



# AEROSPACE TUBING

High pressure and hydraulic tubing for critical airframe and engine applications across the commercial aircraft, defense and space sectors.

Our high quality and reliable precision metal tubes allow aerospace engineers to push the boundaries in application design. Key advantages include:

- Improved aircraft performance, operating efficiency and longer ranges
- Lightweight materials allow significant aircraft weight savings to reduce fuel consumption, emissions and operating costs
- NADCAP Heat Treatment, NDT, Welding, Chemical Processing, Fluid Distribution Systems
- Short lead times for qualification and production

## TUBING EXCELLENCE

With more than 85 years of engineering expertise in manufacturing high precision tubes, Fine Tubes and Superior Tube work closely with major airframe and engine manufacturers worldwide. Our metallurgists develop lightweight and high strength tubes to help solve the technical challenges of our customers.

From fighter jets to commercial aircraft and spacecraft to satellites, our specialty metal tubes are performance enhancing.



### DEFENSE

Military aircraft rely on the unrivalled performance delivered by our specialty tubes. Deployed in critical applications such as engines and airframes – precision, quality and reliability are paramount. Our tubes are engineered to operate in the most extreme working conditions.

From developing the lightweight titanium tubing for the hydraulic systems of the Eurofighter to manufacturing heat resistant Waspaloy® tubing for the afterburners of the F-15/F-16, our tubes are performance enhancing.



### COMMERCIAL

Our high strength and lightweight tubes operate in engines and airframes of major commercial aircraft programs including Airbus and Boeing.

Critical to the safe operation of the aircraft, our 3,000 or 5,000 psi hydraulic tubes are used to actuate flight control surfaces and are crucial components in landing gear and brake systems.

We also supply heat resistant tubing for various systems within commercial aero engines, including fuel delivery, fire suppression, drain lines and bleed air systems.



### SPACE

Our involvement in the space industry goes back to the 1960s, where we contributed to Telstar 1, the world's first communications satellite.

Since then, Fine Tubes and Superior Tube have been developing high quality tubing solutions for innovative space exploration programs, including NASA's Space Shuttle and Mars Exploration projects, and the Solar Orbiter project.

From rocket engines to satellite propulsion systems, our precision-engineered tubes require zero maintenance in the most hostile environments.



**Defense Applications**



- Afterburners
- Combat aircraft hydraulics
- High performance actuation
- Pitot tubes
- Flex-heaters
- Radar / sound detection

**Space Applications**



- Satellite propulsion systems
- Heat exchangers
- Space rocket engines

**ALLOYS**

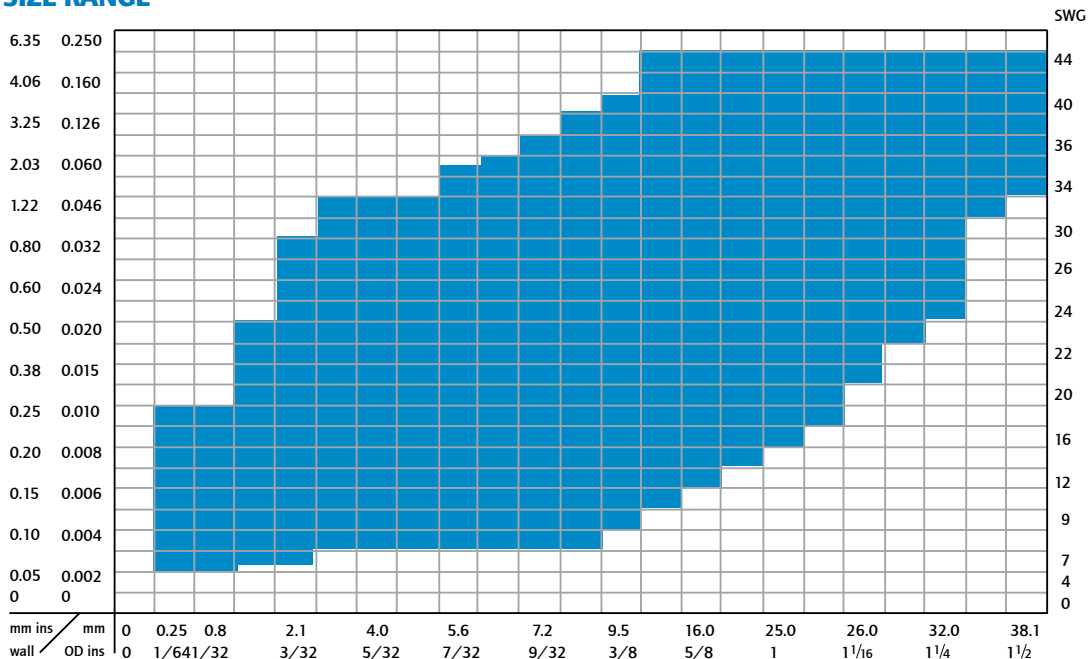
Fine Tubes and Superior Tube produce a wide range of custom-sized tubing in an ever expanding range of alloys – available in three different forms, i.e. seamless, welded or welded & redrawn (Weldrawn®) finish.

	FORM	
	SEAMLESS	WELDED & REDRAWN
<b>STAINLESS STEEL</b>		
304	●	●
316	●	●
321	●	●
347	●	●
15-5PH®	●	
17-4PH®		●
17-7PH®		●
21-6-9	●	●
F607	●	

	FORM	
	SEAMLESS	WELDED & REDRAWN
<b>NICKEL ALLOYS</b>		
Waspaloy®		●
X-750	●	
Nimonic Alloy® 75	●	
Invar® 36		●
C263	●	
200	●	
201	●	
211	●	
600	●	
625	●	●
718	●	
<b>TITANIUM</b>		
Ti 3Al-2.5V (Grade 9)	●	
Ti 6Al-4V (Grade 5)	●	
Ti CP (Grade 1 and 2)	●	
Ti 4Al-2.5V	●	
Ti 6Al-4V ELI (Grade 23)	●	
Ti A-40	●	

We also manufacture tubing in many other grades. Please contact us for more details.

**SIZE RANGE**



Our tubing sizes typical for aerospace applications range from 0.25 mm (0.010 in) to 38.10 mm (1.5 in) OD in seamless, welded and welded & redrawn.

**TUBING QUALITY**

**TUBING QUALITY CERTIFICATIONS**

- Nadcap (Chemical Processing)
- Nadcap (Fluid Distribution Systems)
- Nadcap (Heat Treatment)
- Nadcap (NDT)
- Nadcap (Welding)
- TUV AD-2000 Merkblatt W0-TRD 100
- 97-23-EC (PED) - TÜV
- ISO 9001
- AS EN 9100
- ISO 10012
- ISO 14001
- RCC-M

**CUSTOMER APPROVALS**

- Airbus
- BAE Systems
- Boeing
- Bombardier
- Embraer
- GE Aviation
- Gulfstream
- Hawker Beechcraft
- Liebherr
- Lockheed Martin
- Messier-Dowty
- Raytheon
- Rolls-Royce
- SNECMA-SAFRAN
- UTC
- Westland

**MANUFACTURING STANDARDS**

**TITANIUM 3Al-2.5V**

- ABS 5004
- ABS 5141
- ABS 5918
- AMS 4943
- AMS 4944
- AMS 4945
- AMS 4946
- MBBN 6001-4
- MSRR 8673

**TITANIUM 6Al-4V**

- FT2312 SEAMLESS

**TITANIUM C.P.**

- AMS 4942
- BAEM 4044
- MSRR 8609

**STAINLESS STEEL 21-6-9**

- ABM 7-3058
- AMS 5561
- ASN-A3288-NSA384510
- BACM 157
- BMS7-185
- DAN 41
- S07-2210

**OTHER STAINLESS STEELS**

- AMS-5566 Alloy 304
- AMS-5643 Alloy 17-4PH®
- AMS-5659 Alloy 15-5PH®
- AMS-T-6845 Alloy 304
- BS2T66 Alloy 347
- BST68 Alloy 347
- BST72 Alloy 347
- LN 9398 Alloys 304-321-347
- MIL-T-8808 Alloys 321-347
- MSRR 6524 Alloy 347

**NICKEL ALLOYS/NIMONICS**

- AMS 5580 Alloy 600
- AMS 5581 Alloy 625
- AMS 5582 Alloy X750
- AMS 5589 HTA75 (Alloy 75)
- BSHR 403 Alloy 263
- BSHR 404 FV607
- MSRR 6513 Nimonic Alloy® 75
- MSRR 7006 Alloy C263
- MSRR7037



# SUPERCritical TUBING • GRADE CHART

## AEROSPACE



ALLOY UNS No.	WNR	Chemical Analysis %											Density		Temp	Tensile Rm (min)		Yield Rp 0.2% (min)		Elong. % min	Hardness HV	Properties		
		C	Mn	Ni	Cr	Fe	Mo	Ti	Nb	N	Al	Other	g/cm <sup>3</sup>	lb/in <sup>3</sup>		ksi	MPa	ksi	MPa					
304 S30400	1.4301	0.08 max	8.0-10.5	18.0-20.0											7.93	0.286	ANN	76	517	31	207	40	200 max	High strength, excellent corrosion resistance and minimized carbon content. Resistance to oxidation, excellent formability and ease of fabrication.
316 S31600	1.4401	0.08 max	10.0-14.0 max	16.0-18.0	2.0-3.0									7.93	0.286	ANN	75	515	30	205	35	200 max	The molybdenum gives 316 better overall corrosion resistant properties than Grade 304. Particularly higher resistance to pitting and crevice corrosion in chloride environments.	
321 S32100	1.4541	0.080 max	2.0 max	9.0-12.0	17.0-19.0	bal	5XC -0.600							7.93	0.286	ANN	75	515	30	205	35	200 max	Titanium stabilised grade with good weldability, improved resistance to weld decay attack & better mechanical properties at elevated temperatures.	
347 S34700	1.4546	0.080 max	2.0 max	9.0-12.0	17.0-19.0	bal		10XC -1.000						7.93	0.286	ANN	75	515	30	205	35	200 max	As for 321 but uses niobium as stabilising element.	
21-6-9 S21900		0.080 max	8.0-10.0	19.0-21.5	bal				0.15-0.40					8	0.289	CW	142-162	979-1117	120	827	16	250 min	Good corrosion resistance, high mechanical properties.	
FV607 S64607		0.12-0.16	0.5-1.2	10.0-11.7	bal	0.7-1.2			0.35 max					7.7	0.278	HT	130-152	900-1050	107	740	8	300 min	Capable of developing high mechanical properties by solution treatment & age hardening.	
15-5PH® S15500		0.070 max	1.0 max	14.5-15.5	bal				0.15-0.45					7.8	0.282	HT	155	1070	145	1000	12	290-349	Martensitic grade showing good creep resistance.	
17-4PH® S17400		0.070 max	2.0 max	15.0-17.5	bal				0.15-0.45					7.9	0.286	HT	155	1070	145	1000	5	331-401	Capable of developing high mechanical properties by solution treatment and age hardening.	
17-7PH® S17700		0.09 max	1.0 max	16-18	bal									8.3	0.3	ANN CW	140	966	35/70	241/483	20	220	Excellent fatigue properties, good corrosion resistance and is easily formed. Offers high strength and hardness with minimum distortion under heat treatment.	

STAINLESS STEEL

**FINE TUBES**  
Scan for more details on our grades

**SUPERIOR TUBE**  
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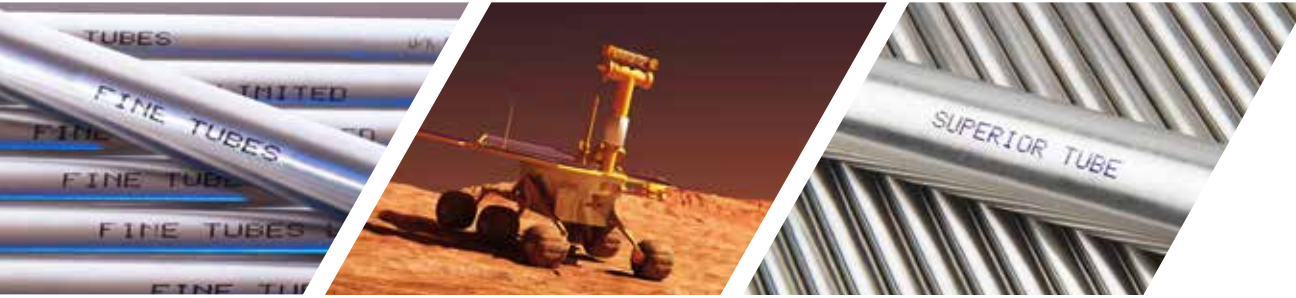
ALLOY UNS No.	WNR	Chemical Analysis %										Density		Temp per	Tensile Rm (min)		Yield Rp 0.2% (min)		Elong. % min	Hardness HV	Properties			
		C	Mn	Ni	Cr	Fe	Mo	Ti	Nb	Al	Other	g/cm³	lb/in³		ksi	MPa	ksi	MPa						
NICKEL ALLOYS	Inva® 36 K93600	0.1 max	35.5 max	0.5											8	0.29	ANN CW	80	552	30/50	207/345	30	170	Low expansion alloy that contains 36% nickel and possesses a rate of thermal expansion approximately one-tenth that of carbon steel.
	Nimonic Alloy 75 N06075	0.08- 0.15	1.0 max	bal	18.0- 21.0	5.0 max		0.20- 0.60							8.37	0.303	ANN	100- 120	690-830	46	300	30	230 max	High temperature oxidation resistance.
	Alloy C263 N07263	0.04- 0.08	0.6 Ma	bal	19.0- 21.0	0.7 max	5.6- 6.1	1.9-2.4	0.3- 0.6		Co 19.0- 21.0	8.36	0.302	HT	140	970	HT	140	970	90	620	39	250 min	High creep strength with good weldability.
	200 N02200	0.15 max	0.35	99			0								9	0.321	ANN CW	80	552	15/38	103/262	30	137	Excellent resistance in alkaline media, high ductility and high electrical and thermal conductivity.
	201 N02201	0.02 max	0.35	99			0								9	0.321	ANN CW	65	448	13/30	90/207	35	147	Low carbon version of Nickel 200. Good corrosion resistance and low electrical resistivity.
	211 N02211	0.2 max	4.25/ 5.25	93.7			0								8.9	0.317	ANN CW	95	655	30/45	207/310	30	147	Similar to Nickel 200 with manganese addition to improve sulphur resistance.
	Alloy 600 N06600	0.15 max	1.0 max	72.0 min	14.0- 17.0	6.0- 10.0									8.42	0.304	ANN	80	550	35	240	30	200 max	Very good combination of strength & oxidation resistance.
	Alloy 625 N06625	0.10 max	0.5 max	bal	20.0- 23.0	5.0 max	8.0- 10.0	0.40 max	3.15- 4.15						8.44	0.305	ANN	120	827	60	414	30	260 max	High strength, excellent fabricability. Superior resistance to a wide range of corrosive environments.
	Alloy X750 N07750	0.08 max	1.0 max	70.0 min	14.0- 17.0	5.0- 9.0	2.25- 2.75	0.40- 1.00							8.25	0.298	HT	160	1103	100	689	20	260-360	High temperature strength performance.
	Alloy 718 N07718	0.08 max	0.4 max	50.0- 55.0	17.0- 21.0	bal	2.80- 3.30	0.65- 1.15	4.75- 5.50						8.19	0.296	HT	150	1084	120	827	20	382 max	Age hardenable, high strength nickel alloy with good sour well corrosion resistance.
TITANIUM	CP Grade 1 R50250	0.08 max	0.08 max			0.20 max						0.03 max			4.48	0.162	ANN	80	552	70	482	15		The most ductile and softest titanium alloy. A good solution for cold forming and corrosive environments.
	CP Grade 2 R50400	0.08 max	0.08 max			0.30 max						0.03 max			4.51	0.163	ANN	50	345	40-65	275-450	20		Very high strength to weight ratio combined with excellent seawater corrosion resistance.
	Ti 6Al-4V Grade 5 ELI R56401	3.7165													4.33	0.156	CWSR	159	1100	141	980	8		ELI grade, very high strength to weight ratio.
	Ti 3Al-2.5V Grade 9 R56320	3.7194	0.08 max			0.25 max						0.03 max			4.48	0.162	CWSR	125	860	105	725	10		Cold worked 75 to 85% to result in moderately high strength and good ductility. Weldability on par with commercially pure grades and excellent torsion and corrosion resistance.
Ti 4Al-2.5V R54250					1.5											CWSR	146	1006	129	890	14		Very high strength to weight ratio with improved ductility.	



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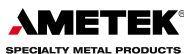
## ABOUT AMETEK SPECIALTY METAL PRODUCTS

AMETEK Specialty Metal Products (SMP) is a business unit of AMETEK, Inc. a leading global manufacturer of electronic instruments and electromechanical devices with annualized sales of approximately \$5.5 billion.

The Specialty Metal Products business unit consists of five businesses and operating facilities in the United States and the United Kingdom.

These businesses are proven experts in the manufacture of advanced metallurgical products including roll bonded clad plate, precision metal strip, ultra-thin foil, shaped wire, engineered components, thermal management materials, water atomized powders and precision tube.

Our high performance metal products are used around the world for critical applications in a range of industries including aerospace, automotive, defense, electronics, industrial, medical, nuclear, oil and gas, and space and satellites.



### Fine Tubes

Plymbridge Road, Plymouth,  
PL6 7LG, United Kingdom

E: [sales.finetubes@ametek.com](mailto:sales.finetubes@ametek.com)

T: +44 (0) 1752 876416

[www.finetubes.com](http://www.finetubes.com)

Scan for more  
information



### Superior Tube

3900 Germantown Pike, Collegeville,  
PA 19426-3112, United States

E: [sales.superiortube@ametek.com](mailto:sales.superiortube@ametek.com)

T: +1 610.489.5200

[www.superiortube.com](http://www.superiortube.com)

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