Stainless Steel
15/5 PH

Precipitation hardening stainless steels are chromium and nickel containing steels that provide an optimum combination of the properties of martensitic and austenitic grades. Like martensitic grades, they are known for their ability to gain high strength through heat treatment and they also have the corrosion resistance of austenitic stainless steel.
The high tensile strengths of precipitation hardening stainless steels come after a heat treatment process that leads to precipitation hardening of a martensitic or austenitic matrix. Hardening is achieved through the addition of one or more of the elements Copper, Aluminium, Titanium, Niobium, and Molybdenum.
The most well known precipitation hardening steel is 17-4 PH. The name comes from the additions 17% Chromium and 4% Nickel. It also contains 4% Copper and 0.3% Niobium. 17-4 PH is also known as stainless steel grade 630.
The advantage of precipitation hardening steels is that they can be supplied in a "solution treated" condition, which is readily machinable. After machining or another fabrication method, a single, low temperature heat treatment can be applied to increase the strength of the steel. This is known as ageing or age-hardening. As it is carried out at low temperature, the component undergoes no distortion.

Characterisation
Precipitation hardening steels are characterised into one of three groups based on their final microstructures after heat treatment. The three types are: martensitic (e.g. 17-4 PH), semi-austenitic (e.g. 17-7 PH) and austenitic (e.g. A-286).

Martensitic Alloys
Martensitic precipitation hardening stainless steels have a predominantly austenitic structure at annealing temperatures of around 1040 to 1065°C. Upon cooling to room temperature, they undergo a transformation that changes the austenite to martensite.

Semi-austenitic Alloys
Unlike martensitic precipitation hardening steels, annealed semi-austenitic precipitation hardening steels are soft enough to be cold worked. Semi-austenitc steels retain their austenitic structure at room temperature but will form martensite at very low temperatures.

Austenitic Alloys
Austenitic precipitation hardening steels retain their austenitic structure after annealing and hardening by ageing. At the annealing temperature of 1095 to 1120°C the precipitation hardening phase is soluble. It remains in solution during rapid cooling. When reheated to 650 to 760°C, precipitation occurs. This increases the hardness and strength of the material. Hardness remains lower than that for martensitic or semi-austenitic precipitation hardening steels. Austenitic alloys remain nonmagnetic.

Strength
Yield strengths for precipitation-hardening stainless steels are 515 to 1415 MPa. Tensile strengths range from 860 to 1520 MPa. Elongations are 1 to 25%. Cold working before ageing can be used to facilitate even higher strengths.

CHEMICAL COMPOSITION

AMS 5659

Element	% Present
Chromium (Cr)	14 - 15.5
Nickel (Ni)	3.5 - 5.5
Copper (Cu)	2.5 - 4.5
Manganese (Mn)	1 max
Silicon (Si)	1 max
Molybdenum (Mo)	0.5 max
Niobium (Columbium) (Nb)	0.45 max
Carbon (C)	0.07 max
Phosphorous (P)	0.03 max
Sulphur (S)	0.02 max
Iron (Fe)	Balance

ALLOY DESIGNATIONS

15/5 PH
UNS S15500
AMS 5659

SUPPLIED FORMS

This is a bar specification, typically available in round and hexagon
- Bar

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Stainless Steel
15/5 PH

MECHANICAL PROPERTIES

AMS 5659

Property	Value
Proof Stress	700-1170 MPa
Tensile Strength	930-1310 MPa
Elongation A50 mm	10-16 %
Hardness Brinell	277-444 HB

Mechanical properties vary greatly according to the heat treatment that the material has undergone.

APPLICATIONS

Due to the high strength of precipitation hardening stainless steels, most applications are in aerospace and other high-technology industries.
Applications include:
~ Gears
~ Valves and other engine components
~ High strength shafts
~ Turbine blades
~ Moulding dies
~ Nuclear waste casks

CORROSION RESISTANCE

Precipitation hardening stainless steels have moderate to good corrosion resistance in a range of environments. They have a better combination of strength and corrosion resistance than when compared with the heat treatable 400 series martensitic alloys. Corrosion resistance is similar to that found in grade 304 stainless steel.

FABRICATION

This grade has good forming characteristics

MACHINABILITY

This grade has reasonable machinability

HEAT TREATMENT

The key to the properties of precipitation hardening stainless steels lies in heat treatment.
After solution treatment or annealing of precipitation hardening stainless steels, a single low temperature "age hardening" stage is employed to achieve the required properties. As this treatment is carried out at a low temperature, no distortion occurs and there is only superficial discolouration. During the hardening process a slight decrease in size takes place. This shrinking is approximately 0.05% for condition H900 and 0.10% for H1150.
Typical mechanical properties achieved for 15-5 PH after solution treating and age hardening are given in the table on the attached page.

WELDABILITY

Precipitation hardening steels can be readily welded using procedures similar to those used for the 300 series of stainless steels.

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CONTACT

Address:	Aldridge Warehouse No. 1 Wharf Approach Anchor Brook Industrial Park Aldridge Walsall WS9 8BX
Tel:	+44 (0)19 2245 3982
Email:	sales@durbinmetals.co.uk
Web:	www.durbinmetals.co.uk

REVISION HISTORY

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