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Submitted for recognition as an American National Standard

WROUGHT NICKEL AND NICKEL-RELATED ALLOYS

***Foreword*—**This Reaffirmed Document has been changed only to reflect the new SAE Technical Standards Board Format.

***1. Scope*—**This Report presents general information on over 50 alloys in which nickel either predominates or is a significant alloying element. It covers primarily wrought materials, and is not necessarily all inclusive. Values given are in most cases average or nominal, and if more precise values are required the producer(s) should be contacted. This report does not cover the so-called "superalloys," or the iron base stainless steels. Refer to SAE J467, Special Purpose Alloys, and SAE J405, Chemical Compositions of SAE Wrought Stainless Steels, respectively, for data on these alloys.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J467—Special Purpose Alloys
SAE J405—Chemical Compositions of SAE Wrought Stainless Steels

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TABLE 1

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
1	*NICKEL*		
1A	Nickel UNS N02200	NICKEL 200[1a] HARDER[12a] 200	Commercially pure, malleable nickel, containing about 99.40% nickel and including a few tenths of a percent of cobalt, which is counted as nickel because its effect upon the significant properties of the alloy is not detrimental. Applications—Electron tube cathodes and grilles, hot caustic handling equipment, catalysts, printed circuits.
1B	Age Hardenable Nickel	DURANICKEL[1a] Alloy 301[1]	Age hardenable, high nickel alloy with high strength and hardness as well as the general corrosion characteristics of nickel. Alloy has good spring properties. Applications—Extrusion press parts, molds used in glass industry, clips, diaphragms and springs.
1C	High Purity Nickel UNS N02270	Nickel 270[1]	A high purity product containing about 99.98% nickel and maximum of 0.001% cobalt. Due to the low level of impurities, the alloy exhibits good thermal conductivity. Applications—Cathode shanks, fluorescent lamps, hydrogen-thyratron components, plates (anodes) and passive cathodes, heat exchangers and heat shields.
2	*NICKEL-BERYLLIUM*		
2A	2 Be—97 Ni—0.5 Ti	BERYLCO[9a] Nickel 440	Age hardenable alloy possessing high strength, extreme hardness and good ductility. Used up to 420 °C (800 °F). Good impact and fatigue properties. Applications—Heat resistant springs and switches, diaphragms, bellows, retainer clips, feather valves, contact springs, electrical shunts.
3	*NICKEL-MANGANESE*		
3A	95 Ni—4 Mn—1 Si	Alloy 667[2] R63 alloy[5]	Highly resistant to attack by the corrosive elements of internal combustion engine fuels—particularly sulphur and lead compounds. Applications—General purpose spark plug electrode.
4	*NICKEL-MANGANESE-ALUMINUM-SILICON*		
4A	95 Ni—2 Mn—2 Al—1 Si	NIAL[3a] T-2[5] ALUMEL[2a]	Applications—Negative leg of ANSI Type K thermocouples; used with 90 Ni—20 Cr alloy as positive element.
5	*NICKEL-COPPER*		
5A	70 Ni—30 Cu UNS N04400	MONEL[1a] alloy 400 CUNEL[11a] HARPER[12a] 400 D-H[5a] 400 alloy	These alloys have high strength and hardness, good resistance to corrosion. The age hardenable alloy contains approximately 2.75% aluminum and is non-magnetic at temperatures down to -100 °C (-150 °F). Its mechanical properties, particularly in large sections, are comparable with those of heat treated alloy steels. The free-machining alloy is suitable for use in automatic screw machines, its free machining characteristics being achieved by a sulphur content of approximately 0.035%. Adjustments in carbon and titanium contents of the age hardenable grade result in an alloy with improved machinability. Applications—Heat exchanger tubing, transmission oil cooler, marine engine components. The age hardenable grade is used for fasteners, pump and propeller shafts, and valve stems.
5B	Age Hardenable 70 Ni—30 Cu—2.75 Al UNS N05500	MONEL[1a] alloy K 500	
5C	Free Machining 70 Ni—30 Cu UNS N04405	MONEL[1a] alloy R-405	
5D	Age Hardenable Free Machining 70 Ni—30 Cu—2.75 Al UNS N05502	MONEL[1a] alloy 502	

TABLE 1 (CONTINUED)

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
6	*COPPER-NICKEL*		
6A	55 Cu—45 Ni	ADVANCE[5a] CUPRON[3a]	These alloys are of the "Constantan" type and are used extensively with iron or copper as thermoelectric elements for temperature measurement and control. They are used for electrical resistance purposes at temperatures up to 500 °C (930 °F) and for thermocouple purposes up to 760 °C (1400 °F). Their temperature coefficient of electrical resistivity is very small in the temperature range 20 to 100 °C (68 to 212 °F), or higher. Applications—Type T, J, and E thermocouples, wire wound resistors, rheostats, low temperature heaters.
6B	77 Cu—23 Ni	MIDOHM[5a] 180 alloy[3]	These alloys are widely used in instruments and controls where resistivity and temperature coefficient must be held within very close limits. This is accomplished by careful control in melting and fabricating Applications—Radio and automotive resistors, high current edge-wound resistors, resistor leads, voltage control relays, and rheostats.
6C	89 Cu—11 Ni	90 alloy[3.5]	
6D	93 Cu—6 Ni	L OHM[5a] 60 alloy[3]	
6E	97.5 Cu—2.5 Ni	30 alloy[3.5]	
7	*COPPER-NICKEL-IRON*		
7A	60 Cu—20 Ni—20 Fe	Cunife[1][3,14,15]	A permanent magnet alloy used in speedometers and small synchronous motors. It is ductile and easily formed after heat treatment. Applications—Permanent magnets which require ductility.
8	*COPPER-NICKEL-MANGANESE*		
8A	83 Cu—13 Mn—4 Ni	Manganin 130 manganin[3]	These alloys are extremely stable with respect to electrical resistance change with time, and have very low temperature coefficients of electrical resistance over certain temperature ranges. Consequently they find wide use as windings for precision and standard resistors. Shunt manganin is designed to carry high currents which cause it to heat-up in service. Therefore the composition of shunt manganin is adjusted so that the temperature range, over which it possesses a low temperature coefficient of resistance, is higher than that at which the other manganins exhibit this property. Applications—Precision resistors, standard resistors, and shunts.
8B	86 Cu—10 Mn—4 Ni	Shunt manganin Manganin (shunt)[3]	
9	*NICKEL-IRON*		
9A	70 Ni—30 Fe	BALCO[3a] HYTEMCO[5a]	Alloy has a high temperature coefficient of resistance along with moderate resistivity useful in various electrical instruments. Applications—Ballast resistors, voltage regulators, resistive thermometers, temperature compensators, low temperature heaters and ballistic devices in instruments and controls.
9B	50 to 51.5 Ni—48.5 to 50 Fe	152 alloy[5] NIRON[3a] 52 Glass sealing 52[7] UNISEAL[6a] 52	Alloy has expansion characteristics for certain glass to metal seals, and has high magnetic permeability for high field strengths. Applications—Reed switches, mercury switches, contact rectifiers, amplifier coils. Glass to metal seals for matching to lead sealing glasses.
9C	47 to 50 Ni—50 to 53 Fe	49 PERMALLOY[3a] SIMALLOY[4a] magnetic 50 UNIMAG[6a] 50 Low expansion 49[7]	A medium high initial permeability alloy and medium high magnetic saturation alloy employed in manufacture of laminated magnetic cores and solid magnetic core configurations. Applications—Magnetic applications in communications industry, sensitive control devices and relays.

TABLE 1 (CONTINUED)

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
9D	46 Ni—54 Fe	146 alloy[5] Glass sealing 46 gas free[7] NIROMET 46[3a]	Expansion properties and inflection temperature between 50 Ni—50 Fe alloys and 42 Ni—58 Fe alloys. Applications—Terminals on vitreous enamelled resistors.
9E	42 Ni—58 Fe	NIROMET[3a] 42 SIMALLOY[4a] glass seal 42 UNISEAL[6a] 42 142 alloy[5] Glass sealing 42 gas free[7]	Alloy has low expansion, matching thermal expansion of some common glasses. It is used for sealing in glass and other controls at temperatures above those for which Invar is suitable. Applications—Headlights, lamps, audio transformers, coils, relays.
9F	36 Ni—64 Fe	Free cut Invar 36[7] NIRON[3a] 36 SIMALLOY[4a] glass seal 36 UNISPAN[6a] 36 NILBAR[5a] CARPENTER[7a] invar UNISPAN[6a] LR 35	Generally known as Invar and has the lowest coefficient of thermal expansion of any known alloy (up to 150C). Used extensively for thermostats and precision instrument parts for aeronautical use, struts in aluminum pistons, and other applications for low thermal expansion. Applications—Thermostat and precision instrument components. Base metal on which to solder silicon chips, bimetal component.
9G	32.5 Ni—67.5 Fe	SIMALLOY[4a] compensator #1 Temperature compensator 32[7]	These two alloys are generally known as magnetic compensator alloys. (The magnetism and permeability of these alloys change gradually and predictably with changes in temperature.) They are used extensively in automotive speedometer applications. Both alloys are representative of a family of alloys in this composition range. Applications—Instrumentation components.
9H	30 Ni—70 Fe	SIMALLOY[4a] compensator #4 Temperature compensator 30[7]	
10	*NICKEL-CHROMIUM*		
10A	90 Ni—10 Cr	CHROMEL[2a] T-1[5] TOPHEL[3a]	This alloy is the positive element in standard ANSI Type K thermocouples. The negative element is basically nickel with an approximate total of 5% of manganese, aluminum, and silicon. Applications—Thermocouple Type K.
10B	80 Ni—20 Cr	NICHROME[5a] V CHROMEL[2a] A TOPHET[3a] A PYROMET[7a] 80-20	A commercially iron-free, non-magnetic alloy developed especially to give maximum life as electrical heating elements which are expected to standup under the most adverse conditions up to surface temperatures of 1175 °C (2150 °F) in air. Its exceptional resistance to oxidation at elevated temperatures, high electrical resistivity, low temperature coefficient of electrical resistance, high tensile strength at temperature, and resistance to chemical corrosion has given it a wide variety of applications. Applications—Heating elements, wire wound resistors, high temperature conveyor belts, thermocouple wire, furnace components and thermocouple tubes.
10C	78 Ni—20 Cr—1 Cb—1 Si	242 alloy[5] TOPHET[3a] A + Cb	A special grade of 80 Ni—20 Cr. Inhibits "green rot" attack in high temperature mechanical or structural applications in reducing or marginal atmospheres.
10D	74 Ni—20 Cr—3 Al—2 Cu—1 Si	EVANOHM[3a] K	These alloys have low temperature coefficient of resistance up to 150 °C and high resistivity.

TABLE 1 (CONTINUED)

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
10E	72 Ni—20 Cr—3 Al—5 Mn	EVANOHM[3a] S	Applications—Precision wound resistors and potentiometers.
10F	70 Ni—30 Cr	TOPHET[3a] 30	Excellent high temperature oxidation resistance. High resistivity and low temperature coefficient of resistance. Applications—Heating elements, wire wound power resistors, high temperature conveyor belts, thermostats.
10G	50 Ni—50 Cr	INCONEL[1a] 671 50 Nickel—50 Chromium[1]	Excellent elevated temperature liquid phase corrosion resistance; especially suitable in highly sulfidizing, high temperature environments. Applications—High temperature and exhaust components, high temperature baffles, supports in high sulphur atmospheres.
11	*NICKEL-CHROMIUM-IRON*		
11A	76 Ni—15 Cr—9 Fe UNS N06600	SIMALLOY[4a] 600 INCONEL[1a] alloy 600 NIREX[5a] PYROMET[7a] 600 HARPER[12a] 600	Good resistance to a great variety of corrosive media, to high temperature oxidation and scaling, and to intercrystalline attack at elevated temperatures. A restricted chemistry modification of this alloy is used for spark plug electrodes. Applications—Heat treating, nitriding, and carburizing fixtures. High temperature belts, screens, pickling baskets, retorts, radiant tubes, exhaust control afterburners.
11B	Age Hardenable 73 Ni—15.5 Cr—8 Fe—2.5 Ti—0.95 Cb + Ta UNS N07750	UNITEMP[6a] 750 SIMALLOY[4a] 750 INCONEL[1a] alloy X750[1a]	Maximum strength and resistance to oxidation at temperatures of 650 to 815 °C (1200 to 1500 °F) for gas turbine and heat engine components. Desirable spring characteristics at temperatures up to 540 °C (1000 °F). Applications—Diesel exhaust valves, high temperature springs, gas turbine parts, bolts, nuclear reactors.
11C	61 Ni—21.5 Cr—5 Fe—9 Mo—3.6 Cb + Ta UNS N06625	INCONEL[1a] alloy 625 SIMALLOY[4a] 625	High strength and toughness from cryogenic temperatures to 1090 °C (2000 °F). High fatigue strength. Good oxidation resistance and resistance to many corrosive media. Virtually immune to chloride stress-corrosion cracking. Good fabrication properties. Applications—Ducting and combustion systems, thrust reversers, fuel nozzles, afterburners, spray bars.
11D	60.5 Ni—14 Cr—24 Fe—1.4 Al UNS N06601	INCONEL[1a] alloy 601	Excellent resistance to oxidizing, carburizing, and sulphur-containing environments. Resistance to oxidation and scaling up to temperatures as high as 1260 °C (2300 °F). Applications—Heat treating baskets and fixtures, radiant furnace tubes, strand-annealing tubes, thermocouple protection tubes, and furnace muffles and retorts. Thermal reactors for controlling automotive emissions.
11E	60 Ni—16 Cr—23 Fe—1 Si UNS N06004	NICHROME[5a] TOPHET[3a] C CHROMEL[2a] C	Maximum life as electrical heating elements up to 1065 °C (1950 °F) in air, non-magnetic, resists chemical corrosion, high electrical resistivity and low thermal coefficient of electrical resistance. Applications—Heating elements, rheostats, potentiometers.
11F	42 Ni—21.5 Cr—32 Fe—3 Mo UNS N08825	INCOLOY[1a] alloy 825	For use in aggressively corrosive environments. Resistant to chloride-ion stress-corrosion cracking. Resistant to reducing acids, as well as to sulphuric acid and phosphoric acid solutions and to sea water. Applications—Phosphoric acid evaporators, pickling tank heaters, hooks and equipment, propeller shafts and tank trucks.
11G thru 11J	32 to 37 Ni—18 to 21 Cr—42 Fe—(Si, Cb)		This family of alloys is one of the most versatile and widely used groups of alloys made. There are numerous modifications around the basic 35-20 analysis to produce alloys for specific, highly demanding applications. Included are chemical corrosion resistance, high temperature strength and oxidation resistance and electrical resistance applications. Some of the specific properties of each alloy are listed next to the names below.

TABLE 1 (CONTINUED)

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
11G		NICHROME[5a] I CHROME[2a] I	Electrical resistance, high temperature strength, oxidation resistance.
11H	UNS N08330	CHROMEL[2a] D CHROMAX[5a] 525 RA 330[8a] SIMALLOY[4a] TOPHET[3a] D	High temperature strength, oxidation resistance, and carburization resistance.
11I	UNS N08800	INCOLOY[1a] alloy 800 HARPER[12a] 800	High temperature, strength, oxidation resistance, carburization resistance and chemical corrosion resistance.
11J		CHROMAX[5a] 520	Higher strength modification of UNS N08330 alloy for mechanical applications.
12	*NICKEL-IRON-COBALT*		
12A	38 Ni—41 Fe—15 Co—3 Cb—1.6 Ti—0.8 Al—(.008 B)	INCOLOY[1a] alloy 903 PYROMET[7a] CTX-1	Precipitation-hardenable alloy which has a constant, low coefficient of thermal expansion, a constant modulus of elasticity, and high strength. Applications—Rocket engine thrust chambers, steam turbine bolts, springs, gage blocks, and ordnance hardware.
12B	29 Ni—54 Fe—17 Co	THERLO[5a] KOVAR[7a] LOCKINVAR[4a] RODAR[3a]	Sealing alloy for hard (borosilicate) glass-to-metal alloy seals.
13	*NICKEL-MOLYBDENUM-IRON*		
13A	65 Ni—28 Mo—5.5 Fe UNS N10001	HASTELLOY[10a] alloy B	Chromium-free alloy used for handling hydrochloric acid. Gas turbine applications, bolting, shafting, high stresses up to 760 °C (1400 °F) in oxidizing atmosphere, and higher temperatures in reducing atmospheres. Applications—Components for hydrochloric acid service. Gas turbine bolting and shafting.
13B	69 Ni—28 Mo—2 Fe	HASTELLOY[10a] alloy B-2 UNILOY[6a] LR-HB	This alloy is a lower carbon, more ductile version of UNS N10001, above. The lower carbon reduces formation of grain boundry carbide formation during welding. Other properties are very similar.
14	*NICKEL-CHROMIUM-MOLYBDENUM-(COBALT-TUNGSTEN-COPPER)*		
14A	64 Ni—16 Cr—16 Mo—3 Fe	HASTELLOY[10a] alloy C-4	Excellent high temperature strength and oxidation resistance. Outstanding corrosion resistance in certain environments. Good thermal shock properties up to 980 °C (1800 °F). Applications—Combustion cups for diesel engines, turbine blade jet engine components. Fixtures in nitric acid and organic acid salts service.
14B	58 Ni—16 Cr—6 Mo—6 Fe—3.5 W UNS N10002	CARPENTER[7a] alloy C UNILOY[6a] C	One of the most universally corrosion resistant alloys available, with excellent high-temperature properties. Resistant to oxidizing and reducing atmospheres up to 1090 °C (2000 °F). Is particularly useful where parts are either highly stressed or subject to repeated thermal shock at temperatures from 870 to 980 °C (1600 to 1800 °F). Exceptional resistance to strong oxidizing agents such as ferric chloride and cupric chloride.

TABLE 1 (CONTINUED)

Key No.*	Alloy Groups and Alloys	Commercial Designations**	Characteristics and Applications
14C	57 Ni—16 Cr—16 Mo— 6 Fe—4 W UNS N10276	HASTELLOY[10a] alloy C 276 UNITEMP[6a] C 276	A modified version of UNS N10002 with improved fabricability. Resists formation of grain boundry precipitates in weld heat-affected zone. Excellent resistance to pitting, stress-corrosion cracking and to oxidizing environments up to 1040 °C (1900 °F).
14D	45 Ni—22 Cr—9 Mo— 1 Co—0.8 W UNS N06002	SIMALLOY[4a] HX UNITEMP[6a] HX HASTELLOY[10a] alloy X PYROMET[7a] 680	Excellent high temperature properties. Suitable for sheet metal and bar components in jet engines, valve parts, furnace parts and heat treat containers and fixtures. Noted for excellent carburization, oxidation resistance and strength properties at temperatures up to 1150 °C (2100 °F). Good resistance to stress corrosion cracking. Applications—Combustion cans, heat treat fixtures, and components.
14E	45 Ni—25 Cr—3 Mo— 3 W—3 Co—1.25 Si UNS N06333	RA 333[8a]	
14F	43 Ni—22 Cr—7 Mo— 1 W—20 Fe—2 Cu	HASTELLOY[10a] G	Excellent resistance to hot sulfuric acid and phosphoric acids. Resists corrosive effects of both oxidizing and reducing agents and both acid and alkaline solutions. Resists stress corrosion cracking and formation of grain boundary precipitates. Austenitic stainless steel with superior resistance to 10 to 40% sulfuric acid, and many other corrosive media. Weldable. Applications—Mixing tanks, heat exchanges, process piping, pump shafts and rods.
14G	35 Ni—20 Cr—2.5 Mo— 3.5 Cu—37 Fe— 1 Cb + Ta	CARPTENTER[7a] 20 Cb 3	
15	*COPPER-NICKEL-ZINC (NICKEL SILVERS)*		These alloys, known as nickel-silvers, find application as car keys (especially, the leaded versions), electrically conductive springs, and switches. They have excellent spring characteristics, mechanical properties, are corrosion resistant, machinable and formable, along with a relatively high electrical conductivity.
15A	72 Cu—18 Ni—10 Zn UNS C73500	CDA 735	
15B	55 Cu—18 Ni—27 Zn UNS C77000	CDA 770	
15C	60 Cu—12 Ni—28 Zn UNS C76200	CDA 762	

* See same Key Number in each table for complete information on each alloy. (Key is used to avoid duplication of data in each table.)
** Superscript numerals (1 to 15) denote producer as shown in Table 6; subscript letter (a) denotes trademark.

TABLE 2—NOMINAL CHEMICAL COMPOSITIONS

Key (1) No.	Percent by Weight							
	Ni (2)	Cu	Cr	Fe	Mn	Si	C	Other
1A	99.4	0.1	—	0.15	0.18	0.18	0.05	0.005 S
1B	93.7	0.13	—	0.35	0.3	0.5	0.17	4.4 Al, 0.005 S, 0.63 Ti
1C	99.98	<0.001	<0.001	0.003	<0.001	<0.001	0.01	<0.001 S, Ti, Co, Mg
2A	97.5	—	—	—	—	—	—	1.95 Be, 0.5 Ti
3A	95	—	—	—	4	1	—	—
4A	94	—	—	0.25	2.5	1.0	—	2.0 Al
5A	67	30	—	1.4	1	0.25	0.15	0.012 S
5B	66	29	—	1	0.75	0.25	0.15	0.005 S, 2.75 Al, 0.60 Ti
5C	67	30	—	1.4	1	0.25	0.15	0.035 S
5D	66.5	28	—	1	0.75	0.25	0.05	0.005 S, 3 Al, 0.25 Ti
6A	43	55	—	0.25	0.5–1.0	—	0.05	—
6B	23	77	—	—	—	—	—	—
6C	11	89	—	—	—	—	—	—
6D	6	93	—	—	—	—	—	—
6E	2.5	97.5	—	—	—	—	—	—
7A	20	60	—	20	—	—	—	—
8A	4	83	—	—	1	—	—	—
8B	4	86	—	—	10	—	—	—
9A	70	—	—	29	1	0.05	0.05	—
9B	50–51.5	—	—	47.5–50	0.05	0.35	0.02	—
9C	47–50	—	—	50–53	0.5	0.40	0.05	—
9D	46	—	—	54	0.1	0.05	0.05	—
9E	42	—	—	58	0.1	0.05	0.05	—
9F	36	—	—	64	0.1	0.05	0.05	—
9G	32.5	—	—	67.5	0.7	0.3	0.1	—
9H	30	—	—	70	0.75	0.2	0.1	—
10A	90	—	10	—	—	—	—	—
10B	77	—	20	0.5	0.2–2	1.25–1.4	0.06–0.1	—
10C	78	—	20	—	—	1	—	1 Cb
10D	74	2	20	—	—	1	—	3 Al
10E	72	—	20	—	5	1	—	3 Al
10F	70	—	30	—	—	—	—	—
10G	51	—	48	—	—	—	0.5	0.35 Ti
11A	76	0.5	15.5	9	1	0.5	0.15	—
11B	73	0.5	15.5	8	1	0.5	0.08	0.7 Al, 2.5 Ti, 0.9 Ca + Ta
11C	68	—	21.5	5	0.5	0.5	0.1	0.4 Al, 0.4 Ti, 1.0 Co, 9.0 Mo
11D	60.5	1	23	13	1	0.5	0.1	1.3 Al
11E	60	—	16	23	—	1.0	—	—
11F	42	2.25	21.5	—	1	—	0.05	0.2 Al, 0.9 Ti, 3.0 Mo
11G	36	—	20	42	—	2	—	—
11H	35	—	19	45	—	1.25	—	—
11I	32.5	0.75	21	—	1.5	1	0.1	0.4 Al, 0.45 Ti
11J	35	—	21	42	—	2	—	1.0 Cb
12A	38	0.50 max	0.20 max	41	0.20 max	0.20 max	0.03	0.8 Al, 1.6 Ti, 1.5 Co, 3 Cb, (0.008 B)
12B	29	—	—	54	—	—	—	17 Co
13A	65	—	—	5.5	1 max	1 max	0.05 max	28 Mo
13B	69	—	—	2–5 max	1 max	0.1 max	0.02 max	28 Mo
14A	64	—	16	3 max	1 max	0.08 max	0.015 max	16 Mo, 0.7 Ti
14B	57	—	16	6	1 max	1 max	0.08 max	16 Mo, 4 W
14C	57	—	16	6	1 max	0.05 max	0.02 max	16 Mo, 4 W
14D	45	—	22	18	1 max	1 max	0.10	9 Mo, 1 Co, 0.8 W
14E	45	—	25	20	2 max	1.25	0.08 max	3 Mo, 3 W, 3 Co
14F	43	2	22	20	2 max	1 max	0.05 max	7 Mo, 1 W, 2 Cb + Ta
14G	35	3.5	20	37	2 max	1 max	0.06 max	2.5 Mo, 1 Cb + Ta
15A	18	72	—	—	0.25	—	—	10 Zn
15B	18	55	—	—	0.25	—	—	27 Zn
15C	18	57	—	—	0.25	—	—	28 Zn

1. See Key Number in each table for complete information on each alloy.
2. Includes a small amount of cobalt which is counted as nickel.

TABLE 3—AVERAGE PHYSICAL CONSTANTS(1)

Key No.	Density at 20 °C g/cm³ (lb/in³)	Melting Range, Solidus-Liquidus °C (°F)	Thermal Conductivity 0-100 °C (32-212 °F) W/m·K (Btu/hr/ft²/F/in)	Coefficient of Linear Thermal Expansion °C⁻¹ x 10⁻⁶ (°F⁻¹ x 10⁻⁶) 0-100 °C (32-212 °F)	Coefficient of Linear Thermal Expansion 0-1000 °C (32-1832 °F)	Specific Heat 0-100 °C (32-212 °F) J/kg K (Btu/lb·°F)	Electrical Resistivity at R.T. Ω·mm²/m (ohm) circular-mil/ft	Temperature Coefficient of Electrical Resistance 20-100 °C Per °C	Temperature Coefficient of Electrical Resistance 20-1000 °C Per °C	Magnetic Properties Condition at R.T.	Magnetic Properties Curie Temp. °C (°F)	Max Operating Temp. in Air (Sulfur Free) °C (°F)
** →	X27.68	—	X0.1441	X1.8	X1.8	X4186.8	X0.16624	—	—	—	—	—
1A	8.88 (0.321)	1435-1446 (2615-2635)	60.52 (420)	13.0 (7.2)	— —	544 (0.13)	9.5 (57)	0.00432	— —	Ferromagnetic	360 (680)	1038 (1900)
1B	8.75 (0.316)	1435-1446 (2615-2635)	60.52 (420)	13.0 (7.2)	— —	544 (0.13)	15.7 (94.5)	0.0036	— —	Ferromagnetic	290-299 (555-570)	— —
1C	8.88 (0.321)	1455 (2650)	79 (548)	13.3 (7.4)	— —	460 (0.11)	7.5 (45)	— —	— —	Ferromagnetic	353 (667)	— —
2A	8.36 (0.302)	1220-1370 (2240-2500)	32 (220)	14.5 (8.0)[1]	— —	473 (0.113)	23.8 (143)	— —	— —	Ferromagnetic	— —	— —
3A	8.40 (0.3035)	1416-1445 (2550-2600)	28.5 (198)	13.2 (7.33)	16.0 (8.89)	— —	22 (130)	— —	0.00135	Strongly Magnetic	— —	— —
4A	8.60 (0.3107)	1380-1410 (2525-2575)	29.7 (206)	12.0 (6.66)	— —	523 (0.125)	29-32 (177-191)	0.00188	— —	Strongly Magnetic	— —	1260 (2300)
5A	8.83 (0.319)	1300-1350 (2370-2460)	25.94 (180)	14.04 (7.8)	14.22 (8.9)	544.3 (0.13)	48.2 (290)	0.00198	— —	Slightly Ferromagnetic	43-60 (110-140)	540 (1000)
5B	8.47 (0.306)	1315-1350 (2400-2460)	18.73 (130)	14.04 (7.8)	14.22 (8.9)	544.3 (0.13)	58.1 (350)	0.00198	— —	Ferromagnetic	-101 (-150)	— —
5C	8.83 (0.319)	1300-1350 (2370-2460)	24.94 (180)	14.04 (7.8)	— —	544.3 (0.13)	48.2 (290)	0.00198	— —	Slightly Ferromagnetic	43-60 (110-140)	— —
5D	8.44 (0.305)	1315-1350 (2400-2460)	— —	13.68 (7.6)	— —	418.7 (0.10)	61.5 (370)	— —	— —	Paramagnetic	<-101 (<-150)	— —
6A	8.88 (0.321)	— —	22.9 (159)	14.6 (8.1)	18.7 (10.4)	394 (0.094)	49 (294)	0.00002	— —	Paramagnetic	— —	760 (1400)
6B	8.88 (0.321)	1130-1210 (2065-2210)	33.4 (232)	15.8 (8.8)	17.5 (9.7)	385 (0.092)	30 (180)	0.0003	— —	Paramagnetic	— —	540 (1000)
6C	8.88 (0.321)	1105-1150 (2020-2100)	38.4 (267)	16.0 (8.9)	— —	385 (0.092)	15 (90)	0.0004	— —	Paramagnetic	— —	430 (800)
6D	8.88 (0.321)	1030-1110 (1995-2030)	37.6 (261)	16.4 (9.1)	18.0 (10.0)	385 (0.092)	10 (60)	0.0005	— —	Paramagnetic	— —	320 (600)
6E	8.88 (0.321)	1083-1100 (1980-2010)	37.7 (262)	16.6 (9.2)	— —	385 (0.092)	5 (30)	0.0013	— —	Paramagnetic	— —	320 (600)
7A	8.61 (0.311)	1146-1330 (2095-2425)	— —	— —	— —	— —	18 (108)	— —	— —	Ferromagnetic	355 (670)	260 (500)
8A	8.41 (0.304)	1020- (1870-)	20.5 (142)	18.72 (10.4)[2]	— —	— —	48.2 (290)	0.0000144[2]	— —	Nonmagnetic	— —	— —
8B	8.48 (0.31)	1020- (1870-)	20.5 (142)	18.72 (10.4)	— —	— —	38.3 (230)	0.0000144[3]	— —	Nonmagnetic	— —	— —
9A	8.44 (0.305)	1432 (2610)	9.2 (64)	12.42 (6.9)	14.94 (8.3)	523 (0.125)	20 (120)	0.0045	0.0054[4]	Ferromagnetic	610 (1130)	594 (1100)
9B	8.30 (0.300)	1424- (2596-)	13 (90)	9.36 (5.2)	12.96 (7.2)	481 (0.115)	43 (260)	0.00306	0.0018	Ferromagnetic	500 (932)	524 (975)
9C	8.25 (0.298)	1427- (2600-)	13 (90)	9.36 (5.2)	— —	500 (0.12)	48 (290)	— —	0.0036[5]	Ferromagnetic	450-500 (840-930)	— —
9D	8.17 (0.295)	1435-1441 (2615-2625)	14.1 (98)	13.5[6] (7.5)	15.48 (8.6)[6]	490 (0.117)	46 (275)	0.0032	— —	Ferromagnetic	490 (914)	600 (1112)
9E	8.11 (0.293)	1441-1452 (2625-2645)	10.7 (74.5)	4.86 (2.7)	12.96 (7.2)	498 (0.119)	67 (400)	0.00216	— 0.000936	Ferromagnetic	380 (716)	374 (705)

TABLE 3—AVERAGE PHYSICAL CONSTANTS(1) (CONTINUED)

Key No.	Density at 20 °C g/cm³ (lb/in³)	Melting Range, Solidus-Liquidus °C (°F)	Thermal Conductivity 0-100 °C (32-212 °F) W/m·K (Btu/hr/ft²/F/in)	Coefficient of Linear Thermal Expansion °C⁻¹ x 10⁻⁶ (°F⁻¹ x 10⁻⁶) 0-100 °C (32-212 °F)	Coefficient of Linear Thermal Expansion °C⁻¹ x 10⁻⁶ (°F⁻¹ x 10⁻⁶) 0-1000 °C (32-1832 °F)	Specific Heat 0-100 °C (32-212 °F) J/kg K (Btu/lb·°F)	Electrical Resistivity at R.T. Ω·mm²/m (ohm) circular-mil/ft	Temperature Coefficient of Electrical Resistance 20-100 °C Per °C	Temperature Coefficient of Electrical Resistance 20-1000 °C Per °C	Magnetic Properties Condition at R.T.	Magnetic Properties Curie Temp. °C (°F)	Max Operating Temp. in Air (Sulfur Free) °C (°F)
∞ →	X27.68	—	X0.1441	X1.8	X1.8	X4186.8	X0.16624	—	—	—	—	—
9F	8.05 (0.291)	1446-1460 (2635-2660)	10.5 (73)	1.44 (0.8)	14.4 (8)	515 (0.123)	80 (484)	0.00135	— —	Ferromagnetic	280 (536)	200 (390)
9G	8.11 (0.293)	— —	11.5 (80)	10.8 (6.0)	— —	502 (0.12)	80 (480)	0.00126	— —	Ferromagnetic	— —	— —
9H	8.19 (0.296)	— —	11.5 (80)	7.70 (4.28)	— —	502 (0.12)	80 (480)	0.00126	— —	Ferromagnetic	— —	— —
10A	8.72 (0.315)	1430- (2610-)	19.16 (133)	23.4 (13)	— —	452 (0.107)	70.6 (425)	0.00036	0.000324[7]	Paramagnetic	— —	1149 (2100)
10B	8.41 (0.304)	1400- (2552-)	15 (104)	11.9-13.7 (6.6-7.6)	17.1-17.6 (9.5-9.8)	435-452 (0.104-0.107)	108 (650)	0.000056	0.0000014-0.0000067	Paramagnetic	— —	1177 (2150)
10C	8.41 (0.304)	1400- (2552-)	15 (104)	— —	17 (9.4)	435-452 (0.104-0.107)	111 (670)	— —	0.00011[8]	Paramagnetic	— —	1150 (2100)
10D	8.41 (0.304)	1400- (2552-)	15 (104)	12.6 (7.0)	— —	— —	133 (800)	— —	±0.000005	Nonmagnetic	— —	315 (600)
10E	7.14 (0.258)	1350-1380 (2460-2510)	14.6 (101)	13 (7.2)	— —	— —	137 (825)	— —	<±0.000005	Nonmagnetic	— —	315 (600)
10F	8.11 (0.293)	1377- (2510-)	15.85 (110)	12.2 (6.8)	— —	452 (0.107)	118 (710)	0.00009	— —	Paramagnetic	— —	1260 (2300)
10G	7.89 (0.285)	1308-1318 (2386-2404)	16.43 (114)	10.0 (5.54)	13.8 (7.66)	456 (0.109)	93 (556)	— —	— —	— —	— —	— —
11A	8.50 (0.307)	1343-1427 (2540-2600)	14.98 (104)	11.5 (6.4)	12.4 (6.9)	460 (0.11)	103 (620)	— —	— —	Paramagnetic	-40 (-40)	1094 (2000)
11B	8.30 (0.3)	1343-1427 (2540-2600)	14.7 (102)	13.7 (7.6)	17.1 (9.5)	460 (0.11)	122 (734)	— —	— —	Paramagnetic	-174 (-280)	815 (1500)
11C	8.44 (0.305)	1288-1349 (2350-2460)	9.80 (68)	12.8 (7.1)	15.7 (8.7)	410 (0.098)	129 (776)	— —	— —	Paramagnetic	<-196 (<-320)	— —
11D	8.05 (0.291)	1301-1368 (2374-2494)	12.54 (87)	13.7 (7.6)	16.7 (9.3)	448 (0.107)	119 (717)	— —	— —	Paramagnetic	<-196 (<-320)	— —
11E	8.41 (0.304)	1350-1375 (2460-2500)	13.3 (92)	— —	17 (9.4)	460 (0.11)	108 (650)	0.000133	0.00009	Paramagnetic	— —	1010 (1850)
11F	8.14 (0.294)	1371-1399 (2500-2550)	— —	14.0 (7.8)	17.3 (9.6)	— —	113 (678)	— —	— —	Paramagnetic	<-196 (<-320)	— —
11G	7.94 (0.287)	1380- (2515-)	13.0 (90)	14.0 (7.8)	18 (10)	502 (0.12)	108 (650)	0.0004	0.00025	Paramagnetic	— —	994 (1800)
11H	8.0 (0.289)	1399-1427 (2550-2600)	13.15 (91.2)	14.9 (8.3)	18.0 (10)	460 (0.11)	102 (612)	0.00035	0.00023	Paramagnetic	— —	954 (1750)
11I	7.94 (0.287)	1368-1380 (2475-2525)	11.53 (80)	14.2 (7.9)	18.2 (10.1)	502 (0.12)	100 (600)	— —	— —	Paramagnetic	-115 (-175)	— —
11J	7.94 (0.287)	1382- (2520-)	13.0 (90)	14.0 (7.8)	18 (10)	502 (0.12)	106 (640)	0.0004	0.00025	Paramagnetic	— —	994 (1800)
12A	8.14 (0.294)	1318-1393 (2405-2539)	17.1 (119)	7.9 (4.4)	— —	435 (0.104)	61.0 (367)	— —	— —	Ferromagnetic	460 (860)	— —
12B	8.36 (0.302)	1450- (2640-)	16.4 (114)	9.2 (5.1-5.5)[9]	12 (6.7)	461 (0.11)	49 (294)	0.0033	— —	Ferromagnetic	435 (815)	— —
13A	9.25 (0.334)	1302-1368 (2375-2495)	11.3 (78.5)	10.0 (5.6)	14.6 (8.1)	381 (0.091)	135 (812)	— —	— —	Paramagnetic	— —	760 (1400)
13B	9.22 (0.333)	1302-1365 (2375-2490)	11.7 (81)	10.26 (5.7)	— —	381 (0.091)	130 (785)	— —	— —	— —	— —	— —

TABLE 3—AVERAGE PHYSICAL CONSTANTS(1) (CONTINUED)

Key No.	Density at 20 °C g/cm³ (lb/in³)	Melting Range, Solidus-Liquidus °C (°F)	Thermal Conductivity 0-100 °C (32-212 °F) W/m·K (Btu/hr/ft²/F/in)	Coefficient of Linear Thermal Expansion °C⁻¹ x 10⁻⁶ (°F⁻¹ x 10⁻⁶) 0-100 °C (32-212 °F)	Coefficient of Linear Thermal Expansion °C⁻¹ x 10⁻⁶ (°F⁻¹ x 10⁻⁶) 0-1000 °C (32-1832 °F)	Specific Heat 0-100 °C (32-212 °F) J/kg K (Btu/lb·°F)	Electrical Resistivity at R.T. Ω·mm²/m (ohm) circular-mil/ft	Temperature Coefficient of Electrical Resistance 20-100 °C Per °C	Temperature Coefficient of Electrical Resistance 20-1000 °C Per °C	Magnetic Properties Condition at R.T.	Magnetic Properties Curie Temp. °C (°F)	Max Operating Temp. in Air (Sulfur Free) °C (°F)
** →	X27.68	—	X0.1441	X1.8	X1.8	X4186.8	X0.16624	—	—	—	—	—
14A	8.64	—	10.66	10.8	15.7	419	125	—	—	Paramagnetic	—	1038
	(0.312)	—	(74.0)	(6.0)	(8.7)	(0.100)	(752)	—	—		—	(1900)
14B	8.94	1210-1305	11.3	11.3	15.3	385	130	—	—	Paramagnetic	—	1038
	(0.323)	(2318-2381)	(78)	(6.3)	(8.5)	(0.092)	(779)	—	—		—	(1900)
14C	8.88	1324-1371	10.23	11.2	15.8	427	130	—	—	Paramagnetic	—	1038
	(0.321)	(2415-2500)	(71.0)	(6.2)	(8.8)	(0.102)	(782)	—	—		—	(1900)
14D	8.23	1260-1355	11.6	13.8	14.9	486	118	—	—	Paramagnetic	—	1204
	(0.297)	(2300-2470)	(80.5)	(7.7)	(8.4)	(0.116)	(712)	—	—		—	(2200)
14E	8.25	1327-1352	11.0	13.9	17.5	460	114	0.00027	0.000127	Paramagnetic	—	1204
	(0.298)	(2420-2465)	(76.2)	(7.7)	(9.7)	(0.11)	(687)				—	(2200)
14F	8.30	1260-1343	10.66	13.5	—	460	—	—	—	—	—	—
	(0.300)	(2300-2450)	(74.0)	(7.5)	—	(0.110)	—	—	—	—	—	—
14G	8.05	—	—	14.96	16.74	502	104	—	—	—	—	—
	(0.291)	—	—	(8.31)	(9.43)	(0.12)	(625)	—	—	—	—	—
15A	8.80	—	38.6	14.9	16.4	—	21.6	—	—	Paramagnetic	—	—
	(0.318)	—	(268)	(8.3)	(9.1)[10]	—	(130)	—	—		—	—
15B	8.69	—	29.4	16.7	16.7	—	31.4	0.000093	—	Paramagnetic	—	—
	(0.314)	—	(204)	(9.3)	(9.3)	—	(189)		—		—	—
15C	8.69	—	41.8	15.8	16.0	—	19.9	—	—	Paramagnetic	—	—
	(0.314)	—	(290)	(8.8)	(8.9)	—	(120)	—	—		—	—

* Consult producer for more specific values.

** Metric values shown were computed by use of these conversion factors.

[1] At 20 to 550 °C

[2] At 59 to 95 °F

[3] At 104 to 140 °F

[4] At 0 to 500 °C

[5] At -20 to 500 °C

[6] At 30 to 350 °C

[7] At 25 to 870 °C

[8] At 20 to 500 °C

[9] At 30 to 450 °C

[10] At 68 to 572 °F

TABLE 4—RANGE OF MECHANICAL PROPERTIES(1)

Key No.	Available Forms(2)	Yield Strength 0.2% Offset 10^6Pa (10^3psi)	Tensile Strength 10^6Pa (10^3psi)	Elongation in 50 mm (2 in) %	Reduction of Area %	Hardness		Modulus of Elasticity 10^9Pa (10^6psi)	Endurance Limit 10^8Cycles 10^6Pa (10^3psi)	Impact at R.T.	
						Brinell 3000 kg	Rockwell			Standard Izod J (ft–lb)	Standard Charpy J (ft–lb)
(3) →		X6.9	X6.9	—	—	—	—	X6.9	X6.9	X1.356	X1.356
1A	A,B,C,D,E,F,G	103–1070 (15–155)	415–1140 (60–165)	50-2	75-50	90–230	B40–100	207 (30)	160–250 (23–36)	163 (120)	301–264 (222-195)
1B	A,C,E	207–1030 (30–150)	620–1030 (90–150)	50-2	65-15	140–380	B75–C46	207 (30)	360–407 (52–59)	163-34 (120-25)	325-49 (240-36)
1C	A,C,D,E,F	110–620 (16–90)	345–655 (50–95)	50-4	— —	80–210	B35–95	207 (30)	— —	— —	— —
2A	D,E	310–1588 (45–230)	724–1863 (105–270)	40-2	— —	— —	B70–C51	186–207 (27–30)	655–966 (95–140)	— —	149-81 (110-60)
3A	C,E	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
4A	A,C,E	193 (28)	587–1173 (85–170)	45	— —	— —	— —	— —	— —	— —	— —
5A	A,B,C,D,E,F,G	172–1104 (25–160)	483–1173 (70–170)	50-2	75-50	110–250	B60–C23	179.4 (26.0)	207–345 (30–50)	163-102 (120-75)	298-203 (220-150)
5B	A,B,C,D,E,F	276–1207 (40–175)	620–1380 (90–200)	45-2	70-25	140–320	B75–C40	179.4 (26.0)	283–407 (41–59)	163-35 (120-26)	230-57 (170-42)
5C	A,C	172–897 (25–130)	483–966 (70–140)	50-4	70-50 —	110–230	B60–100	179.4 (26.0)	193–283 (28–41)	163-130 (120-96)	266-190 (196-140)
5D	A,C,D,E,F	255–648 (37–94)	586–973 (85–141)	47-25	—	135–255	B74-C25	179.4 (26.0)	— —	— —	— —
6A	A,B,C,E	207–828 (30–120)	414–931 (60–135)	45-0.5	70-25	— —	B50–93	— —	— —	— —	— —
6B	A,B,C,E	138–483 (20–70)	276–552 (40–80)	55-2	75-50	— —	B50–85	— —	— —	— —	— —
6C	A,B,C,E	138–483 (20–70)	276–552 (40–80)	55-2	75-50	— —	B50–85	— —	— —	— —	— —
6D	A,B,C,E	138–483 (20–70)	276–552 (40–80)	55-2	75-50	— —	B50–85	— —	— —	— —	— —
6E	A,B,C,E	138–483 (20–70)	276–552 (40–80)	55-2	75-50	— —	B50–85	— —	— —	— —	— —
7A	C,E	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —

Key No.	Available Forms[2]	Yield Strength 0.2% Offset 10^6Pa (10^3psi)	Tensile Strength 10^6Pa (10^3psi)	Elongation in 50 mm (2 in) %	Reduction of Area %	Hardness		Modulus of Elasticity 10^9Pa (10^6psi)	Endurance Limit 10^8Cycles 10^6Pa (10^3psi)	Impact at R.T.	
						Brinell 3000 kg	Rockwell			Standard Izod J (ft–lb)	Standard Charpy J (ft–lb)
(3) →		X6.9	X6.9	—	—	—	—	X6.9	X6.9	X1.356	X1.356
8A	C	—	276–621	15–30	—	—	—	—	—	—	—
		(25–40)	(40–90)		—	—	—	—	—	—	—
8B	E	—	345–690	15–30	—	—	—	—	—	—	—
		(25–40)	(50–100)		—	—	—	—	—	—	—
9A	A,B,C,E	241–965	483–1035	35-0.5	60-30	—	B58–93	—	—	—	—
		(35–140)	(70–150)			—		—	—	—	—
9B	A,B,C,D,E	241–965	483–1035	35-0.5	60-30	—	B58–100	165	—	—	—
		(35–140)	(70–150)			—		(24)	—	—	—
9C	A,B,C,D,E	241–965	483–1035	35-0.5	60-30	—	B58–100	165	—	—	—
		(35–140)	(70–150)			—		(24)	—	—	—
9D	A,C,E	207–965	552–1035	35-0.5	70-40	—	B58–93	—	—	—	—
		(30–140)	(80–150)			—		—	—	—	—
9E	A,B,C,D,E	241–965	483–1035	35-0.5	65-30	—	B58–93	145	—	—	—
		(35–140)	(70–150)			—		(21)	—	—	—
9F	A,B,C,D,E	241–965	483–1035	40-0.5	65-30	—	B58–98	141	—	—	—
		(35–140)	(70–150)			—		(20.5)	—	—	—
9G	E	276	483	35	—	—	B75 Ann.	152	—	—	—
		(40)	(70)		—	—		(22)	—	—	—
9H	E	276	483	35	—	—	B75 Ann.	152	—	—	—
		(40)	(70)		—	—		(22)	—	—	—
10A	C	—	655–1138	—	—	—	—	—	—	—	—
		—	(95–165)	—	—	—	—	—	—	—	—
10B	A,B,C,D,E,F,G	345–1311	690–1380	35-0.5	70-40	150–320	B85–C30	214	—	—	—
		(50–190)	(100–200)					(31)	—	—	—
10C	A,C,E	345–1311	690–1380	35-0.5	70-40	150–320	B80–85	214	—	—	—
		(50–190)	(100–200)					(31)	—	—	—
10D	A,C,E	517–655	966–1104	35-15	—	—	—	—	—	—	—
		(75–95)	(140–160)		—	—	—	—	—	—	—
10E	A,C,E	517–655	966–1104	35-15	—	—	—	—	—	—	—
		(75–95)	(140–160)		—	—	—	—	—	—	—
10F	A,C,E	414–586	828–1035	30-10	—	—	—	166	—	—	—
		(60–85)	(120–150)		—	—	—	(24)	—	—	—

Key No.	Available Forms[2]	Yield Strength 0.2% Offset 10^6Pa (10^3psi)	Tensile Strength 10^6Pa (10^3psi)	Elongation in 50 mm (2 in) %	Reduction of Area %	Hardness		Modulus of Elasticity 10^9Pa (10^6psi)	Endurance Limit 10^8Cycles 10^6Pa (10^3psi)	Impact at R.T.	
						Brinell 3000 kg	Rockwell			Standard Izod J (ft–lb)	Standard Charpy J (ft–lb)
(3) →		X6.9	X6.9	—	—	—	—	X6.9	X6.9	X1.356	X1.356
10G	A,D,G	497 (72)	1035 (150)	19	25	— —	— —	— —	— —	— —	— —
11A	A,B,C,D,E,F,G	172–1207 (25–175)	552–1276 (80–185)	50-2	70-40	120–190	B65–C30	214 (31)	283–414 (41–60)	163-95 (120-70)	312-205 (230-151)
11B	A,B,C,D,E,F,G	345–1656 (50–240)	759–1897 (110–275)	45-2	60-30	200–500	B93–C47	214 (31)	310–448 (45–65)	54 (40)	— —
11C	A,B,C,D,E,F	290–759 (42–110)	724–1104 (105–160)	65-30	— —	110–240	— —	207 (30)	— —	— —	— —
11D	A,B,C,D,E,F	193–345 (28–50)	586–759 (85–110)	58-45	— —	115–160	— —	206 (29.9)	— —	— —	— —
11E	A,C,E	311–1346 (45–195)	656–1380 (95–200)	40-20	50-20	83	B85–C30	214 (31)	— —	— —	— —
11F	A,B,C,D,E,F	241–448 (35–65)	586–724 (85–105)	50-30	— —	120–180	— —	193 (28.0)	— —	— —	— —
11G	A,C,E	207–1000 (30–145)	483–1035 (70–150)	35-0.5	— —	—	B80	— —	— —	— —	— —
11H	A,C,D,E	290 (42)	586 (85)	45	65	—	B75-85	197 (28.5)	— —	— —	>325 (>240)
11I	A,B,C,D,E,F	241–862 (35–125)	517–1035 (75–150)	60-10	— —	120–130	— —	197 (28.5)	— —	— —	— —
11J	A,C,E	207–1000 (30–145)	483–1035 (70–150)	35-0.5	— —	—	B80	— —	— —	— —	— —
12A	A,C,D,E,F	362–1242 (52.5–180)	652–1476 (94.5–214)	52-13	— —	— —	— —	152 (22)	— —	— —	— —
12B	A,C,D,E	276–966 (40–140)	517–1035 (75–150)	30-0.5	— —	—	B82-100	— —	— —	— —	— —
13A	A,B,C,D,E,F	462 (67)	925 (134)	51	— —	—	B96	215 (31.1)	— —	81 (60)	— —
13B	A,B,C,D,E,F	504 (73)	987 (143)	51	— —	—	—	217 (31.4)	— —	— —	240 (177)
14A	A,B,C,D,E,F	414 (60)	766 (111)	52	— —	—	B90	212 (30.8)	— —	— —	— —