

STANDARD	SOPRAL ALUMINIUM ALLOYS	
ISO : - EN : - DIN : -		

1. Scope and field of application

These specifications apply to mechanical fasteners (mainly bolts, screws, nuts and washers) made from aluminium alloys of the manufacturer's trade mark SOPRAL as indicated in section 10.

This information contains manufacturer's data having no relationship with DIN 267 Part 18.

The very extensive field of application may be derived from the following specific features:

- high mechanical properties, SOPRAL P 60 is about comparable with the steel property class 5.8 and the stainless steel property class 50 and about 35% stronger than brass. So it is very suitable in the aluminium structural joints.
 - light weight (one-third the weight of steel and stainless steel), which, besides its use in the aircraft and space industry is becoming increasingly important in the vehicle and transport industry, shipbuilding etc.
 - adequate corrosion resistance in sea climate among other things, so it has many maritime applications.
 - very resistant at extremely low temperatures. The mechanical properties even increase at -196 °C, which is very attractive in the cryogenic industry.
 - good thermal conductivity (13 x higher than stainless steel, 4 x higher than steel and 60% of that of copper), so it is applicable in the industry of heat exchangers, air conditioning, radiators, etc.
 - the electrical conductivity is, on basis of equal weight, twice that of copper.
- Also through its non-magnetizability, this material is used very frequently in the electrical industry.
- decorative colour which can be varied by anodic coatings.
- Together with a high reflectivity these properties find application in buildings and in the lighting, telecommunication and general decoration industry.
- non-toxic, so it is applicable in installations and equipment in the agriculture and food industry.

2. Materials

In our delivery programme we carry 6 SOPRAL material grades on stock:

SOPRAL P40. This is an aluminium- magnesium- silicon alloy for bolts, screws and nuts for general applications, not requiring very high mechanical properties, but requiring optimal corrosion resistance.

SOPRAL P60. This aluminium- zinc- magnesium alloy for bolts, screws, nuts and spring washers has increased mechanical properties with a well balanced corrosion resistance. This is the favourite grade for load transmitting bolts and nuts in aluminium structural joints.

This type is frequently used in electric power plants and electric transport systems and meet the strict regulations according to the French technical specification No. 15-SE-565 (1983) of the EDF (Electricité de France).

SOPRAL P65, a similar alloy to P60, but somewhat stronger, used exclusively for screws.

SOPRAL A-G3M, an aluminium- magnesium alloy for washers, which in combination with P60 have to be used on the nut side.

SOPRAL A5, pure aluminium with $\geq 99\%$ aluminium, is used for general purpose washers.

2030 (Dural), an aluminium grade for the small nut sizes M3, M4 and M5.

3. Chemical composition

Material Grade	Heat treatment *	Chemical composition in %								corresponding designations				
		Si	Fe	Cu	Mn	Mg	Cr	Zn	Al	Germany		unified numbering system (USA)	France	
										Werkstoff nr.	DIN		new	old
SOPRAL P40	T8	0,3-0,7	0,5	0,1	0,03	0,35-0,8	-	0,1	rem.	3.3207	Al Mg Si 0,5	6101		A-GS
SOPRAL P60	T73	0,4	0,5	1,2-2	0,3	2,1-2,9	-	5,1-6,1	rem.	3.4365	Al Zn Mg Cu 1,5	7075		A-Z5GU
SOPRAL P65	T6													
SOPRAL A-G3M	H26	0,4	0,5	0,1	0,1-0,5	2,6-3,6	0,1	0,2	rem.	3.3535	Al Mg3	5754		A-G3M
SOPRAL A5	-	0,25	0,4	0,05	0,05	0,05	-	0,05	rem.	3.0255	AAL 99,5	1050A		A5
2030 (Dural)	-	-	-	3,5-4,5	-	0,5-1,3		Pb 0,8-1,5	rem.	3.1645	AlCuMgPb	2030		A-U4Pb

* Heat treatment (Temper)

T 6 = solution heat-treated, artificially aged.

T 8 = solution heat-treated, cold-worked and artificially aged.

T 73 = solution heat-treated, tempered at + 108 °C and tempered again at + 177 °C (over-aged), see clause 9.

H26 = 3/4 hardness by cold-working and partially annealing.

4. Mechanical properties¹⁾

Material grade	Tensile strength N/mm ²	0,2% Yield limit N/mm ²	Elongation %	Brinell ²⁾ hardness HB	Modulus ³⁾ of elasticity N/mm ²
SOPRAL P40	300-350	260-300	8-10	95-105	67.000
SOPRAL P60	490-560	420-480	11-15	154-169	72.000
SOPRAL P65	550-600	490-530	12-15	160-180	72.000
SOPRAL A-G3M	min. 200	-	-	-	71.000
SOPRAL A5	min. 100	-	-	-	69.000
2030 (Dural)	min. 390	-	-	-	-

1) the mechanical properties may vary according to size.

2) the Brinell hardness is only as a reference and can easily be used to distinguish between two aluminium grades and especially to be able to check whether the heat treatment has been carried out properly.

3) these values are the average of the tensile and compression moduli.

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5. Physical properties

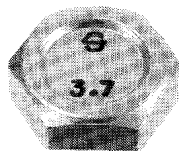
Material grade	Specific weight g/cm ³	Electrical resistance at 20 °C Ohm mm ² /m	Thermal conductivity at 20 °C th cm ² /ms °C	Linear coefficient of expansion between 20 and 100 °C	Melting range °C
SOPRAL P40	2,7	0,0325	0,44	23 x 10 ⁻⁶	615 - 655
SOPRAL P60	2,8	0,055	0,29	27,5 x 10 ⁻⁶	475 - 635
SOPRAL P65	2,8	0,61	0,29	23,5 x 10 ⁻⁶	475 - 635

6. Pre-loads and tightening torques

Nominal size		M3	M4	M5	M6	M8	M10	M12	M16	M20	M24	M27	
Pre-load in N	SOPRAL P60					8000	14000	21000	40000	62000	100.000	130.000	
Tightening torque in Nm	SOPRAL P40	min.	-	0,9	1,6	2,7	7,5	14	28	-	-	-	
		max.	-	1,1	1,9	3,3	8	17	32	-	-	-	
	SOPRAL P60	min.	-	-	-	-	8	15	30	65	110	200	300
		max.	-	-	-	-	10	20	40	90	150	280	400
	SOPRAL P65	min.	0,5	1,3	2,5	4,4	11	-	-	-	-	-	-
		max.	0,6	3,16	3	5	12,5	-	-	-	-	-	-

These tightening torques are based on a friction coefficient of $\approx 0,05$.
Torquing on the minimum values with a torque wrench is preferred.
The maximum values shall never be exceeded.
This table serves only as a reference, for which no liability is accepted.

7. Marking



The hexagon bolts -grade SOPRAL P60- are marked on the head with the manufacturer's mark S for SOPRAL and the digit combination 3.7.
The first digit 3 identifies the special heat treatment T 73.
The second digit 7 indicates that grade P60 is made from the aluminium alloy 7075.
These marks are according to the specifications of the EDF (Electricité de France).
All other aluminium fasteners are not marked.

8. Surface treatment and colour

SOPRAL P40 for common use is delivered untreated. The colour is silver-white.

On request these fasteners can be pickled and greased with lanoline for easier assembly and disassembly, or anodized and greased with lanoline for difficult usage conditions, or colour anodized for decoration.

SOPRAL P60 is anodized (thickness of layer: 8-12 microns), bichromated and grease impregnated according to the specifications of the EDF (Electricité de France). In this condition an optimal corrosion resistance and ease of assembling are obtained. In the case of strong dynamic loads is advisable to request P60 without grease impregnation. The colour is yellow.

SOPRAL P65 are supplied colourless anodized. For decoration the screws are chemically brightened and/or colour anodized.

9. Corrosion resistance

Because of the automatic restoration of a thin self-protecting layer of aluminium oxide the SOPRAL grades offer an effective to excellent resistance to attack by the atmosphere, industry and sea water.

In this respect P40 is most favourable.

The majority of chemicals have no effect. However strong bases with a pH > 10, e.g. sodium and potassium, and concentrated acids with a pH < 4, e.g. hydrochloric and sulphuric acid, have to be avoided.

SOPRAL P60 has undergone a special heat treatment T 73 (see clause 3) providing an optimal resistance to intergranular and stress corrosion in aggressive environments and making it immune to exfoliation corrosion type.

When aluminium, in the presence of a conducting liquid, comes in contact with another more electropositive metal e.g. steel, stainless steel, copper, it will corrode. On the other hand, when in contact with more electronegative metals, e.g. magnesium, zinc etc., then these will be corroded, thus protecting the aluminium.

To prevent contact corrosion it is advisable to use aluminium fasteners in aluminium constructions.

10. Weldability

You are strictly advised against performing welding on P60 and P65 bolts and nuts; the heat generation during welding has the effect of totally or partially destroying the mechanical properties acquired by the heat treatment.

SOPRAL P40 can be welded using all normal methods.

STANDARD	PLASTICS	
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1. Polyamide PA 6-6 (nylon)

1.1 Scope and field of application

These specifications apply to mechanical fasteners (mainly bolts, screws and nuts) made from **thermoplastic** polyamide PA 6-6 - often called nylon- of the manufacturer's trade mark PLASTIVIS as indicated in section 10.

- The field of application extends to nearly all sectors of industry, where low strength is not detrimental, but the following other performance properties may be attractive:
- rust-proof under atmospheric influences, humidity, soft and sea water. No danger of rust or seizing.
 - chemical-resistant to usual solvents e.g. acetone, alcohol, petrol, benzol, trichlorethylene and to oil, grease, bases and most diluted acids. Not resistant to concentrated acids. See the chemical corrosion table elsewhere in this section.
 - not toxic and so applicable in the food industry.
 - electrically and thermally insulating.
 - not magnetizable, which is important in the electrotechnical industry.
 - light in weight, about 7 times lighter than steel and even about 2 1/2 times lighter than aluminium, so an ideal material for all applications where light weight plays an important role.
 - self-locking against loosening; no rattling joints.
 - esthetical performance. The standard colour is natural white. On request other colours can also be manufactured in order to harmonize it with whatever it is used with.
 - auto-extinguishable according to the American specification ASTM D 635.

1.2 Mechanical properties

tensile strength	53 N/mm ²	acc. to ISO 527
shear strength	54 N/mm ²	acc. to ASTM D 732
Shore hardness	7,5 N/mm ²	acc. to ISO 868

	M 3	M 4	M 5	M 6	M 8	M 10	M 12
breaking loads in N	200	400	700	1000	2000	2500	4000
tightening torques in Nm	0,13	0,35	0,6	1,27	3,91	6,8	

These are theoretical values determined in the laboratory at 60% relative humidity and 23 °C. The mechanical properties will decrease with increasing temperature and humidity. You are advised to take your own tests, depending on the real circumstances.

1.3 Chemical properties (see table on next page)

1.4 Physical properties

density	1,14 g/cm ³	acc. to ISO R1183

humidity absorption cold water	1,3 - 1,4%	acc. to ISO 62
humidity absorption hot water	1,95%	acc. to ISO 62

1.5 Thermal properties

fusion point	255 °C
normal use temperature	-20 to 100 °C
peak use temperature	150 °C

linear expansion coefficient	11 x 10 ⁻⁵ per °C	acc. to ASTM D 696
combustability	V 2	acc. to UL 94

1.6 Electrical properties

transversal resistance	10 ¹¹ ohm cm
dielectric rigidity	24,7 kV/mm

conductivity resistance	300 V	

1.7 Tolerances on dimensions

screwthread		
	external thread	internal thread
major diameter	8 e	2 x 7G
minor diameter	2 x 8g	7H
effective diameter	2 x 8g	2 x 7H
pitch	± 5%	

For all other dimensions the tolerances indicated in DIN 267 Part 2 and DIN ISO 4759 have to be doubled.

For more technical data see VDI-Richtlinien 2544 "Fasteners made from thermoplastics".

2. Phenolformaldehyde FS 31 (bakelite)

FS 31 is a heat treatable **duroplastic** on the base of phenolformaldehyde-resin with wood flour as a filler, often also called bakelite.

In the designation FS 31 the letters FS are an abbreviation of the German word "Formstoff", the number 31 identifies the type of filler material, in this case wood flour in the phenoplastic mass.

FS 31 belongs to group 1 of the phenoplastics, used for general applications e.g. the plastic ball knobs, star grips, hand wheels, knurled thumb screws and hand knobs in section 10. Some of the most important properties are:

Density DIN 53479 g/cm ³	Tensile strength DIN 53455 N/mm ²	Bending strength DIN 53452 N/mm ²	Shock resistance DIN 53453 kJ/m ²	Impact strength DIN 53457 kJ/m ²	Form stability DIN 53458 °C	Temperature range °C	Water absorption DIN 53472 mg	Surface resistance DIN 53482 Ohm	Transversal resistance DIN 53482 Ohm . cm	Disruptive strength DIN 53481 kV/mm
1,4	min. 25	min. 70	min. 6	min. 1,5	min. 125	-40/+ 100	max. 150	10 ⁸	10 ¹⁰	15 - 20

For more technical data see DIN 7708.

PLASTICS



STANDARD

ISO : -
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CHEMICAL PROPERTIES OF PA6-6

- 1 good
2 moderate (swelling and/or decrease of properties)
3 bad

CHEMICAL AGENT	CONCENTRATION IN %	resistance at		CHEMICAL AGENT	CONCENTRATION IN %	resistance at	
		Temp. 23°C	Temp. 100°C			Temp. 23°C	Temp. 100°C
acetic acid	10	2	3	mineral oils		1	1
acetic acid	30	3	3	monochloric acetic acid	10	3	
acetic acid	90	3	3	nitric acid	0,1	2	
acetone		1		nitric acid	5	3	3
aluminium chloride	10	1		nitric acid	45	1	2
ammonia gas		2	3	oxalic acid	10	2	
ammonium chloride	35	1	2	ozone		3	
ammonium hydroxide	40	1		perchlorethylene		1	3
aniline		3		perchloric acid	10	3	
benzene		1		petrol		1	
benzene carbon acid	conc.	3		petroleum oil		1	
calcium chloride	10	1	2	petrolic ether		1	
calcium chloride	saturated	2	3	phenol		3	
chlorine water	normal	2		phosphoric acid	0,3	1	
chlorine water	10	3		phosphoric acid	3	2	
chloroform		3		phosphoric acid	10	3	3
chrome alun	10	1		potassium hydroxide	10	1	
citric acid	10	2		potassium hydroxide	50	2	
citric acid	conc.	2		potassium nitrate	10	1	
copper sulphate	saturated	1		potassium permanganate	1	3	
copper sulphate	0,5	2		pyridine		1	
cresol		3		pyrocatechol	norm.	3	
cyclohexanol		2		resorcinol		3	
ether		1		silicone oils		1	
ethylacetate		1		soap	norm.	1	
ethylalcohol	96	1		sodium acetate	5	1	
ethylenedichloride		1		sodium bisulphate	20	1	2
ferrichloride	2,5	2	3	sodium carbonate	saturated	1	
ferrichloride	5	2		sodium chloride	5	1	2
ferrichloride	10	3		sodium dichromate	10	1	
formaldehyde	30	1		sodium hydroxide	10	1	
formic acid	2	2		sodium hydroxide	50	2	
formic acid	10	3		sodium mono sulphide	2	1	
formic acid	90	3		sodium silicate	saturated	1	
glycerol, glycol		1	3	sodium sulphate	10	1	
hydrochloric acid	2	2	3	sulphuric acid	6	3	
hydrochloric acid	10	3		sulphuric acid	100	3	
hydrogen peroxide	0,5	2		tetrachlor methane		1	
hydrogen peroxide	1	3		toluene		1	
lactic acid	90	3		trichlorethylene		1	2
magnesium chloride	10	1		vegetable oils		1	1
maleic acid	conc.	3		water		1	2
malonic acid	conc.	3		wine	1	1	
manganic sulphate	10	1		xylene			
mercuric chloride	verz.	2		zinc chloride	10	2	
mercuric chloride	10	2					
methanol	95	1					