EURAL
GNUTTI S.p.A.

## 2033 & 2077 & 6026$^{LF}$ by Eural

# LEAD FREE

Free-Cutting Aluminium Alloys

## HOW TO MACHINE

**USEFUL TIPS FOR EXCELLENT PERFORMANCES**

### COMMON ALUMINIUM ALLOYS

- Many machine stops required to clean working area
- Poor yield / productivity
- Higher production costs
- Machines busy for longer periods

### FREE-CUTTING ALUMINIUM ALLOYS

- 24hr machining with limited supervision by operators
- More parts in less time / increased productivity
- Reduced production costs
- Machines available for additional orders

## FREE-CUTTING ALUMINIUM ALLOYS by Eural

# 2033 & 2077 & 6026$^{LF}$
# LEAD FREE

### HOW TO ACHIEVE SMALL CHIPS WITH **LEAD FREE** ALLOYS by Eural

Achieving small chips during machining is the result of four factors:

**1.** Raw material quality
**2.** Lubricants & coolants
**3.** Inserts
**4.** Machining parameters

All the above are equally important.

The following provides a short and useful guide on how to achieve the best results from machining alloys 2033 & 2077 & 6026$^{LF}$ **LEAD FREE** by Eural.

# 1. RAW MATERIAL QUALITY

The choice and quality of raw material is crucially important as several factors contribute to the determination of a bar that can create a small chip.

**Chip breaking elements**: they are low-melting temperature intermetallic elements. If properly sized and distributed in the alloy, they represent an element of discontinuity which, thanks to their different response to the heat generated by the friction of machining tools, ensure the breaking of the chips.

These elements are:
- **LEAD** (Pb)
- **TIN** (Sn)
- **BISMUTH** (Bi)

These elements can be present in all free-cutting alloys, either individually or in combination.

For years, lead has been the subject of attention by European regulatory bodies as it is considered dangerous for human health and for the environment. For this reason EURAL has developed **LEAD FREE** aluminum alloys.
EURAL also decided not to use tin (Sn) as due to its brittle nature, it melts at a relatively low temperature (160°C) and can generate porosity and weakness in machined parts.


# 2. LUBRICANTS & COOLANTS

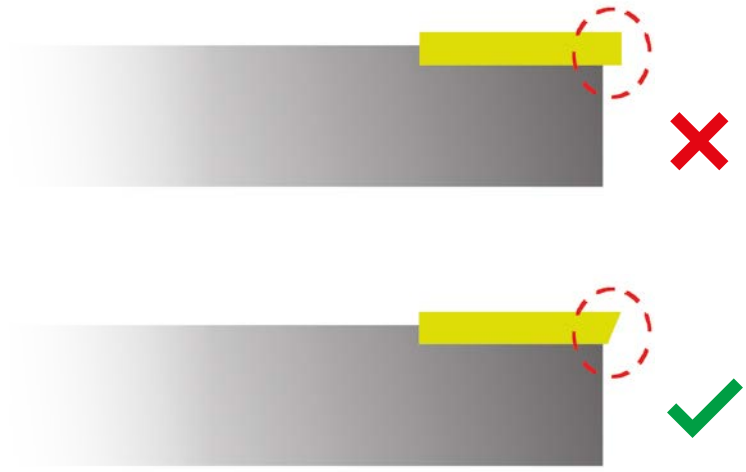
The role of lubricants and coolants is critical for machining performance.

Eural recommends to use pure oil whenever possible. The use of the emulsion may negatively influence the chip formation and breaking therefore it would be necessary to reduce the cooling percentage by increasing the quote of oil.

The appropriate lubricant should facilitate the efficient evacuation of chips and clearing of the working area.
An excessive presence of water however could increase the cooling effect limiting a proper heat propagation, which is necessary for the low-melting elements to break the chip.

# 3. INSERTS

## TORNITURA - TURNING - DREHEN - TOURNAGE - TORNEADO



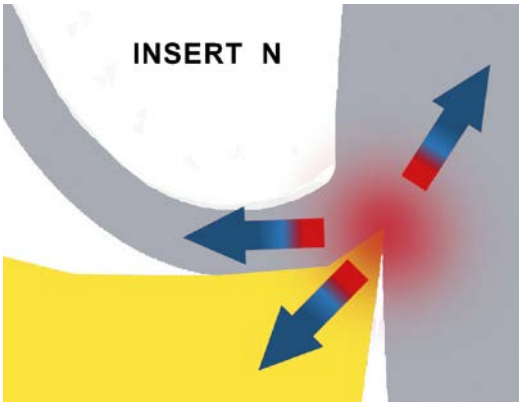
The offer of tools for machining aluminum is rather modest and in many cases are not suitable for extruded and drawn bars in aluminium alloys.

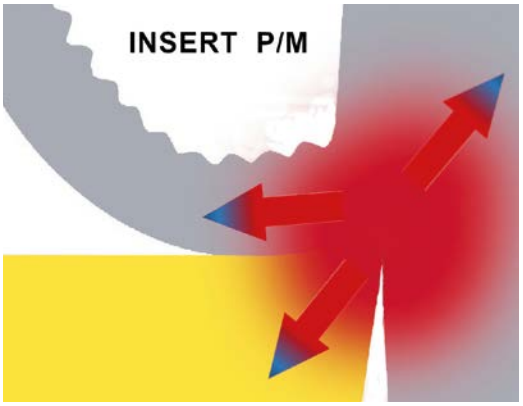
Eural recommends for turning operations on our **LEAD FREE** alloys:
- positive turning inserts
- inserts for steel and stainless steel (P/M)

### POSITIVE INSERTS
(type B / C 5-7° as per ISO 1832)

- lower cutting forces and vibrations
- better finishing

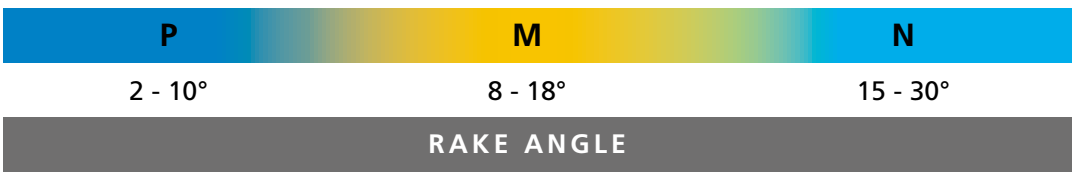
### RAKE ANGLE
The best rake angle is the one that allows a greater and more homogeneous distribution of the heat generated during turning. If it is well distributed between the part, the insert and the chip, it will enable the chip to break into small fragments.




The inserts commonly called N and designed specifically for machining aluminium have a rake angle that does not allow an appropriate and sufficient distribution of heat during turning. Therefore, chip breaking is compromised, forming long and curled chips.

The P / M inserts, which should be more suitable for machining steel and stainless steel, are perfect for turning **LEAD FREE** aluminum alloys bars by Eural.
The heat generated by the friction of the tool is greater and well distributed, facilitating the breaking of the chips into small pieces.



## TORNITURA - TURNING - DREHEN - TOURNAGE - TORNEADO

With the same machining parameters, here below we show how the chip changes on **LEAD FREE** alloys by Eural according to the type of inserts used.

| | |
|---|---|
| **Cutting speed ( $v_c$ )** | 200 m/min |
| **Feed rate ( $f$ )** | 0.2 mm/rev |
| **Depth of cut ( $a$ )** | 1 mm |

### MACHINING INSERTS

| N (non-ferrous metals) | M (stainless steels) | P (steels) |
|---|---|---|
|  |  |  |
|  |  |  |
|  |  |  |

**2033**
**by Eural**

**LEAD FREE**

**2077**
**by Eural**

**LEAD FREE**

**6026$^{LF}$**
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**LEAD FREE**

| EURAL RECOMMENDS | |
|---|---|
| ROUGHING / MEDIUM TURNING | P / M |
| FINISHING | M |

## FORATURA - DRILLING - BOHRUNG - FORAGE - BARRENADO

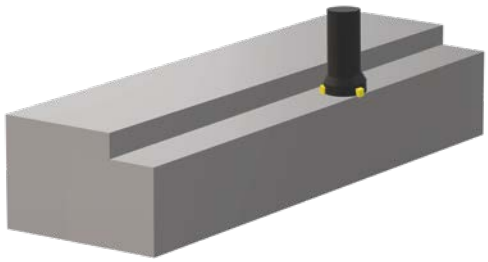
**LEAD FREE** alloys by Eural demonstrate excellent characteristics for drilling performance allowing significantly higher feed rates.

**Cutting speed ( $v_c$ )** 150 - 600 m/min

**Feed rate ( $f$ )** 0.2 - 0.8 mm/rev

Eural recommends, when possible, the use of indexable insert drills because, as for turning, they leave the freedom to mount the most suitable ones for an adequate chip evacuation and therefore better overall performance.

## FRESATURA - MILLING - FRÄSEN - FRAISAGE - FRESADO



Face and profile milling performance are never a big issue when machining aluminium alloys.

The advantage of **LEAD FREE** alloys by Eural is mostly with side milling or making closed slots thanks to its excellent chip forming attitude and easy evacuation.

For good results, Eural recommends the use of suitable lubricants and coolants.

# 4. MACHINING PARAMETERS

**LEAD FREE** alloys by Eural allow to increase machining parameters and to reduce cycle times, without losses on machinability and part finishing.

| | | |
|---|---|---|
| **TURNING** | $v_c$ | 150 - 600 m/min |
| | $f$ | 0.15 - 0.8 mm/rev |
| **DRILLING** | $v_c$ | 150 - 600 m/min |
| | $f$ | 0.2 - 0.8 mm/rev |
| **MILLING** (Face & side milling) | $v_c$ | 150 - 300 m/min |
| | $f_z$ | 0.08 - 0.45 mm/tooth |
| **MILLING** (closed slots) | $v_c$ | 250 - 2.000 m/min |
| | $f_z$ | 0.08 - 0.3 mm/tooth |

*(general parameters)*

$v_c$ - *cutting speed*
$f$ - *feed rate*
$f_z$ - *feed rate per tooth*

## 2033 LEAD FREE by Eural

| Properties | T3/T6 | T8 |
|---|---|---|
| Machinability | ■■■■ | ■■■■ |
| Protective anodizing | ■■ | ■■ |
| Decorative anodizing | ■■ | ■■ |
| Hard anodizing | ■■ | ■■ |
| Resistance to atmospheric corrosion | ■■ | ■■ |
| Resistance to marine corrosion | ■ | ■ |
| MIG-TIG weldability | ■ | ■ |
| Friction stir weldability (FSW) | ■■■ | ■■■ |
| Brazing weldability | ■ | ■ |
| Plastic formability when cold | ■■ | ■ |
| Plastic formability when hot | ■■ | ■■ |

| Chemical composition | |
|---|---|
| Si | 0,10 ÷ 1,20 |
| Fe | ≤ 0,70 |
| Cu | 2,20 ÷ 2,70 |
| Mn | 0,40 ÷ 1,00 |
| Mg | 0,20 ÷ 0,60 |
| Cr | ≤ 0,15 |
| Ni | ≤ 0,15 |
| Zn | ≤ 0,50 |
| Ti | ≤ 0,10 |
| Sn | ≤ 0,05 |
| Bi | 0,05 ÷ 0,80 |
| Others | Each.0,05 – Tot.0,15 |
| Al | Rem. |

**Production program**

| Unit / mm | ● | ■ | ▬ | ⬣ |
|---|---|---|---|---|
| Drawn | 6 ÷ 76,2 | 10 ÷ 65 | Thick. 12 ÷ 55 | 10 ÷ 63,5 |
| Extruded | 30 ÷ 254 | 30 ÷ 165 | Thick. 30 ÷ 127 | - |

**Minimum mechanical properties**

| | | Ø mm | Rm MPa | Rp0,2 MPa | A% | HBW Typical |
|---|---|---|---|---|---|---|
| Drawn | T3 | ≤ 30 | 370 | 240 | 7 | 95 |
| | T3 | 30 < D ≤ 80 | 340 | 220 | 7 | 95 |
| | T351 | ≤ 80 | 370 | 240 | 5 | 95 |
| | T8 | ≤ 80 | 370 | 270 | 8 | 95 |
| Extr. | T6 | ≤ 80 | 370 | 250 | 8 | 95 |
| | T6 | 80 < D ≤ 250 | 340 | 220 | 8 | 95 |

## 2077 LEAD FREE by Eural

| Properties | T4 | T6 |
|---|---|---|
| Machinability | ■■■■ | ■■■■ |
| Protective anodizing | ■■ | ■■ |
| Decorative anodizing | ■■ | ■■ |
| Hard anodizing | ■■ | ■■ |
| Resistance to atmospheric corrosion | ■■ | ■■ |
| Resistance to marine corrosion | ■ | ■ |
| MIG-TIG weldability | ■■ | ■■ |
| Friction stir weldability (FSW) | ■■■ | ■■■ |
| Brazing weldability | ■ | ■ |
| Plastic formability when cold | ■■ | ■ |
| Plastic formability when hot | ■■■ | ■■ |

| Chemical composition | |
|---|---|
| Si | 0,40 ÷ 1,00 |
| Fe | ≤ 0,70 |
| Cu | 4,00 ÷ 5,00 |
| Mn | 0,60 ÷ 1,20 |
| Mg | 0,60 ÷ 1,20 |
| Cr | ≤ 0,20 |
| Ni | ≤ 0,20 |
| Zn | ≤ 0,25 |
| Ti | ≤ 0,15 |
| Ag, Li, Zr | Each. ≤ 0,15 |
| Bi | 0,20 ÷ 0,90 |
| Others | Each. 0,05 - Tot. 0,15 |
| Al | Rem. |

**Production program**

| Unit / mm | ● | ■ | ▬ | ⬣ |
|---|---|---|---|---|
| Drawn | 10 ÷ 76,2 | To be defined | To be defined | To be defined |
| Extruded | 30 ÷ 254 | 50 ÷ 165 | Thick. 30 ÷ 127 | - |

**Minimum mechanical properties**

| | | Ø mm | Rm MPa | Rp0,2 MPa | A% | HBW Typical |
|---|---|---|---|---|---|---|
| Drawn | T6/T651 | ≤ 80 | 480 | 400 | 5 | 130 |
| Extruded | T4/T4511 | ≤ 75 | 400 | 270 | 10 | 105 |
| | T4/T4511 | 75 < D ≤ 150 | 390 | 260 | 9 | 105 |
| | T4/T4511 | 150 < D ≤ 200 | 370 | 240 | 8 | 105 |
| | T4/T4511 | 200 < D ≤ 254 | 360 | 220 | 7 | 105 |
| | T6/T6511 | ≤ 150 | 455 | 380 | 5 | 130 |
| | T6/T6511 | 150 < D ≤ 200 | 420 | 280 | 8 | 120 |
| | T6/T6511 | 200 < D ≤ 254 | 400 | 270 | 8 | 110 |

## 6026$^{LF}$ LEAD FREE by Eural

| Properties | T4 | T8/9 |
|---|---|---|
| Machinability | ■■■ | ■■■ |
| Protective anodizing | ■■■ | ■■■ |
| Decorative anodizing | ■■■ | ■■■ |
| Hard anodizing | ■■■■ | ■■■■ |
| Resistance to atmospheric corrosion | ■■■ | ■■■ |
| Resistance to marine corrosion | ■■ | ■■ |
| MIG-TIG weldability | ■■■ | ■■■ |
| Friction stir weldability (FSW) | ■■■ | ■■■ |
| Brazing weldability | ■■ | ■■ |
| Plastic formability when cold | ■■ | ■■ |
| Plastic formability when hot | ■■■ | ■■■ |

| Chemical composition | |
|---|---|
| Si | 0,60 ÷ 1,40 |
| Fe | ≤ 0,70 |
| Cu | 0,20 ÷ 0,50 |
| Mn | 0,20 ÷ 1,00 |
| Mg | 0,60 ÷ 1,20 |
| Cr | ≤ 0,30 |
| Ni | - |
| Zn | ≤ 0,30 |
| Ti | ≤ 0,20 |
| Sn | ≤ 0,05 |
| Pb | ≤ 0,05 (tracce) |
| Bi | 0,50 ÷ 1,50 |
| Others | Each. 0,05 - Tot. 0,15 |
| Al | Rem. |

**Production program**

| Unit / mm | ● | ■ | ▬ | ⬣ |
|---|---|---|---|---|
| Drawn | 6 ÷ 76,2 | 10 ÷ 65 | Thick. 12 ÷ 55 | 10 ÷ 63,5 |
| Extruded | 30 ÷ 254 | 50 ÷ 165 | Thick. 30 ÷ 127 | - |

**Minimum mechanical properties**

| | | Ø mm | Rm MPa | Rp0,2 MPa | A% | HBW Typical |
|---|---|---|---|---|---|---|
| Drawn | T6 | ≤ 80 | 370 | 300 | 8 | 95 |
| | T8 | ≤ 80 | 345 | 315 | 4 | 95 |
| | T9 | ≤ 80 | 360 | 330 | 4 | 95 |
| Extruded | T6 | ≤ 140 | 370 | 300 | 8 | 95 |
| | T6 | 140 < D ≤ 250 | 340 | 250 | 8 | 90 |
| | T6 | 200 < D ≤ 250 | 300 | 200 | 8 | 90 |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