar conditions and are not universal design allowables. Confirm the governing ASTM/AMS/EN standard, product size, test orientation and specified H-condition.



3. Physical Properties & Heat Treatment

Physical values are typical room-temperature data intended for engineering comparison rather than design-code substitution.

Physical Property	Typical Value
Density	Approx. 7.8 g/cm ³
Elastic modulus at 20 C	Approx. 197-200 GPa
Mean thermal expansion, 20-100 C	Approx. 10.8 um/m.K
Thermal conductivity near room temperature	Approx. 17-18 W/m.K
Specific heat near room temperature	Approx. 460 J/kg.K
Electrical resistivity near room temperature	Approx. 0.77-0.80 ohm.mm ² /m
Magnetic behavior	Magnetic

Heat-treatment guidance

Condition / Treatment	Representative guidance
Condition A - solution treated	Approx. 1038 C / 1900 F solution treatment; cooling per applicable specification. Common machining starting condition.
H900	Approx. 482 C / 900 F, commonly 1 hour aging; highest common strength and hardness.
H925	Approx. 496 C / 925 F, commonly 4 hours aging; slightly reduced strength, improved toughness.
H1025	Approx. 552 C / 1025 F, commonly 4 hours aging; high strength with better toughness.
H1075	Approx. 580 C / 1075 F, commonly 4 hours aging; balanced strength and toughness.
H1100	Approx. 593 C / 1100 F, commonly 4 hours aging; greater toughness and ductility.
H1150	Approx. 621 C / 1150 F, commonly 4 hours aging; lower strength, higher toughness / ductility.

Heat-treatment note: Exact solution-treatment temperature, aging time, cooling route and permitted reheating sequence must follow the governing specification. Do not infer certified H-condition from hardness alone when specified mechanical properties are required.

Dimensional stability

Precipitation aging generally produces less severe distortion than conventional quench hardening, which can be valuable for precision parts. Dimensional change is not zero and still depends on part geometry, residual machining stress, section thickness and aging condition. Tight-tolerance parts may require final grinding or finish machining after aging.

4. Corrosion & Environmental Performance

15-5 PH provides good general corrosion resistance for a high-strength stainless steel. Corrosion behavior depends on aging condition, applied stress, surface condition, temperature, chloride level and the actual service environment.

Environment	General Suitability	Engineering Note
Dry indoor service	Excellent	Strong combination of high strength and stainless corrosion resistance.
Outdoor atmospheric exposure	Good	Suitable for many general industrial and aerospace environments.
Freshwater	Good	Review chloride level, temperature, deposits and crevice geometry.
Mild industrial environment	Good	Confirm contaminants, wetting cycle and surface condition.
Coastal atmosphere	Evaluate	Airborne chlorides and sustained wetting reduce corrosion margin.
Chloride process environment	Evaluate carefully	316L or duplex grades may provide a stronger localized-corrosion margin.
Marine-related components	Evaluate	Used selectively; service conditions and aging condition matter.
Direct seawater immersion	Not preferred	2205 / 2507 or another seawater-capable alloy often provides a better fit.
Aggressive chemical service	Evaluate / limited	Select alloy based on chemistry, concentration, temperature, pH and stress level.

Key corrosion considerations

- **Localized corrosion:** Chlorides, deposits and tight crevices can initiate pitting or crevice attack.
- **Stress-corrosion cracking:** High-strength conditions require caution in SCC-sensitive environments; stress, chloride level and temperature matter.
- **Aging condition:** Higher-temperature / overaged conditions generally trade strength for greater toughness and can improve SCC margin in some services.
- **Surface quality:** Embedded iron, rough crevices, heat tint and contamination can reduce practical corrosion performance.
- **Material selection:** 15-5 PH should be chosen for high mechanical performance plus useful corrosion resistance, not as a universal corrosion upgrade over 304/316L.

Selection principle: When chloride resistance dominates the design, compare 15-5 PH with 316L, 2205 or 2507 based on localized-corrosion resistance, SCC risk and required mechanical strength.

5. Manufacturing Characteristics

15-5 PH is well suited to precision machining and forging. The manufacturing route should coordinate machining, precipitation aging, dimensional control and final finishing to achieve the specified H-condition.

Process	Compatibility	Material Consideration
CNC machining	Good	Generally preferred in Condition A before final aging.
Turning	Good	Common for shafts, pins, fasteners, fittings and precision bar components.
Milling	Good	Rigid workholding and sharp tooling support dimensional stability.
Drilling / tapping	Good	Cutting load and tool wear increase in high-strength aged conditions.
Grinding	Excellent	Useful after aging for bearing surfaces, sealing surfaces and tight tolerances.
Forging	Good	Requires controlled hot working plus appropriate solution treatment and aging.
Forming / bending	Limited-Moderate	Prefer before final aging; aged material has reduced formability.
Welding	Good*	Procedure and final heat-treatment route should be qualified together.
Sheet / laser processing	Good*	Feasible in suitable product forms, normally before final aging.
Metal 3D printing	Qualified route*	15-5 PH powders exist, but printed properties are not automatically equivalent to wrought stock.

Recommended manufacturing route

Condition A stock -> rough/semi-finish machining -> precipitation aging -> finish machining or grinding -> cleaning/passivation -> final inspection

Machining behavior

15-5 PH is generally manageable before final aging, while high-strength aged conditions increase cutting forces and tool wear. Use rigid workholding, sharp tooling, stable engagement, effective coolant and suitable allowance for final finishing after heat treatment.

Welding behavior

15-5 PH can be welded using appropriate procedures. For strength-critical parts, the starting condition, filler selection, welding procedure and subsequent heat-treatment route should be specified together because the heat-affected zone and aging sequence influence final properties.

Additive manufacturing note

15-5 PH powder routes are commercially available, but additive material should not be assumed equivalent to wrought ASTM A564 or AMS 5659 stock. Chemistry, density, build orientation, microstructure and post-build heat treatment require qualification.



6. Standards, Material Forms & Surface Conditions

Grade designation alone is not a complete purchasing specification. Product form, heat-treatment condition, surface condition, dimensions and certification should be defined where relevant.

Designation systems

Designation System	15-5 PH Designation
Common grade name	15-5 PH
UNS	S15500
ASTM grade name	XM-12
EN material number	1.4545
Common EN designation	X5CrNiCuNb15-5 / X5CrNiCu15-5 (reference-dependent)

Common product specifications

Specification	Typical Scope
ASTM A564 / A564M	Age-hardening stainless steel bars and shapes; includes UNS S15500 / XM-12 product forms.
ASTM A693 / A693M	Precipitation-hardening stainless steel plate, sheet and strip.
ASTM A705 / A705M	Age-hardening stainless steel forgings.
AMS 5659	Aerospace specification commonly associated with 15-5 PH bars, wire, forgings, rings and extrusions.
AMS 5862	Aerospace specification commonly associated with 15-5 PH sheet, strip and plate.
EN 10088 series	European stainless flat / long-product references; verify grade, condition and properties.

Common material forms

Round Bar / Flat Bar / Plate / Sheet / Strip / Billet / Forged Stock / Rings / Precision Bar Stock

Common purchase conditions and finishing options

Category	Examples
Heat-treatment condition	Condition A / H900 / H925 / H1025 / H1075 / H1100 / H1150
Machined / precision surfaces	Turned / milled / ground / polished / honed as project requires
Post-fabrication finishes	Passivation / bead blasting / laser marking / cleaning as specified

Purchasing note: For controlled parts, specify the complete requirement, for example: **15-5 PH / UNS S15500 / ASTM A564 / H1025 / bar**, together with dimensions, mechanical or hardness requirements, certification and heat/lot traceability.

7. Material Quality, Traceability & Technical References

For controlled projects, material grade, starting condition, final H-condition, certification and traceability should be agreed before production.

Control Point	Recommended Practice
Grade verification	Check 15-5 PH / UNS S15500 identity and applicable material standard against drawing and purchase requirement.
Material certification	MTR / material certificate and CoC where specified; review chemistry, condition and applicable mechanical properties.
Heat / lot traceability	Maintain heat, lot or batch identification where project traceability applies.
Heat-treatment control	Record specified H-condition; retain heat-treatment certificate and process data where required.
Hardness / mechanical verification	Use the specified acceptance method. Hardness alone does not replace required tensile testing.
Incoming inspection	Verify identification, dimensions, surface condition, starting condition and documentation.
Additional alloy verification	PMI may confirm major alloy chemistry where required, but does not verify aging condition or final mechanical properties.

Technical references

- ASTM A564/A564M - age-hardening stainless steel bars and shapes.
- ASTM A693/A693M - precipitation-hardening stainless steel plate, sheet and strip.
- ASTM A705/A705M - age-hardening stainless steel forgings.
- SAE AMS 5659 - aerospace material specification commonly associated with 15-5 PH bars, wire, forgings, rings and extrusions.
- SAE AMS 5862 - aerospace specification commonly associated with 15-5 PH sheet, strip and plate.
- EN 10088 series - European stainless steel grade and product references.
- Producer technical datasheets for UNS S15500 / 15-5 PH physical properties, heat-treatment behavior and corrosion guidance.

Important: This document is a general engineering reference, not a material certificate, design-code substitute or final application specification. Mechanical properties, heat treatment, corrosion suitability and allowable stresses must be verified for the actual product form, condition and service environment.

Need a material review for your project?

Send your drawing, required H-condition, mechanical requirements and service environment to NAITE TECH.

Website	www.naitetech.com
Email	naiteservice@naitetech.com
Phone	+86 18018270716