SAE steel grades

Iron alloy phases

Ferrite (α-iron, δ-iron)
Austenite (γ-iron)
Pearlite (88% ferrite, 12% cementite)
Martensite
Bainite
Ledeburite (ferrite-cementite eutectic, 4.3% carbon)
Cementite (iron carbide, Fe_3C)

Steel classes

Crucible steel
Carbon steel (≤2.1% carbon; low alloy)

- Spring steel (low or no alloy)

Alloy steel (contains non-carbon elements)

- Maraging steel (contains nickel)
- Stainless steel (contains ≥10.5% chromium)
- Weathering steel
- Tool steel (alloy steel for tools)

Other iron-based materials

Cast iron (>2.1% carbon)

- Ductile iron
- Gray iron
- Malleable iron
- White iron

Wrought iron (contains slag)

The Society of Automotive Engineers (SAE) designates **SAE steel grades**. These are four digit numbers which represent chemical composition standards for steel specifications. The American Iron and Steel Institute (AISI) originally started a very similar system. Over time they used the same numbers to refer to the same alloy, but the AISI system used a letter prefix to denote the steelmaking process. The prefix "C" denoted open-hearth furnace, electric arc furnace or basic oxygen furnace, while "E" denotes electric arc furnace steel.

Prior to 1995 the AISI was also involved, and the standard was designated the **AISI/SAE steel grades**. The AISI stopped being involved because it never wrote any of the specifications.

Contents

Carbon and alloy steel

Main articles: Carbon steel and Alloy steel

Carbon steels and alloy steels are designated by a four digit number, where the first digit indicates the main alloying element(s), the second digit indicates the secondary alloying element(s), and the last two digits indicate the amount of carbon, in hundredths of a percent by weight. For example, a 1060 steel is a plain-carbon steel containing 0.60 wt% C.

An "H" suffix can be added to any designation to denote hardenability is a major requirement. The chemical requirements are loosened but hardness values defined for various distances on a Jominy test.

Major classifications of steel

SAE designation	Type
1xxx	Carbon steels
2xxx	Nickel steels
3xxx	Nickel-chromium steels
4xxx	Molybdenum steels
5xxx	Chromium steels
6xxx	Chromium-vanadium steels
7xxx	Tungsten steels
8xxx	Nickel-chromium-vanadium steels
9xxx	Silicon-manganese steels

Carbon and alloy steel grades

SAE designation	Type
	Carbon steels
10xx	Plain carbon (Mn 1.00% max)
11xx	Resulfurized
12xx	Resulfurized and rephosphorized
15xx	Plain carbon (Mn 1.00% to 1.65%)
	Manganese steels
13xx	Mn 1.75%
	Nickel steels
23xx	Ni 3.50%
25xx	Ni 5.00%
	Nickel-chromium steels
31xx	Ni 1.25%, Cr 0.65% or 0.80%
32xx	Ni 1.25%, Cr 1.07%
33xx	Ni 3.50%, Cr 1.50% or 1.57%
34xx	Ni 3.00%, Cr 0.77%
	Molybdenum steels
40xx	Mo 0.20% or 0.25% or 0.25% Mo & 0.042 S
44xx	Mo 0.40% or 0.52%
	Chromium-molybdenum (Chromoly) steels
41xx	Cr 0.50% or 0.80% or 0.95%, Mo 0.12% or 0.20% or 0.25% or 0.30%
	Nickel-chromium-molybdenum steels
43xx	Ni 1.82%, Cr 0.50% to 0.80%, Mo 0.25%
43BVxx	Ni 1.82%, Cr 0.50%, Mo 0.12% or 0.35%, V 0.03% min
47xx	Ni 1.05%, Cr 0.45%, Mo 0.20% or 0.35%
81xx	Ni 0.30%, Cr 0.40%, Mo 0.12%
81Bxx	Ni 0.30%, Cr 0.45%, Mo 0.12%
86xx	Ni 0.55%, Cr 0.50%, Mo 0.20%

87xx Ni 0.55%, Cr 0.50%, Mo 0.25%
88xx Ni 0.55%, Cr 0.50%, Mo 0.35%
93xx Ni 3.25%, Cr 1.20%, Mo 0.12%
94xx Ni 0.45%, Cr 0.40%, Mo 0.12%
97xx Ni 0.55%, Cr 0.20%, Mo 0.20%
98xx Ni 1.00%, Cr 0.80%, Mo 0.25%

Nickel-molybdenum steels

46xx Ni 0.85% or 1.82%, Mo 0.20% or 0.25%
48xx Ni 3.50%, Mo 0.25%

Chromium steels

50xx Cr 0.27% or 0.40% or 0.50% or 0.65%
50xxx Cr 0.50%, C 1.00% min
50Bxx Cr 0.28% or 0.50%
51xx Cr 0.80% or 0.87% or 0.92% or 1.00% or 1.05%
51xxx Cr 1.02%, C 1.00% min
51Bxx Cr 0.80%
52xxx Cr 1.45%, C 1.00% min

Chromium-vanadium steels

61xx Cr 0.60% or 0.80% or 0.95%, V 0.10% or 0.15% min

Tungsten-chromium steels

72xx W 1.75%, Cr 0.75%

Silicon-manganese steels

92xx Si 1.40% or 2.00%, Mn 0.65% or 0.82% or 0.85%, Cr 0.00% or 0.65%

High-strength low-alloy steels

9xx Various SAE grades
xxBxx Boron steels
xxLxx Leaded steels

Stainless steel

- 100 Series—austenitic chromium-nickel-manganese alloys
- Type 101—austenitic that is hardenable through cold working for furniture
- Type 102—austenitic general purpose stainless steel working for furniture
- 200 Series—austenitic chromium-nickel-manganese alloys
- Type 201—austenitic that is hardenable through cold working
- Type 202—austenitic general purpose stainless steel
- 300 Series—austenitic chromium-nickel alloys
- Type 301—highly ductile, for formed products. Also hardens rapidly during mechanical working. Good weldability. Better wear resistance and fatigue strength than 304.
- Type 302—same corrosion resistance as 304, with slightly higher strength due to additional carbon.
- Type 303—free machining version of 304 via addition of sulfur and phosphorus. Also referred to as "A1" in accordance with ISO 3506.
- Type 304—the most common grade; the classic 18/8 stainless steel. Also referred to as "A2" in accordance with ISO 3506.
- Type 304L—same as the 304 grade but contains less carbon to increase weldability. Is slightly weaker than 304.
- Type 304LN—same as 304L, but also nitrogen is added to obtain a much higher yield and tensile strength than 304L.
- Type 308—used as the filler metal when welding 304
- Type 309—better temperature resistance than 304, also sometimes used as filler metal when welding dissimilar steels, along with inconel.
- Type 316—the second most common grade (after 304); for food and surgical stainless steel uses; alloy addition of molybdenum prevents specific forms of corrosion. It is also known as marine grade

stainless steel due to its increased resistance to chloride corrosion compared to type 304. 316 is often used for building nuclear reprocessing plants. 316L is an extra low carbon grade of 316, generally used in stainless steel watches and marine applications, as well exclusively in the fabrication of reactor pressure vessels for boiling water reactors, due to its high resistance to corrosion. Also referred to as "A4" in accordance with ISO 3506. 316Ti includes titanium for heat resistance, therefore it is used in flexible chimney liners.

- Type 321—similar to 304 but lower risk of weld decay due to addition of titanium. See also 347 with addition of niobium for desensitization during welding.
- 400 Series—ferritic and martensitic chromium alloys
- Type 405—ferritic for welding applications
- Type 408—heat-resistant; poor corrosion resistance; 11% chromium, 8% nickel.
- Type 409—cheapest type; used for automobile exhausts; ferritic (iron/chromium only).
- Type 410—martensitic (high-strength iron/chromium). Wear-resistant, but less corrosion-resistant.
- Type 416—easy to machine due to additional sulfur
- Type 420—Cutlery Grade martensitic; similar to the Brearley's original rustless steel. Excellent polishability.
- Type 430—decorative, e.g., for automotive trim; ferritic. Good formability, but with reduced temperature and corrosion resistance.
- Type 439—ferritic grade, a higher grade version of 409 used for catalytic converter exhaust sections. Increased chromium for improved high temperature corrosion/oxidation resistance.
- Type 440—a higher grade of cutlery steel, with more carbon, allowing for much better edge retention when properly heat-treated. It can be hardened to approximately Rockwell 58 hardness, making it one of the hardest stainless steels. Due to its toughness and relatively low cost, most display-only and replica swords or knives are made of 440 stainless. Available in four grades: 440A, 440B, 440C, and the uncommon 440F (free machinable). 440A, having the least amount of carbon in it, is the most stain-resistant; 440C, having the most, is the strongest and is usually considered more desirable in knifemaking than 440A, except for diving or other salt-water applications.
- Type 446—For elevated temperature service
- 500 Series—heat-resisting chromium alloys
- 600 Series—martensitic precipitation hardening alloys
- 601 through 604: Martensitic low-alloy steels.
- 610 through 613: Martensitic secondary hardening steels.
- 614 through 619: Martensitic chromium steels.
- 630 through 635: Semiaustenitic and martensitic precipitation-hardening stainless steels.
- Type 630 is most common PH stainless, better known as 17-4; 17% chromium, 4% nickel.
- 650 through 653: Austenitic steels strengthened by hot/cold work.
- 660 through 665: Austenitic superalloys; all grades except alloy 661 are strengthened by second-phase precipitation.
- Type 2205—the most widely used duplex (ferritic/austenitic) stainless steel grade. It has both excellent corrosion resistance and high strength.

Stainless steel designations

SAE designation	UNS designation	% Cr	% Ni	% C	% Mn	% Si	% P	% S	% N	Other
Austenitic										
201	S20100	16–18	3.5–5.5	0.15	5.5–7.5	0.75	0.06	0.03	0.25	-
202	S20200	17–19	4–6	0.15	7.5–10.0	0.75	0.06	0.03	0.25	-
205	S20500	16.5–18	1–1.75	0.12–0.25	14–15.5	0.75	0.06	0.03	0.32–0.40	-
254	S31254	20	18	0.02 max	-	-	-	-	0.20	6 Mo; 0.75 Cu; "Super austenitic"; All values nominal
301	S30100	16–18	6–8	0.15	2	0.75	0.045	0.03	-	-
302	S30200	17–19	8–10	0.15	2	0.75	0.045	0.03	0.1	-
302B	S30215	17–19	8–10	0.15	2	2.0–3.0	0.045	0.03	-	-
303	S30300	17–19	8–10	0.15	2	1	0.2	0.15	-	Mo 0.60 (optional)

								min		
303Se	S30323	17–19	8–10	0.15	2	1	0.2	0.06	-	0.15 Se min
304	S30400	18–20	8–10.50	0.08	2	0.75	0.045	0.03	0.1	-
304L	S30403	18–20	8–12	0.03	2	0.75	0.045	0.03	0.1	-
304Cu	S30430	17–19	8–10	0.08	2	0.75	0.045	0.03	-	3–4 Cu
304N	S30451	18–20	8–10.50	0.08	2	0.75	0.045	0.03	0.10–0.16	-
305	S30500	17–19	10.50–13	0.12	2	0.75	0.045	0.03	-	-
308	S30800	19–21	10–12	0.08	2	1	0.045	0.03	-	-
309	S30900	22–24	12–15	0.2	2	1	0.045	0.03	-	-
309S	S30908	22–24	12–15	0.08	2	1	0.045	0.03	-	-
310	S31000	24–26	19–22	0.25	2	1.5	0.045	0.03	-	-
310S	S31008	24–26	19–22	0.08	2	1.5	0.045	0.03	-	-
314	S31400	23–26	19–22	0.25	2	1.5–3.0	0.045	0.03	-	-
316	S31600	16–18	10–14	0.08	2	0.75	0.045	0.03	0.10	2.0–3.0 Mo
316L	S31603	16–18	10–14	0.03	2	0.75	0.045	0.03	0.10	2.0–3.0 Mo
316F	S31620	16–18	10–14	0.08	2	1	0.2	0.10 min	-	1.75–2.50 Mo
316N	S31651	16–18	10–14	0.08	2	0.75	0.045	0.03	0.10–0.16	2.0–3.0 Mo
317	S31700	18–20	11–15	0.08	2	0.75	0.045	0.03	0.10 max	3.0–4.0 Mo
317L	S31703	18–20	11–15	0.03	2	0.75	0.045	0.03	0.10 max	3.0–4.0 Mo
321	S32100	17–19	9–12	0.08	2	0.75	0.045	0.03	0.10 max	Ti 5(C+N) min, 0.70 max
329	S32900	23–28	2.5–5	0.08	2	0.75	0.04	0.03	-	1–2 Mo
330	N08330	17–20	34–37	0.08	2	0.75–1.50	0.04	0.03	-	-
347	S34700	17–19	9–13	0.08	2	0.75	0.045	0.030	-	Nb + Ta, 10 x C min, 1 max
348	S34800	17–19	9–13	0.08	2	0.75	0.045	0.030	-	Nb + Ta, 10 x C min, 1 max, but 0.10 Ta max; 0.20 Ca
384	S38400	15–17	17–19	0.08	2	1	0.045	0.03	-	-
						Ferritic				
405	S40500	11.5–14.5	-	0.08	1	1	0.04	0.03	-	0.1–0.3 Al, 0.60 max
409	S40900	10.5–11.75	0.05	0.08	1	1	0.045	0.03	-	Ti 6 x C, but 0.75 max
429	S42900	14–16	0.75	0.12	1	1	0.04	0.03	-	-
430	S43000	16–18	0.75	0.12	1	1	0.04	0.03	-	-
430F	S43020	16–18	-	0.12	1.25	1	0.06	0.15 min	-	0.60 Mo (optional)
430FSe	S43023	16–18	-	0.12	1.25	1	0.06	0.06	-	0.15 Se min
434	S43400	16–18	-	0.12	1	1	0.04	0.03	-	0.75–1.25 Mo
436	S43600	16–18	-	0.12	1	1	0.04	0.03	-	0.75–1.25 Mo; Nb+Ta 5 x C min, 0.70 max
442	S44200	18–23	-	0.2	1	1	0.04	0.03	-	-
446	S44600	23–27	0.25	0.2	1.5	1	0.04	0.03	-	-

Martensitic										
403	S40300	11.5–13.0	0.60	0.15	1	0.5	0.04	0.03	-	-
410	S41000	11.5–13.5	0.75	0.15	1	1	0.04	0.03	-	-
414	S41400	11.5–13.5	1.25–2.50	0.15	1	1	0.04	0.03	-	-
416	S41600	12–14	-	0.15	1.25	1	0.06	0.15 min	-	0.060 Mo (optional)
416Se	S41623	12–14	-	0.15	1.25	1	0.06	0.06	-	0.15 Se min
420	S42000	12–14	-	0.15 min	1	1	0.04	0.03	-	-
420F	S42020	12–14	-	0.15 min	1.25	1	0.06	0.15 min	-	0.60 Mo max (optional)
422	S42200	11.0–12.5	0.50–1.0	0.20–0.25	0.5–1.0	0.5	0.025	0.025	-	0.90–1.25 Mo; 0.20–0.30 V; 0.90–1.25 W
431	S41623	15–17	1.25–2.50	0.2	1	1	0.04	0.03	-	-
440A	S44002	16–18	-	0.60–0.75	1	1	0.04	0.03	-	0.75 Mo
440B	S44003	16–18	-	0.75–0.95	1	1	0.04	0.03	-	0.75 Mo
440C	S44004	16–18	-	0.95–1.20	1	1	0.04	0.03	-	0.75 Mo
Heat resisting										
501	S50100	4–6	-	0.10 min	1	1	0.04	0.03	-	0.40–0.65 Mo
502	S50200	4–6	-	0.1	1	1	0.04	0.03	-	0.40–0.65 Mo
Duplex										
2205	S31803 S32205	22	5	0.03 max	-	-	-	-	0.15	3 Mo; All values nominal
Super duplex										
2507	S32750	25	7	0.03 max	-	-	-	-	0.28	4 Mo; All values nominal