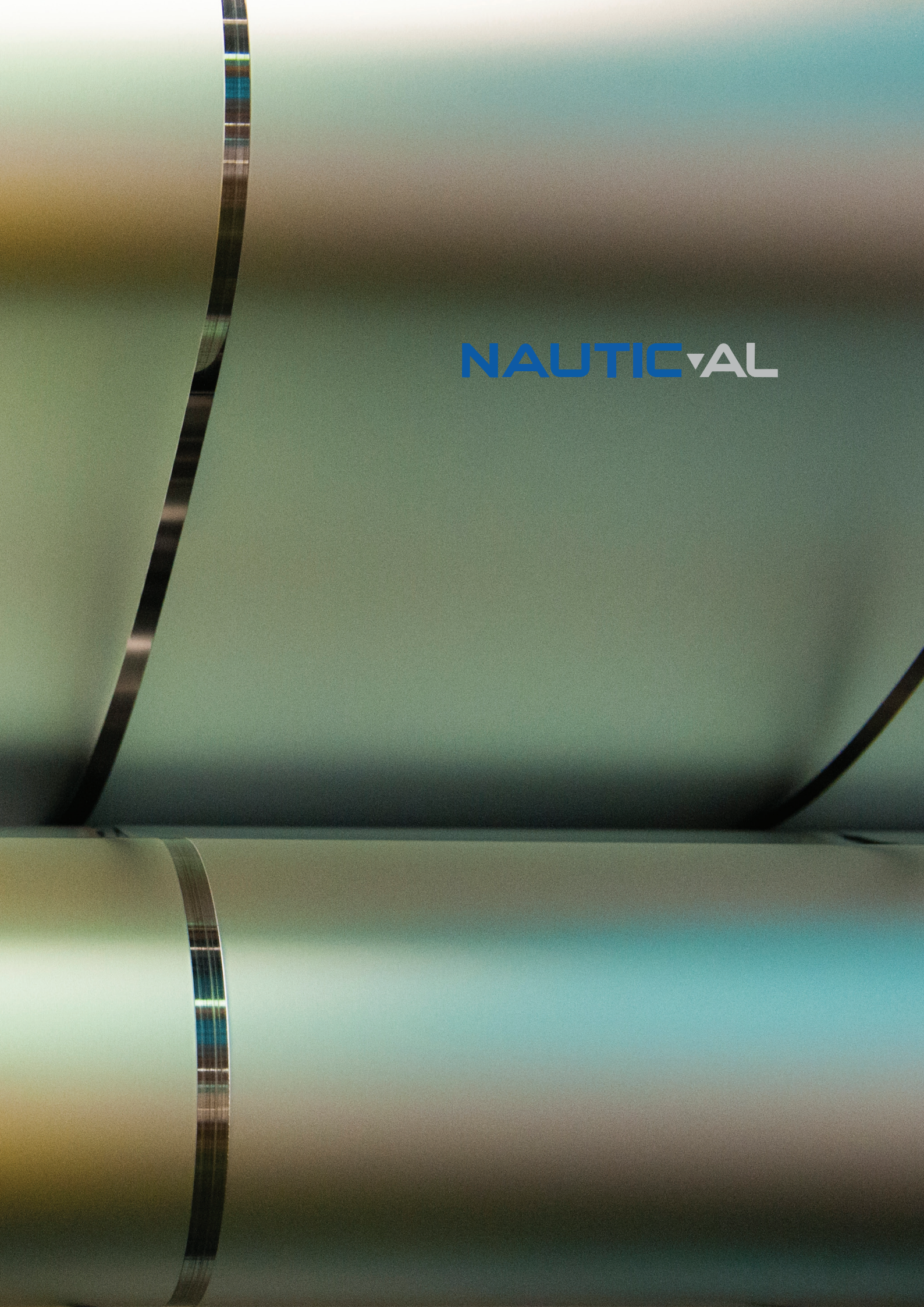

NAUTICAL

Making waves

Performance is as important in the yard as it is on the water. You want high performance, user-friendly materials that give you the freedom to express your vision. Structural efficiency. Unimpeachable quality. And genuine versatility.

That's why so many of today's best performing vessels, large and small, are constructed from SLIM aluminium. Ever since we developed strain-hardened 5xxx series alloys to provide the exceptional strength, workability and corrosion resistance that marine applications require, aluminium has been the material of choice for forward-looking designers wherever durability, economy of operation and construction, responsiveness or sheer speed are priorities.

"Whether you're an architect, designer, constructor or vessel operator, the beauty of aluminium is that it's always on your side. Its lightness and strength mean faster speeds, bigger payloads, higher fuel efficiency and better controllability. It's easy to work with and maintain, allowing you to shape the most dramatic of designs. For corrosion resistance, durability and recyclability, it's unrivalled – and with Nautic-Al products from SLIM Fusina Rolling, you're getting expertise and alloys specifically designed for maritime use from the global technology leader."

Gennaro Candida Di Matteo | CRN Yachts, Chief Operating Officer

Naval Aluminium

Think light

With a specific weight about one third that of steel, an aluminium hull and superstructure typically weighs less than half as much as a steel one of equivalent strength. This lightness translates into greater capacity, speed or fuel economy and range as well as conferring inherently superior maneuverability. The advantage is even greater in vessels of less than 30 meters (where hull weight is more critical) because of minimum plate thickness.

Stronger

An aluminium hull will survive significantly higher ultimate loads than a comparable GRP (glass reinforced plastic) hull, and since aluminium is less brittle there is less risk of hull penetration. Additionally, small holes do not enlarge with external pressure as is the case with GRP. Aluminium has far greater structural efficiency (stiffness-to-density ratio) than steel – and with magnesium as the major alloying element, the fatigue strength of 5xxx series products is among the highest of all aluminium alloys.

Tougher

With a microstructure designed for excellent corrosion resistance in the harshest marine environments, aluminium sheets can be used without additional protection such as painting or sacrificial anodes, with all that this implies for long-term maintenance. They are, however, suitable for a wide range of surface treatments where required.

Easier

Aluminium is of course as easy to work as it is versatile – easy to cut, bend, cold form and engineer with standard tools. Alcoa 5xxx alloys are quick to weld using GMA-W or GTA-W processes; not only does aluminium resist distortion during welding better than steel, but the welds themselves are highly ductile for subsequent cold forming. Taken together, these factors deliver considerable cost advantages for the constructor.

Total capability

The undisputed world leader in aluminium production and technology, Alcoa gives you the benefit of complete technical design, engineering and production support. All the marine aluminium products in the comprehensive Nautic-Al range are tested to the highest international standards. And as you would expect of a company voted one of the most sustainable corporations on the planet by the World Economic Forum every year since the ranking began, Alcoa products are easy to recycle - almost 70% of the aluminium ever produced is still in use.

Improving performances

SLIM Fusina rolling team demonstrated to contribute in material development for marine to fight extremely severe conditions with improved corrosion resistance. All alloys containing more than 3% Mg, such as 5083, can be sensitized when exposed to temperatures above 60:65°C. Sensitization is defined as formation of continuous film of beta phase precipitated at the grain boundaries (dark lines). Beta phase start the precipitation already above 50°C.

Mechanical Properties

The following limits are given according to EN 485-2 standard; tensile testing is performed according to ISO 6892-1. When materials are specified for marine use, and when applicable, they are supplied according to ASTM B928, ASTM B209 standards or upon request to Lloyd's Register, Det Norske Veritas - GL, American Bureau of Shipping, RINA or Bureau Veritas rules.

Alloy	Temper	Thickness mm		R_m Mpa		$R_{p0,2}$ Mpa		Elongation, min. %		Bend radius		Hardness HBW [1]
		Over	Up to	Min.	Max.	Min.	Max.	A50	A	180°	90°	
EN AW-5052	H32	3,0	6,0	210	260	130		10			1,5 t	61
		6,0	12,5	210	260	130		12			2,5 t	61
	H34	3,0	6,0	230	280	150		7			2,5 t	67
		6,0	12,5	230	280	150		9			3,0 t	67
EN AW-5754	O H111	≥ 2,5	3,0	190	240	80		16		1,0 t	1,0 t	52
		3,0	6,0	190	240	80		18		1,0 t	1,0 t	52
		6,0	12,5	190	240	80		18			2,0 t	52
		12,5	80,0	190	240	80			17			52
	H32	3,0	6,0	220	270	130		11			1,5 t	63
		6,0	12,5	220	270	130		10			2,5 t	63
	H34	3,0	6,0	240	280	160		8			2,5 t	70
		6,0	12,5	240	280	160		10			3,0 t	70
EN AW-5154A	O H111	≥ 2,5	3,0	215	275	85		15		1,0 t	1,0 t	58
		3,0	6,0	215	275	85		17			1,5 t	58
		6,0	12,5	215	275	85		18			2,5 t	58
		12,5	50,0	215	275	85			16			58
EN AW-5086	O H111	≥ 2,5	3,0	240	310	100		13		1,0 t	1,0 t	65
		3,0	6,0	240	310	100		15		1,5 t	1,5 t	65
		6,0	12,5	240	310	100		17			2,5 t	65
		12,5	80,0	240	310	100			16			65
	H112	≥ 8,1	12,5	250		105		8				69
		12,5	40,0	240		105			9			65
		40,0	80,0	240		100			12			65
	H116 H321	≥ 2,5	3,0	275	360	195		8		2,0 t	2,0 t	81
		3,0	6,0	275	360	195		9			2,5 t	81
		6,0	12,5	275	360	195		10			3,5 t	81
		12,5	50,0	275	360	195			9			81
EN AW-5083 *ASTMB928	O H111	≥ 2,5	3,0	275	350	125		13		1,5 t	1,0 t	75
		3,0	6,3	275	350	125		15			1,5 t	75
		6,3	12,5	270	345	115		16			2,5 t	75
		12,5	50,0	270	345	115			15			75
		50,0	80,0	270	345	115			14			73
	H112	≥ 8,1	12,5	275		125		12				75
		12,5	40,0	275		125			10			75
		40,0	80,0	270		115			10			73
	H116 H321	≥ 2,5	3,0	305	385	215		8		3,0 t	2,0 t	89
		3,0	6,0	305	385	215		10			2,5 t	89
		6,0	12,5	305	385	215		12			4,0 t	89
		12,5	40,0	305	385	215			10			89
		40,0	80,0	285	385	200			10			83
	H128*	> 4,0	12,5	305	385	215		10				

Alloy	Temper	Thickness mm		R_m Mpa		$R_{p0,2}$ Mpa		Elongation, min. %		Bend radius		Hardness HBW (1)
		Over	Up to	Min.	Max.	Min.	Max.	A50	A	180°	90°	
EN AW-5456	O H111	> 2,5	6.3	290	365	130	205	16			2,5 t	80
		6.3	80,0	285	360	125	205	16	14			80
	H116	> 3,0	12,5	315	405	230		10			4,0 t	90
		12,5	30,0	315	385	230			10			90
		30,0	40,0	305	385	215			10			90
		40,0	60,0	285	370	200			10			85
	H321	2,5	4,0	330	405	235		10			4,0 t	90
		4,0	12,5	315	405	230		12				90
		12,5	40,0	305	385	215			10			85
		40,0	60,0	285	370	200			10			85
EN AW-5383	O	≥ 2,5	3,0	290	360	145		13		5,1t	1,0 t	85
		3,0	6,0	290	360	145		15			1,5 t	85
	H111	6,0	12,5	290	360	145		16			2,5 t	85
		12,5	50,0	290	360	145			15			85
		50,0	80,0	285	355	135			14			80
	H116 H321	≥ 1,5	3,0	330	400	230		8				90
		3,0	6,0	330	400	230		10		3,0 t	2,0 t	90
		6,0	12,5	330	400	230		10			2,5 t	90
		12,0	40,0	330	400	230			10		4,0 t	90
		40,0	60,0	330	400	230			10			84

Chemical Composition

Alloy	%	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Thickness (mm)	
										each	total
5052	Min.	-	-	-	-	2.2	0.15	-	-	-	-
	Max.	0.2	0.4	0.1	0.1	2.6	0.35	0.2	0.15	0.05	0.15
5754	Min.	-	-	-	-	2.6	-	-	-	-	-
	Max.	0.4	0.4	0.1	0.5	3.6	0.30	0.2	0.15	0.05	0.15
5154A	Min.	-	-	-	-	3.1	-	-	-	-	-
	Max.	0.5	0.5	0.1	0.5	3.9	0.25	0.2	0.2	0.05	0.15
5086	Min.	-	-	-	0.2	3.5	0.05	-	-	-	-
	Max.	0.4	0.5	0.1	0.7	4.5	0.25	0.25	0.15	0.05	0.15
5083	Min.	-	-	-	0.4	4.0	0.05	-	-	-	-
	Max.	0.4	0.4	0.1	1.0	4.9	0.25	0.25	0.15	0.05	0.15
5456	Min.	-	-	-	0.5	4.7	0.05	-	-	-	-
	Max.	0.25	0.4	0.1	1.0	5.5	0.2	0.25	0.2	0.05	0.15
5383	Min.	-	-	-	0.7	4.0	-	-	-	-	-
	Max.	0.25	0.25	0.2	1.0	5.2	0.25	0.4	0.15	0.05 (0,20 Zr)	0.25

Rolled Products

Alloy	Properties	Application	Tempers
5052	Excellent corrosion resistance with medium strength combined with formability and weldability. Shinny coloration.	Applications in small leisure boats unpainted or partially painted, Substitution of reinforced fiber glass.	H32 H34
5754	Superior corrosion resistance at elevated temperatures, good strength, good workability and weldability.	Applications with prolonged temperatures higher than 66°C. Welded structures, separators, ..	O H111 H34 H34
5154A	Very good corrosion resistance. Good weldability and formability. Medium-high strength (higher than 5754). High fatigue strength. Good anodizing properties.	Welded structure, storage tanks, pressure vessels, tanks, ship masts.	O H111
5086	High strength with excellent resistance to corrosion in marine environment. Good workability and weldability.	Shipyard sheet and plate, shipping drums, support structures, welded structures, bulkheads, patrol and work boat hulls.	O H111 H116 H321
5083	High strength with excellent resistance to corrosion in marine environment, highly suitable for welding.	Shipyard sheet and plate, naval and fast ship hulls, yacht hulls, LNG storage tanks, chemical equipment, welded superstructures (high strength), pressure vessels.	O H111 H112 H116 H321
5083 H128	High strength alloy with superior thermal stability preventing sensitization and exceptional resistance to corrosion and stress Corrosion (SCC) proven with extremely severe tests and conditions, highly suitable for welding.	Developed for US Navy against extreme environmental conditions and stresses due to natural thermal excursions, H128 is particularly indicated for hulls or unpainted decks.	H128
5456	Very high strength with excellent resistance to corrosion in marine environment, highly suitable for welding.	Shipyard sheet and plate, naval and fast ship hulls, yacht hulls, welded superstructures (high strength), allowing further weight reduction.	O H111 H112 H116 H321
5383	Very high strength with excellent resistance to corrosion in marine environment, highly suitable for welding.	Shipyard sheet and plate, naval and fast ship hulls, yacht hulls, welded superstructures (high strength), allowing further weight reduction.	O H111 H112 H116 H321

Dimensions

The dimensional limits of the products which can be supplied depend upon alloys and tempers. In the following table the absolute limits are given for indication only.

Product name	Tempers	Thickness (mm)		Width (mm)		Length (mm)	
		Min	Max	Min	Max	Min	Max
5083	H128	4	8	980	2500	1000	14000
5083 5086 5456 5383	0 – H111 H116 – H321	3	4	980	2200	1000	14000
		4	10		2500		
	0 – H111 H112	10	15	900	2400	1000	14000
		15	30		2500		
		30	40		2200		
		40	50		1600		
		50	60		1250		
		60	80		1000		
	H116 – H321	10	40	900	2200	1000	12000
		40	50		1520		
		50	60		1000		

Dimensional Tolerances

The allowed dimensional tolerances are in compliance with the limits provided by the applicable required standards (i.e., EN 485-3, EN 485-4, ANSI H35.2). Other sizes, thickness and tighter tolerances on request.

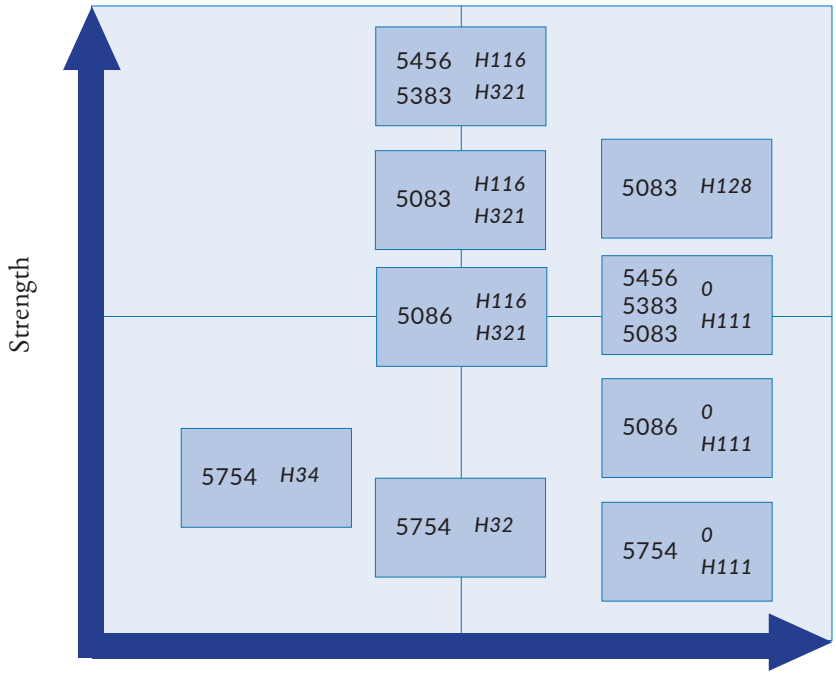
Corrosion Capability

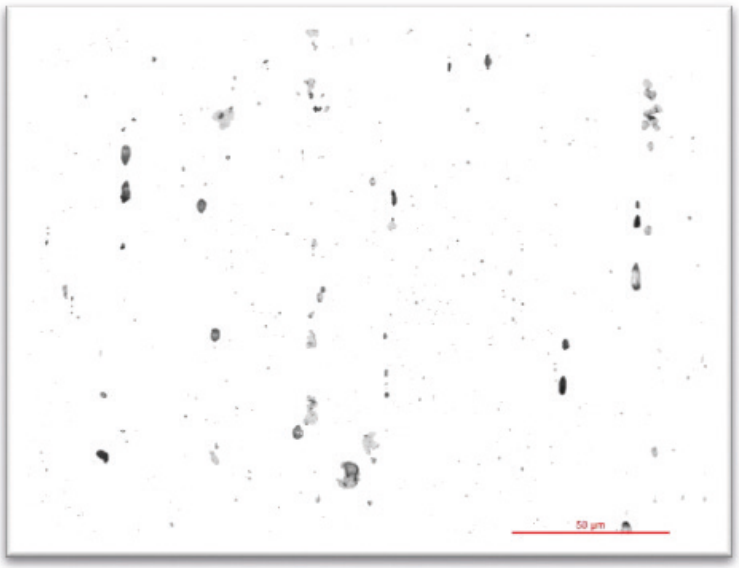
The excellent corrosion resistance of Nautic-Al alloys is one of their most important characteristics. Welds of these products are normally as corrosion resistant as the parent alloy. Under certain conditions such as exposure to high temperatures, alloys containing 3% or more of magnesium may become susceptible to intergranular corrosion and exfoliation corrosion, although the incidence is both rare and entirely preventable.

All Nautic-Al products meet or exceed the ASTM B928 standard for high magnesium aluminum-alloy sheet and plate for marine service and similar environments, and therefore meet the corrosion requirements of both the ASTM G66 (ASSET) test for assessing the susceptibility exfoliation corrosion of 5xxx Series aluminium alloys and the ASTM G67 (NALMT) test for determining the susceptibility of 5xxx Series aluminium alloys to inter-granular corrosion by mass loss after exposure to nitric acid. Additionally, to the corrosion tests, Nautical-Al products in H116, H321 and H128 are inspected with micrographic examination to verify the microstructure and grain boundaries distribution to establish a direct relation between microstructure and corrosion resistance, as required by ASTM B928 and by Classification Society Marine Rules. Corrosion Tests Results Reports and / or Micrographic Examination Reports are included in the certificates.

Corrosion Resistance and Strength

Marine Alloy selection guide





Example of microstructure of corrosion resistance consistent material. Absence of continuous network of precipitates at grain boundaries prevent starting and growth of intergranular corrosion.

Typical Technological Properties

WELDING CAPABILITY

Alcoa Nautic-Al marine aluminium can be welded by TIG, MIG, Electron Beam or Spot welding. The mechanical properties in the heat-affected zone after welding* for marine sheet and plate alloys are summarized below:

Alloy	Temper	Thickness (mm)	Rm (MPa)	Rp,02 (MPa)
5052	0	All	≥ 165	≥ 65
	H111			
5754	0	All	≥ 190	≥ 80
	H111			
5154A	0	All	≥ 215	≥ 85
	H111			
5086	0	All	≥ 240	≥ 100
	H111			
	H112			
	H116			
	H321			
5083	0	All	≥ 275	≥ 125
	H111			
	H112			
	H116			
	H321			
	H128			
5456	0	All	≥ 285	≥ 125
	H111			
	H112			
	H116			
	H321			
5383	0	All	≥ 285	≥ 135
	H111			
	H112			
	H116			
	H321			

* Butt joint welding. 5356 or 5183 filler.

Certifications

When materials are specified for marine use, and when applicable, they are supplied according to ASTM B928, ASTM B209 standards or upon request to ABS, Bureau Veritas, Det Norske Veritas, Lloyd's Register, RINA and other rules.

Certification body	Alloy Class designation	Temper	Max approved Thickness (*)	Material specification	Certification procedure	Inspection document
American Bureau of Shipping ABS	AB 5083	0 - H111 - H112 (*)	60 mm	ABS Rules	ABS Quality Assurance Program	According to EN10204 3.2 + ABS Cover
		H116 - H321				
		H128	8 mm	ASTM B928		
	AB 5086	0 - H111 - H112 (*)	50 mm	ABS Rules		
		H116 - H321				
	AB 5456	H116 - H321	40 mm	ABS Rules		
	AB 5383 (**)	0 - H111	50 mm	DNV-GL Rules		
		H116 - h321				
Bureau Veritas BV	5083	0 - H111 - H112 (*)	60 mm	BV Rules	BV Mode I	According to EN10204 3.2 + BV Cover
		H116 - H321				
		H128	8 mm	ASTM B928		
	5456	H116 - H321	50 mm	BV Rules		
	5383 (**)	0 - H111 H116 - 321	50 mm	DNV-GL Rules		
Det Norske Veritas Germanischer Lloyd DNV GL	VL-5052	H32 - H34	10 mm	DNV-GL Rules	DNV Manufacturer Survey Arrangement	According to EN10204 3.2
	VL-5754	0 - H111	50 mm			
		H32 - H34	10 mm			
	VL-5154A	0 - H111	10 mm			
	VL-5086	0 - H116	50 mm			
	VL-5456	H116 - H321	50 mm			
	VL-5083	0 - H111 - H112 (*)	60 mm			
		H116 - H321				
		H128	8 mm	ASTM B928		
	VL - 5383	0 - H111	50 mm	DNV-GL Rules		
		H116 - H321				
Lloyds Register LR	5083	0 - H111 - H112 (*)	60 mm	LR Rules	Material Quality Scheme	According to EN10204 3.2
		H321 - H321	40 mm			
		H128	8 mm	ASTM B928		
Registro Italiano Navale RINA	5083	0 - H111	40 mm	RINA Rules	Alternative Testing Scheme (COLALT)	According to EN10204 3.2
		H321 - H321	60 mm			
		H128	8 mm	ASTM B928		
	5456	H116 - H321	50 mm	RINA Rules		
	5383 (**)	0 - H111	50 mm	DNV-GL Rules		
		H116 - H321				

Certification body	Alloy Class designation	Temper	Max approved Thickness (*)	Material specification	Certification procedure	Inspection document
Nippon Kaiji Kyokai NKK	5083P	0 - H112 (*)	60 mm	NKK Rules	NKK Approval	According to EN10204 3.2 + NKK Certificate
		H16 - H321				
		H128	8 mm	ASTM B928		
	5083	H111	60 mm	EN-485-2		
		H32		EN 485-2 (≥ 40 mm)		
				ASTM B209 (> 40 mm)		
Korean Register KR	5083P	H116	50 mm	KR Rules	Witness test	KR Certificate
	5083P	0 - H112 (*)	60 mm			
		H116 - H321				
		H128	8 mm	ASTM B928		
	5456P	H116 - H321	50 mm	KR Rules		
China Classification Society CCS	5083P	0 - H111 - H112 (*)	50 mm	CCS Rules	Witness test	CCS Certificate
		H116 - H321				

(*) Only from 8 mm
(**) Available from 2019 only

SLIM FUSINA

Via dell'Elettronica, 31
30176 Venezia VE, Italy

Tel. +39 041 2917111
info.fusina@slimalu.com

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