

S. Roy Smith *72/16-00/00*

PROPERTIES OF METALS
TO BE USED BY
TEST EQUIPMENT DESIGN SECTION
GAS TURBINE DIVISION
A.V. ROE (CANADA) LTD.

By John H. Clarke
Joe Conrath

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Introduction

The information collected on the following pages has been collected so as to aid the engineer in selecting a metallic alloy for design purposes.

The data is to be used only as a guide and the engineer should seek further information on the type of alloys which may seem fit to do the job. The following should be kept in mind whilst using the supplied information.

1. The alternate specifications are not complete. They list material of the same composition, but they may be in alternate form and have different heat treatment.
 2. It was endeavoured to give the lower or average Mechanical properties for a particular composition and heat treatment, these properties may vary widely with mass effect, degree of heat treat, cold working and subsequent machining etc. etc.
 3. In general, hardness was given as Brinell 3000 kg. load with 10 mm ball, up to 400. Over that the Rockwell 'C' scale was used for all metals and alloys except aluminum when a 500 kg load with 10 mm ball is used throughout.
 4. The Endurance limit is the max load in psi of the original Gross-sectional area that the material is capable of standing after 500,000,000 cycles of reversed stressing.
 5. For Carbon and Alloy steels, SAE numbers are used.
For Stainless Steels AISI numbers are used.
For Aluminum alloys, ALCAN numbers are used, with the exception of A111-A25 (BB-50) and BB-53R, these are Turbo-Engine standard numbers.
- For the rest, trade names are used ex. Monel, Inconel. Note Different companies could use different compositions or heat treats for the same numbers particularly with aluminums and brasses.

5. Aluminum Alloys

5-1 3S Wrought Alloy

5-2 2hS " " (Dural Type)

5-3 26S " " " "

5-4 65S " "

5-5 75S

5-6 AC123 Alloy Casting

5-7 AC125 " "

5-8 AC135 " "

5-9 A111-A25 (RR-50) Alloy Casting

5-10 RR-53_B Alloy Casting

List of future additions:-

Meehanite

Magnesium Alloys

S.A.E. 1010-Carbon SteelAlternate Specs:- AMS 5040D)

QQ-S-636) sheet for deep drawing QQ-S-633)

A151-31010)

(FS 1010 annealed)

Barstock

Composition:- 0.08-0.13C, 0.30-0.60Mn, 0.010P max, 0.050 S max.

Mechanical Properties (as called) T.S. = 61,000 psi YP = 45,500 psi

El. = 39.0%

Redn. 61.0%

Brinell = 126

Izod. = 31.5

Not Heat-treatable

Case Hardened Properties

.048 case

Core

1. Carburised at 1675°F for 8 hrs.

TS 71000

2. Pot cooled

YP 44000

3. Reheated at 1425°F

El. 33.0%

Red 71.0%

4. Water Quenched

Br. 140

Izod. 90

5. Tempered at 350°F

Poor Corrosion Resistance

R. 62.

Machinability - Poor to Fair, is not recommended for parts requiring fine machining.

Surface Finish may be fair to good when deep drawn.

The steel may be cold worked and drawn particularly in sheet form when a good surface finish may be obtained. May be welded brazed readily.

Uses For press steel work, cold drawing of sheets, strip rod or wire, where excellent surface finish is required. It has a fairly low tensile strength with good ductility.

S.A.E. 1020-Carbon Steel

Alternate Specs:- AMS 50703)

Barstock:

MIL-S-7097 Cond. C2)

AN-S-11) Sheet

AN-QQ-S-616a. Cond. C2)

A.I.S.I. No:- 1020)

Composition:- 0.18-0.23C; 0.30-0.60Mn; 0.040P max; 0.050S max;

Mechanical Properties (as rolled) T.S. = 65,000 psi YP = 48,000 psi
 El = 36.0% on 2" Redn = 59%
 Brinell = 143. Izod = 64 ft. lb.

Stress for 0.1% creep per 1000 hrs at 800°F = 19,500 psi

at 900°F = 15,100 psi

at 1000°F = 7,200 psi

Not readily Heat-treatableCase-Hardened Properties

1. Carburized at 1675°F for 8 hrs

2. Pot cooled

3. Reheated to 1425°F

4. Water Quenched

5. Tempered at 350°F

.046 case
 Core
 TS 75000
 YP 48000
 El. 31%
 Redn. 71%
 Br. 156
 Izod 93

Rc 62

Poor Corrosion Resistance

As rolled Machinability-Fair to Good is not recommended for smooth threading, turning or broaching. Surface Finish may be poor to fair.

May be easily plated, brazed, welded and drawn into various shapes, but is not too good for deep drawing operations.

Uses This is a standard carburizing grade of carbon steel of medium core strength where the main requirement is for high casing hardness.

S.A.E.-1035-Carbon Steel

Alternate Specs:- AISI 5080R)

AN-S-1a Cond A1 or Cond C2.)

Barstock

AISI-C1040)

Composition:- C .32, S .038C, 0.60-0.90Mn, 0.040P max, 0.050S max.

Mechanical Properties (as called) TS-85,000 psi YP-55,000 psi

EL 28%

Redn 52%

Brinell 190

Izod 45

7,500 psi produces 0.1% creep at 850°F in 1000 hrs.

Heat Treatable. Normalizing at 1700°F, Reheat to 1600°F, Quenched in water.

draw temperature	400°F	800°F	1200°F
T.S.	126,000	115,000	90,000
YP	95,000	88,000	68,000
EL	16%	23%	30%
Redn	45%	58%	68%
Brinell	500 (CSO)	326	204
Izod	6	68	89

Poor Corrosion Resistance

May also be oil quenched which

Weldability Fair

results in a softer, tougher

Machinability Fair to Good

material.

Surface Finish Fair to Good

Suitable for small and medium sized forgings

Uses This steel has moderate physical properties and is a useful steel where medium strength, good machinability and surface finish are required.

Alternate Specs:- AISI 5121 Wire
 MIL-W-6101-1)
 AN-1-17)
 AN-1-17-1)
 AISI 5121 Sheet
 AN-QQ-S-666)
 AISI 5121

Composition:- 0.90-1.05C, 0.30-0.50Mn, 0.040P max, 0.050S max.

Mechanical Properties (as rolled) T.S. = 142,000 psi YP = 84,000 psi
 El. = 3% Redn = 17%
 Brinell = 293 I_{rod} = 3 ft. lb.

Material Normalised at 1650°F, Reheated to 1475°F and Quenched in Oil.

Heat Treatment

draw temperature	1100°F	800°F	1200°F
T.S.	137,000	176,000	130,000
Y.P.	120,000	111,000	90,000
El.	10%	12%	21%
Redn	30%	32%	17%
Brinell	401	363	269
I _{rod}	5	6	6

Poor Corrosion Resistance

Poor Weldability.

Machinability dependant upon heat treatment generally the lower draw temperatures make for more difficult machine but with a corresponding improvement of surface finish.

May be easily plated or drawn into sections.

Uses Being a high grade carbon steel may be used where a fairly high uniform strength is desired, note the low resistance to impact.

S.A.E. 2331-Nickel Steel

Alternate Specs:- A.M-QQ-S-689a Cond F2)

Barstock

or Cond G2)

Also 2330

Composition 0.28-0.33C, 0.60-0.80Mn, 0.010P max, 0.010S max, 0.20-0.35Si 3.25-3.75Ni

Mechanical Properties - entirely dependant upon heat-treatment and mass-effect.

Draw Temp °F	400	800	1000	1200
T.S.	250,000	168,000	136,000	113,000
Y.P.	205,000	157,000	126,000	102,000
El	13%	15%	20%	25%
Redn	50%	60%	64%	67%
Brinell	195 C50	331 C35	277	229
Izod	30	59	77	100

Normalised at 1600°F, Reheated to 1425°F Quenched in Water Simple and easy heat treatment.

Fair corrosion resistance.

Good Machinability, generally fair surface finish.

Weldability fair to good.

Uses It is useful where strength and toughness are required note how the strength and toughness vary with draw temperature.

4.4.1. 3310-Michel Chrome Steel

SAE-A130-Chrome Molybdenum Steel

Alternate Specs:-	AMS 63600	)	
	MIL-T-6736 Type 1 Cond W	)	
	AN-T-69 " "	)	Tubing
	AN-TN-T-850A " "	)	
	AMS 6370D	)	
	MIL-B-6758-1 Cond C2	)	
	AN-S-68L	)	Barstock
	AN-CC-S-663a Cond C2	)	Forgings
	AMS 6340P	)	
	AN-CC-S-685 Cond I	)	
	AN-CC-S-685 Cond II	)	Sheet
	AISI-A130	)	

Composition:- 0.28-0.33C, 0.40-0.60Mn, 0.040P, 0.040S, 0.20-0.35Si 0.80-1.10Cr, 0.15-0.25Mo.

Heat Treatment

Temp	400°F	800°F	1200°F
AS.	200,000	190,000	110,000
TS	190,000	160,000	98,000
EL	12%	11%	22%
Redn	44%	55%	67%
Brinell	461 OH9	401	241
Rock	32	32	96

Normalised at 1600°F Reheated to 1575°F Quenched in Water.

Fair Corrosion resistance

Fair to acid machinability and weldability

good cold and hot working properties, particularly for forgings and pressings fair to good anti fatigue resistance.

Uses Where a steel is required of moderately high strength, good ductility fairly hard and tough together with desirable manufacturing qualities.

S.A.E.-4140-Chrome Molybdenum Steel

Alternate Specs:- AMS 6382D)
 MIL- S-5626-1 Cond C2)
 AN-QQ-S-752 Cond C2 .) Barstock
 AISI-4140) Forgings

Composition:- 0.38-0.43, 0.75-1.00Mn, 0.040P, 0.040S, 0.20-0.35Si, 0.80-1.10Cr, 0.15-0.25Mo.

Heat Treatment

Draw Temp	1000°F	800°F	1200°F
TS	265,000	210,000	150,000
YP	253,000	195,000	115,000
El	11%	15%	21%
Redn	42%	50%	60%
Brinell	578 C57	429	277
Izod	11	21	83

Normalised at 1600°F Reheated to 1550°F Quenched in Agitated oil

Fair corrosion resistance.

Good creep and anti-fatigue resistance

Weldability and Machinability fair to good

Cold and hot working qualities make it useful for forgings

Uses Used where high fatigue and high strength are required.

SAT 4340-Nickel Chrome Molybdenum Steel

Alternate Specs:- AMS 6415 D)
 MTL-S-5000A Cond C2)
 AN-QQ-S-756a Cond C2) Barstock
 AISI-4340) Forgings

Composition:-.38-.43C, .60-.80Mn, .04OP max, 1040S max .20-.35Si, 1.65-2.00Ni, .70-.90Cr
 .20-.30Mo.

Mechanical Properties - entirely dependant upon heat-treatment and mass effect

Draw Temp °F	400	800	1000	1200
T.S.	285,000	210,000	171,000	142,000
Y.P.	227,000	193,000	158,000	130,000
El	12%	14%	16%	21%
Redn	4.7%	52%	56%	64%
Brinell	555	415	363	293
Rockwell	18	23	45	77

Normalised at 1600°F, Reheated to 1475°F, Quenched in Agitated Oil

Fairly easily heat treated

Fair corrosion resistance

Weldability fair

Uses An extremely hard, strong steel varying to a tough, fairly strong steel depending upon heat treatment. Very good antifatigue properties, suitable for use where there are repeated reversals of stress.

Creep Properties:- Stress 63,000 for 250 hrs at 550 hrs produces 0.1% creep

Stress 38,000 for 1000 hrs at 800 hrs produces 0.1% creep

S.A.E.-41620 Nickel Molybdenum Steel

Alternate Specs:- AMS 6294C) Barstock

AISI-E41620) Forgings

Composition, 0.17-0.22C, 0.45-0.65Mn, 0.025P, 0.025S, 0.20-0.35Si, 1.65-2.00Ni,

0.20-0.27Mo

Case-Hardening

.075 case

For good case and core properties

Core

1. Carburized at 1700°F for 8 hrs

TS 119,500

YP 83,500

El 19.5%

2. ~~Hot~~ Cooled

Red 59.4%

3. Reheated to 1500°F

Br 277

Izod 52

4. Quenched in Agitated Oil

5. Tempered at 300°F

R_c 62.5

The above is for max. case hardness, for max. core toughness, temper at 450°F

Fair corrosion resistance

Fair creep resistance

Good heat treatment qualities

High fatigue resistance

Weldability and Machinability fair to good before case hardening

Note It may be used where high fatigue resistance and a good case is required with a good fine grain medium strength steel core.

ATSI-302 Chromium-Nickel Stainless Steel

Alternate Specs:- AMS 5515C) Sheet

Composition:- 0.08-0.15C, 2.00Mn max, 0.04P max, 0.03S max, 1.00Si max 17.0-19.0Cr,
8.0-10.0Ni

Mechanical Properties

Condition	Annealed	Cold rolled $\frac{1}{4}$ hard
T.S.	90,000	125,000 min
Y.P. (x2% Set)	40,000	75,000 min
El	55%	12% min
Redn	65%	55%
Hardness	150	265
Izod	100-120	90

Mean Coefft of Thermal Expansion 9.6×10^{-6} per $^{\circ}\text{F}$

Melting Point 2550-2590 $^{\circ}\text{F}$

Scaling Temperature 1650 $^{\circ}\text{F}$

Creep Strength Temp $^{\circ}\text{F}$ 1000; 1100; 1200; 1300;

0.1% in 10,000 hrs. psi 11,000; 7000; 4000; 2200

Cold working, drawing, spinning and pressing-very good to excellent welding very good

Machinability-poor to fair Surface finish very good.

High temperature and corrosion Resistance very good.

Uses Where corrosion resistance or high temperature creep strength is required. Also where a good surface finish or deep drawings are required.

AISI-303 Chromium-Nickel Stainless Steel

Alternate Specs. AMS 5640E Type 1 or 2)
 MIL-S-7720 Comp FM Cond A)
 AN-S-771) Barstock
 Comp FM Cond A)
 AN-QQ-S-771)

Composition:-0.15C max, 2.00Mn max, 0.07P, S or Se (min), 1.00 Si max, 0.60 Mo or Zr
 max, 17.0-19.0Cr, 8.0-10.0Ni

Mechanical Properties

Condition	Annealed	Cold Drawn-High Tensile 1½" dia
TS	90000	110,000
YP (.2% Set)	35000	75,000
El	50%	30%
Redn	55%	50%
Hardness	160 Brinell	240
Izod	65-100	30-50

Mean Coefft. of Therman Exp = 9.6×10^{-6} per °F

Melting Point 2550-2590°F

Scaling Temperature 1650°F

Creep Strength	Temp °F	1000	1100	1200	1300
0.1% in 10000 hrs	psi	11000	7000	4000	2000

Cold working, drawing spinning and pressing-very good to excellent Welding-very good

Machinability-fair to good Surface finish very good.

High temperature and Corrosion Resistance properties very good.

Uses - Generally the same as AISI-302 except that the machining is easier, hence this is better when machining is required.

ASTM-A166 Chromium-Nickel Stainless Steel

Alternate Specs:- AMS 5565C) Tubing

Composition:- 0.08C max, 2.00Mn max, 0.04P max, 0.03S max, 1.00 Si max, 18.0-20.0Cr,
8-11.0Ni

Mechanical Properties

Condition	Annealed	Cold Drawn-High Tensile $1\frac{1}{2}$ " dia
TS	90000	110,000
YP (.2% set)	35000	75,000
El	50%	30%
Redn	55%	50%
Hardness	150	240
Izcd	65-100	30-50

Mean Coefft of Thermal Exp = 9.6×10^{-6} per °F

Melting Point = 2550-2650 °F

Scaling Temperature = 1650°F

Creep Strength	Temp °F	1000	1100	1200	1300
0.1% in 10,000 hrs	psi	11000	7000	4000	2000

Cold working, drawing, spinning and pressing-very good to excellent

Weldability-very good to excellent Machinability-poor to fair Surface finish-very good.

High temperature and corrosion resistance properties-good

Uses generally used when welding is necessary. Is not recommended for use above 800°F under severely corrosive conditions. Useful for smaller parts since annealing at 1950°F after welding is necessary.

ATST-321 and ATST-347 Chromium-Nickel Stainless Steel

Alternate Specs:- AMS 5510 (T1)E)	AMS 5646 (T1)F)	Barstock
AMS 5512 (cb)B)	AMS 5646 (cb)C)	
MIL-S-6721A)	QQ-S-763a-1)	Forgings
AN-S-757) sheet	Type A C18)	
AN-QQ-S-757)	AMS 5575 (cb)E)	Tubing (Welded.)
DTD 171)	AMS 5576 (T1))	
AMS 5570(T1) F) Tubing	MIL-T-6737)	
AMS 5571 (cb)A) (Seamless)	AN-T-43 Comp2)	
AN-WN-T-858)		

Composition:- 0.08C max, 2.00Mn max, 0.04P max, 0.03S max, 1.00 Si max, 17.0-19.0Cr,

321-8.0-11.0Ni, Ti-5x8 min

347-9.0-12.0Ni Cb-Ta-10xC min

Mechanical Properties:-

Condition	Annealed	Annealed and Cold Drawn 1" dia
T.S.	85,000	100,000
YP (.2% set)	40,000	65,000
El	50%	40
Redn	65%	60
Hardness	150	212
Izod	92-120	95-120

Mean Coefft of Thermal Expansion = 9.3×10^{-6} °F

Scaling Temperature = 1650 °F

Creep Strength Temp °F 1100 1200

0.1% in 10000 hrs psi 14000 7000

Cold working=good to very good

Surface finish=very good

Weldability=very good to excellent

Machinability=poor to fair

High temperature and corrosion resistance properties=very good

Uses The different between 321 and 347 is just the differences in additives to stop

parts, since no annealing is reqd after welding. Used extensively because of this for welded parts.

AISI-403 and AISI-410 Martensitic Chromium Stainless Steel

Alternate Specs:- AMS 5613B)

MIL-A-861 (Ships) 11a)

Barstock

AISI-403

Forgings

U.S. Navy 16S12C 11a)

AMS 5591A) Tubing AISI-410

Composition:- C.15C max, 1.00 Mn max, 0.04P max, 0.03S max.

410 1.00Si max, 11.5-13.5Cr

403 0.050Si max, 11.5-13.00Cr

Mechanical Properties:-

Condition	Annealed	1550 ^o F furnace	Tempered 1250 ^o F Air	Hardened 1800 ^o F Oil Strain Relieved 600 ^o F Air
T.S.	75,000		110,000	180,000
YF	40,000		85,000	140,000
El	35		23	15
Redn	70		65	55
Hardness	155		230	375
Redd	95-115		75-100	20-45

Mean Coefft of Thermal Expansion = 5.5×10^{-6} per ^oFMelting Point = 2700-2790 ^oFSoftening Temperature = 1250^oF

Creep Strength	Temp ^o F	1000	1100	1200	1300
0.1% in 10000 hrs	psi	10000	3500	1000	750

Cold working, forging, drawing-good

Machinability-excellent to fair. Surface finish-very good

Weldability-good to very good (anneal afterwards)

High temperature and corrosion resistance-properties-good

Uses This is a readily heat-treatable stainless steel. Low in cost. A wide range of mechanical characteristics may be obtained with heat treatment. Corrosion resistance and high temperature properties are not as high as in other stainless steels.

Iron-Chrome-Nickel Alloy 18-10-Cb

Alternate Specs:- AMS 5362A) Castings

Nearest AISI 347

AMS 5362B) Precision castings

Composition:- 0.08C max, 1.50Mn max, 2.00Si max, 18.0-21.0Cr, 9.0-12.0Ni Cb-8xC
(1.00 max).

Mechanical Properties.

TS 70,000

YP 30,000

EL 30.0%

Minimum tensile properties

Creep data .0001% per hr. temp °F	1400°F	1500°F	1600°F
Creep stress	6000	4400	3200

Weldability fair to good

Machinability poor

Very good high temperature properties and corrosion resistance.

Good resistance to attacks by most acids and alkalis, consult handbook for any particular case.

Uses Used when high temperature properties are required or high corrosion resistance is at a premium. Not so good as 25-20

3-2

Iron-Chrome-Nickel Alloy 25-20

Alternate Specs:- AMS 5361A) Castings

Newest AISI 310

Composition:- 0.20C max 1.50Mn max, 2.00Si max, 23.0-27.0Cr, 19.0-22.0Ni

Mechanical Properties

T.S. 65,000

Y.P. 28,000

El 30%

All these values are minimum for stresses

Creep data .0001% per hr temp °F	1400 °F	1600°F	1800°F
creep stress			
	7000	4200	2100

Machinability poor

Weldability fair to good

Exceptionally good high temperature properties and corrosion resistance.

Good resistance to attacks by most acids and alkalis, consult handbook for any particular case though

Uses Used when high temperature properties are required or high corrosion resistance is at a premium. Better than 18-10-Cb.

Monel

Alternate Specs:- AMS 4730A Wire

Composition:- 67%Ni, 30% Cr, 1.4%Fe, 1.0%Mn, 15C, .1Si

(Note: Monel contains .035S, this should be used for better machining properties but is slightly inferior mechanically and for corrosion resistance and cannot be hot forged)

Mechanical Properties

Condition	Rod, hot rolled	Rod drawn & annealed			Wire Spring Temper
T.S.	80-95,000	70-85,000			110-170,000
Y.P.	40-65,000	30-40,000			130-160,000
Elong	45-30%	50-35%			10-2%
Redn	75-60%	75-60%			-
Brimell	110-135	120-140			-
Hard	120-100	120-90			-
Creep Rate	Temp °F	600	800	1000	1200
.1% per 1000 hrs stress		36000	23000	4300	-

Poor Machinability

Welding fair to good providing special fluxes are used and other precautions taken.

Good to Excellent corrosion resistance and high temperature properties depending upon the type of atmosphere.

Easy drawn, spun and worked, particularly in the annealed state.

Uses, where high resistance to corrosion and temperature is desired together with the ability to be cold worked.

Inconel

Alternate Specs:- AMS 5540D
MIL-N-6840
AN-QQ-N-271a
AN-N-271a
AMS 5665B
MIL-N-6710 Cond EL
AN-QQ-N-268 Cond A
or Cond B

Sheet

Barstock

Forgings

Composition:- 77.5% Ni, 13.5%Cr, 6.0Fe, 0.8Mn, 0.25Cr, 2.0Si, 0.2C, 0.01S.

Mechanical Properties.

Condition	(Hot Rolled annealed) (Cold Drawn annealed)	Cold drawn (as drawn)	Hot-Rolled-Forged
T.S.	80-100,000	95-150,000	85-120,000
Y.P.	25-50,000	75-125,000	35-90,000
El	50-35%	30-15%	45-20%
Rdn	70-60%	60-40%	65-50%
Brinell	120-170	180-290	140-210
Izod	120 $\frac{1}{2}$	100-70	120-100

Density 0.307 lb/cut in Melting Point 2540°F

Creep strength	Temp °F	800	900	1000	1100	1200	1400
0.10% in 10,000 hrs Stress psi		46000	28000	14000	7000	5500	1700
Endurance Limit)							
for 10 ⁸ cycles)		47250	41750			26500	15500

High Corrosion Resistance. High Temperature properties excellent. Very good workability. Machining fair with proper tools and lubricant. Welding, Brazing etc, very good to good.

Uses Where exceptional high temperature and high corrosion resistance properties are desirable.

Nimonic 75

Alternate Specs:- D.T.D. 703.) Sheet

Composition:- 0.08-0.15C, 0.2-0.6Ti, 1.0Si max, 1.0Mn max, 0.5Cu, 5.0Fe max. 18.0-21.0 Cr
72Ni (the remainder)

SAE 72 Free Cutting Brass

Alternate Specs:- AMS 4610E)

QQ-B-611a Comp B $\frac{1}{2}$ H) Barstock

Anaconda 271)

Composition, 60.0-63.0Cu, 2.50-3.75Pb, 0.15Fe, Remainder Zn (35%)

Mechanical Properties

Condition	Hard	Soft
T.S.	52,000	47,000
Y.P @ 0.5% El	42,000	18,000
El	18%	60%
Rockwell	B70	B20

Melting Point 895°C = 1644°F

Density 0.307 lb/cub in

E = 1.1×10^6 lb/in²

Machinability very good to excellent

Weldability poor to fair

Fe may cold worked and formed, brazed and soldered, but not so readily as pure copper.

Corrosion resistance very good to excellent.

Uses Where decorative finish, good surface finish or corrosion resistance is required.

Alternate Specs:- WIL-B-69h6)
Barstock
AV-B-16)

Composition:- 78.0-93.0%Cu, 1.00Fe, 6.50-11.0%Al. 2.00Mn max, and 5.50Ni or 2.25Si.

Note When Ni is present max Si = 0.25% and when Si is present, max Ni = 0.25%.

Mechanical Properties

Condition	Hard	Soft
T.S.	105,000	90,000
Yp at 0.5% El	60,000	
El	12	12
Rockwell	B 105	
	Melting Point $1055^{\circ}\text{C} = 1930^{\circ}\text{F}$	
	Density 0.271 lbs/cub in	
	$E = 15 \times 10^6 \text{ lbs/in}^2$	

Machinability poor to fair

High corrosion resistance.

Not as suitable for forming or drawing as pure copper but may be cold worked if desired.

Uses:- Where corrosion resistance, hardness and high strength are required.

Alternate Specs:- AMS 45000)
Sheet
QQ-C-501a Soft)

Composition 99.9% Copper

Mechanical Properties

Condition	Annealed	Cold Drawn	Cold rolled
T.S.	32,000	45,000	52,000
YF (.2% set)	10,000	40,000	48,000
E1	40%	20%	5%
Brinell	30	105	120

Melting Point = 1980°F

Density = 0.322 lb/cub in

E = 15.9 lb/in²

Machinability - Poor to Fair

Weldability - Fair

Can be easily drawn, stamped, formed and spun. Brazed and Soldered. Corrosion Resistance very good.

Uses Practically endless, where metal forming, atmospheric corrosion resistance is desired or a good appearance is wanted.

No known alternate specs.

Available forms include Casting pigs for sand castings, Plaster-mold castings and Investment Castings.

Composition:- 2.00-2.25Be, 0.35-0.60 Cobalt, the remainder copper.

Mechanical Properties:- (Annealed and Heat Treated) 1 hr per in. at 1450°F, Quenched in water, 3 hrs at 600°F, and rate of cooling.

T.S. 155-170,000 psi

.002% Y.S. 80-110,000 limit of proportionality

.01% Y.S. 100-115,000

.2% Y.S. 130-155,000

% El in 2" 1.5%

Hardness C38-45

Endurance 29-30,000 psi

Melting Range 1600-1900°F

E 18,500,000 psi

Density .292 lbs/cub in

Coefft of Exp (Thermal) .94 in per °F x 10⁻⁵

May be joined by all methods, similar to phosphor bronze

May be formed spun or cold worked.

Good corrosion resistance, good high temperature properties up to 400°F good creep and anti-fatigue properties.

Working poor to fair. Castability exceptionally good.

Uses Where Precision casting is reqd with moderate strength, and good endurance and stress reversal limits are required. e.g. blades.

3S - Aluminum Wrought Alloy

Alternate Specs

AMS 4006B)

Sheet - 3S0

QQ-A-3596 Cond A)

A.M.S. 4006B)

Sheet - 3S $\frac{1}{2}$ HQQ-A-3596 Cond $\frac{1}{2}$ H)

Composition:- 0.20Cu, 0.7Fe, 1.0-1.5Mn, 0.6Si, Sn0.10 and other elements.

Mechanical Properties for 3S0

T.S.	Y.S.	El % in 2" (1/16 thick)	Brinell	Shear Strength	Endurance Limit
27,000	7,500	30	23	11,000	7,000

Characteristics - Non-heat-treatable, weldable and brazable, readily machined, higher resistance to corrosion.

Uses:- For parts that are fabricated by spinning or some major forming operation.

245 - Aluminum Wrought Alloy (Dural Type)

Alternate Specs:-

- AMS 4152E)
- QQ-A-267) Barstock 24ST
- QQ-A-354-Cond Th)
- AMS 4037C)
- AN-A-12-CondT) Sheet 245 T
- QQ-A-355b-CondTh)
- AMS 4040C) Sheet 2450 Alclad
- AN-A-13-Cond A)
- QQ-A-362a Cond O)
- AMS 4041C)
- AN-A-13-Cond T) Sheet 245T Alclad
- QQ-A-362a Cond Th)

Composition:- 3.8-4.9Cu, 0.5Fe, 1.2-1.8Mg, 0.3-0.9Mn, 0.5Se, 0.10Zn, 0.10Cr, & others

Mechanical Properties for 245-0

T.S.	Y.S.	% El in 2 ins (1/16 thick)	Brin	Shear Strength	Endurance Limit
20,000	12,000	18		40,000	

Characteristics:- Heat treatable, welding not recommended, non brazable alclad types give maximum corrosion resistance, readily machined.

Uses:- Structural applications QQ-A-354-Cond Th used up to 200 °C. AN-A-13-2 Cond A is used where slight spinning, drawing or forming operations are required.

5-3

26S - Aluminum Wrought Alloy (Mural Type)

Alternate Specs

A.M.S. 4135G)

Forced 26ST

QQ-A-367C Comp. 5 Cond T6)

Composition:- 3.9-4.00Cu, 1.0Fe, 0.2-0.5Mg, 0.4-1.2Mn, 1.2Si, 0.10Zn, 0.10Cr, 0.15Ti

& others.

Mechanical Properties for 26S.0

T.S.	Y.S.	% El in 2 ins (1/16 thick)	Brin.	Shear Strength	Endurance Limit
30,000	16,000	14	45	18,000	11,000

Characteristics:- Heat treatable, welded not recommended, non-brazeable readily machined.

Uses:- Structural applications.

65S - Aluminum Wrought Alloy

Alternate Specs

AMS 4150B)
Barstock 655T

QQ-A-325a Cond T6)

QQ-A-325a Cond O - Barstock 6550

AMS 4025B)
Sheet 6550

QQ-A-327a Cond T0)

AMS 4027B)
Sheet 655T

QQ-A-327a Cond T6)

Composition:- 0.15-0.4Cu, 0.7Fe, 0.8-1.2Mg, 0.15Mn, 0.4-0.8Si, 0.10Zn, 0.35Cr, 0.15Ti,
& others.

Mechanical Properties for 65S-0

T.S.	Y.S.	% El in 2 ins (1/16 thick)	Brin	Shear Strength	Endurance Limit
18,000	8000	22	30	12,500	9,000

Characteristics:- Heat treatable, weldable and brazeable, superior corrosion resistance,
readily machined, formed and fabricated.

Uses:- Extruded structural sections.

5-5

75S - Aluminum Wrought Alloy

Alternate Specs.

DTD 683 - Forging

Composition:- 1.2-2.0Cu, 0.7Fe, 2.1-2.9Mg, 0.30Mn, 0.5Si, 5.1-6.1Zn, 0.15-0.4Cr,
0.2Ti, & others

Mechanical Properties for 75S-0

T.S.	Y.S.	% El in 2 ins (1/16 thick)	Brin	Shear Strength	Endurance Limit
33,000	15,000	17			

Characteristics:- Heat treatable, welding not recommended non-brazeable, readily machined. Suited to highly stressed parts operating below 100°C. Can be produced as sheet, extrusions forgings and tubing.

Uses:- Compressor discs

AC 123 - Aluminum Alloy Casting

Alternate Specs

AY-A-27)

AY-QQ-A-405) Sand Casting

QQ-A-601a Comp 2)

Composition:- 0.15Cu, 0.30Fe, 0.10Mn, 4.5-6.0Si, 0.20Ti, & others

Mechanical Properties for Alcan 123

T.S.	T.S.	% El	Comp	Brin	Shear Strength	Endurance Limit
11,000*	9,000	6.0	10,000	40	14,000	6,500

Min. guaranteed.

Characteristics - Non-heat-treatable, excellent castability, excellent corrosion resistance, fair machinability, Brazeable.

AC 125 Aluminum Alloy Casting

Alternate Specs

AN-A-41)

Permanent Mold Casting

QQ-A-596)

GT-A-12 Cond A)

Precision Casting

GT-A-1a Cond B)

AMS 4212D)

AN-A-40)

Sand Casting

QQ-A-601a Comp 10 (T6))

Composition:- 1.0-1.5Cu, 0.60Fe, 0.40-0.60Mg, 0.10Mn 4.5-5.5Si, 0.20Ti, & others

Mechanical Properties for Alcan 125-A43

TS	YS	%EL	Compr	Brin	Shear Strength	Endurance Limit
25,000*	23,000	1.5	24,000	65	22,000	7000

*Min guaranteed

Note: High strength can be obtained by heat treatment.

Characteristics:- Heat treatable, good castability, fair corrosion resistance, good machinability.

Uses:- This alloy precision casts well and is used for the inlet guide vanes on axial compressor. Generally used for stressed castings of intricate shape and requiring good mechanical properties.

AC 135 - Aluminum Alloy Casting

Alternate Specs

- AN-A-311)
Permanent - Mould Casting
- QQ-A-596)
- AMS 4217)
- AN-A-39 Class II) Sand Casting alloy
- QQ-A-601a Comp 3 (T6))

Composition:- 0.20Cu, 0.60Fe, 0.20-0.40Mg, 0.10 Mn, 6.5-7.5Si, 0.20Ti, & others

Mechanical Properties for Alcan 135-AA3

T.S.	Y.S.	% El in 2 ins	Comp	Brin	Shear Strength	Endurance Limit
25,000	20,000	2.0	22,000	60	18,000	7,500

Note: Higher strength can be obtained by heat treatment.

Characteristics - Heat treatable, castability excellent, excellent corrosive resistance, good machinability, weldable and brazeable.

Uses: Used where requirements include high strength, corrosion resistance, pressure tightness and/or dimensional stability on temperature variations up To 125°C

A11-A25 (RR-50)-Aluminum Alloy Casting

Alternate Specs

DTD 133C-Sand or Die Casting Alloy

Composition:- 0.3-2.0Cu, 0.05-0.20Mg, 1.5-2.8Si, 0.8-1.4Fe, 0.1Mn, 0.8-1.7Ni, 0.1Zn, 0.05, P, 0.05Sn, & others

Mechanical Properties

T.S. .1%P	Y.S. % El	Comp	Brin	Shear Strength	Endurance Limit
	Min				
Room Temp. 11,000 min	20,000 2		60 typical		
100°C 13,200 typ.	21,600 2				
200°C 14,000 typ	19,200 2				

Uses;- This alloy is ideal for large and intricate castings because its heat treatment does not cause distortion. It is recommended for elevated temperature service up to 300°C

RR-53B Aluminum Alloy Casting

Alternate Specs

DTD 131B - Sand or Die Casting Alloy.

Composition 1.3-3.0Cu, 0.5-1.7Mg, 0.6-2.0Si, 0.8-1.4Fe, 0.1Mn 0.5-2.0Ni, 0.1Zn,
0.05Pb, 0.05Sn, & others

Mechanical Properties

T.S.	V.S.	%El	Comp	Brin	Shear Strength	Endurance Limit
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10,000

Uses: This alloy is recommended for elevated temperature service (up to 300°C)

It is not applicable to large castings, however, because of distortion upon heat treating.