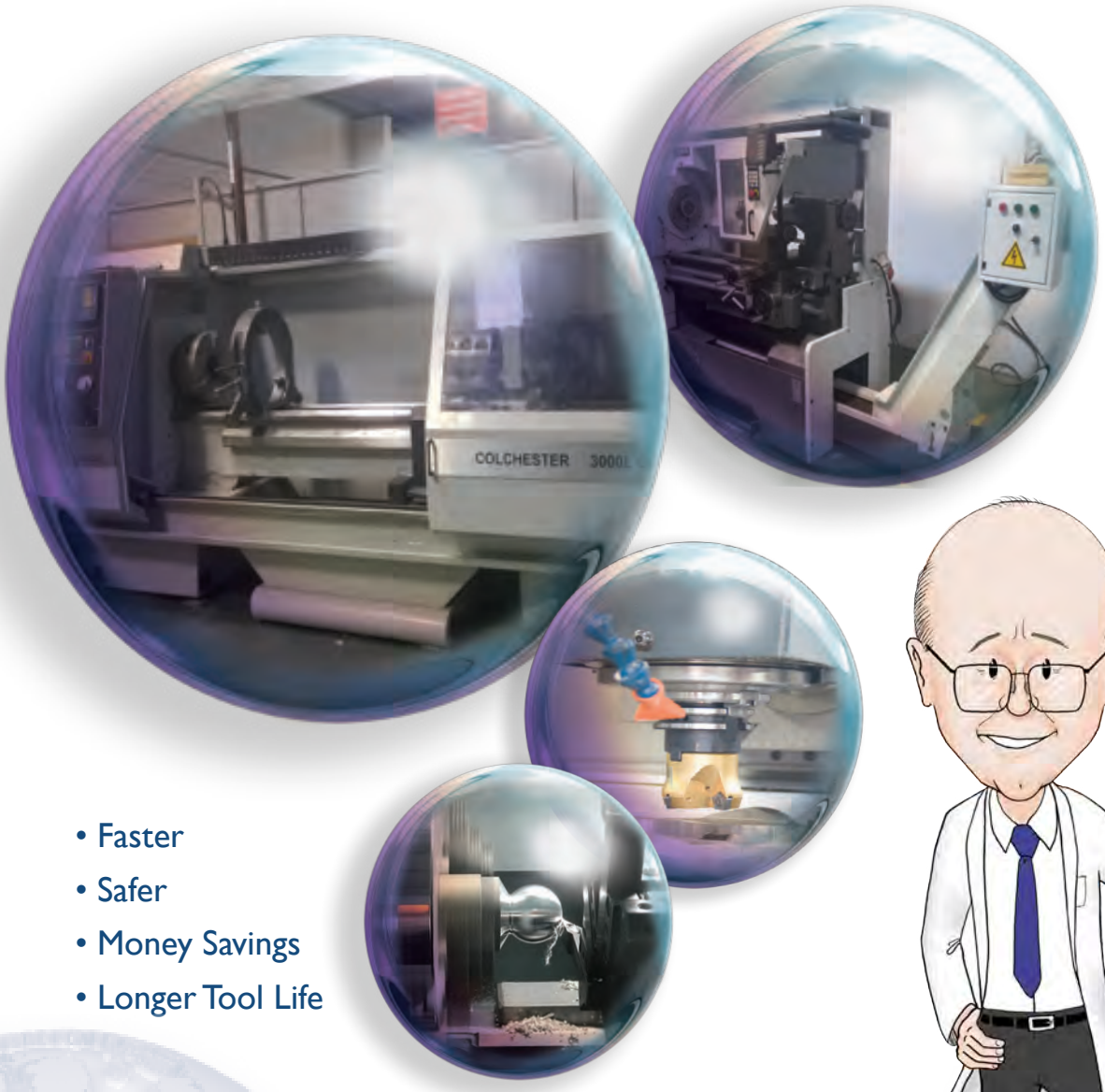
LUXFER®
MAGNESIUM
ROLLED PRODUCTS

AN INTRODUCTION TO

MACHINING MAGNESIUM



- Faster
- Safer
- Money Savings
- Longer Tool Life


Longer Tool Life


Faster


Safe

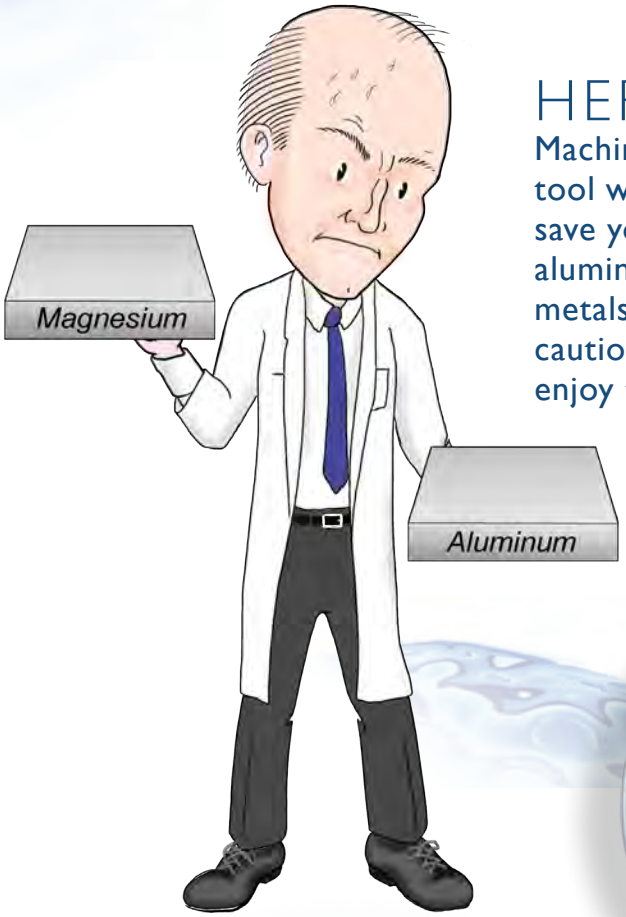

Excellent Finish

Magnesium Machining

DID YOU KNOW MAGNESIUM IS THE LIGHTEST AND EASIEST MACHINABLE OF ALL STRUCTURAL METALS?

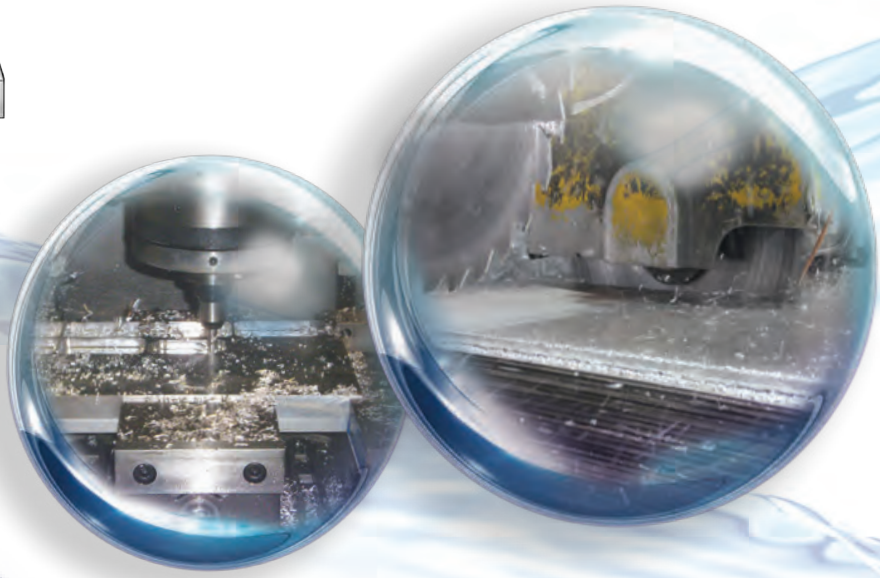
33% LIGHTER THAN ALUMINUM

75% LIGHTER THAN STEEL



HERE'S WHY

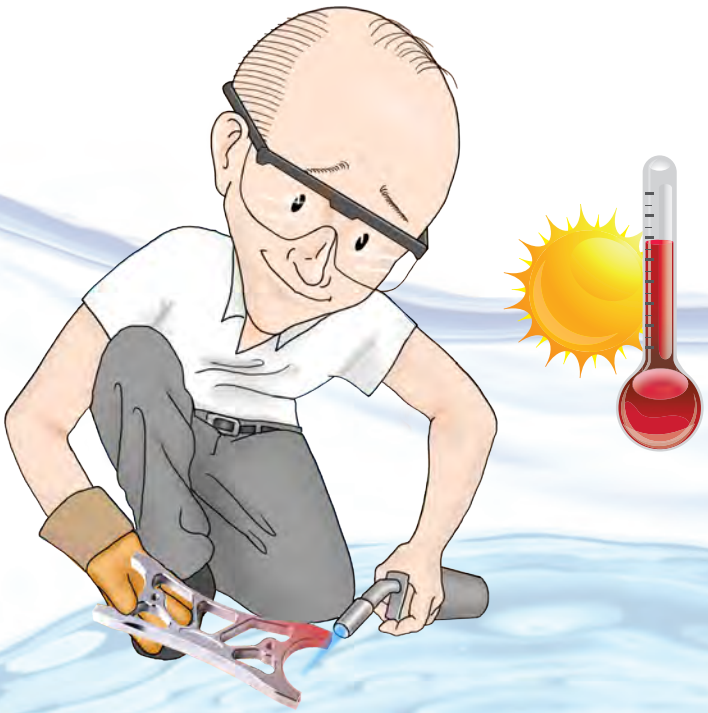
Machining magnesium is only limited to the speed of the tool which is doing the cutting. Machining magnesium will save you time, cost, and improve production compared to aluminum, steel, titanium and any other metal. Like other metals magnesium must be machined by using certain pre-cautions. Once these precautions are understood you can enjoy the benefits of machining magnesium.



Metal	Turning Rough m/mm	Turning Finish m/mm	Drilling (5 - 10mm drill) m/mm	Milling 100mm miller 1mm cut m/mm
Magnesium	Up to 1200	1800 - 2400	150 - 500	200 - 500
Aluminum	75 - 750	120 - 1200	60 - 400	200 - 300
Steel	40 - 200	60 - 300	15 - 30	20 - 25
Cast Iron	30 - 90	60 - 120	10 - 40	15 - 20

SOLID MAGNESIUM PARTS ARE EXTREMELY DIFFICULT, IF NOT IMPOSSIBLE TO BURN

Many misconceptions exist about the flammability of magnesium alloys and the fire hazards associated with their machining and use in applications with elevated temperatures.



Magnesium engine blocks used in automotive applications perform at temperatures of 212°F (100°C).

Rotorcraft transmission housings made from magnesium see temperatures exceeding 250°F (121°C).

Magnesium sand castings used in military fighter jet applications see temperatures exceeding 350°F (176°C).

Magnesium tooling plate is thermally flattened in ovens reaching temperatures of 700°F (371°C) and heat-treatable magnesium alloys go through a heat treat cycle in excess of 950°F (510°C).

In order to get solid magnesium components to burn they must reach a melting point of 1202° F (650°C) and the entire component must be saturated with heat.

The mass of the magnesium component withdraws the heat of combustion dropping the metal below the temperature of ignition. A propane torch does not have enough heat to ignite a large magnesium component. Even aimed at the corner, the heat is quickly distributed through the rest of the component and dissipated before ignition can begin.

With a higher heat source a large component may ignite locally but high thermal conductivity of magnesium will ensure rapid cooling and prevent the fire from spreading. When the heat source is removed the magnesium fire will be self extinguishing.

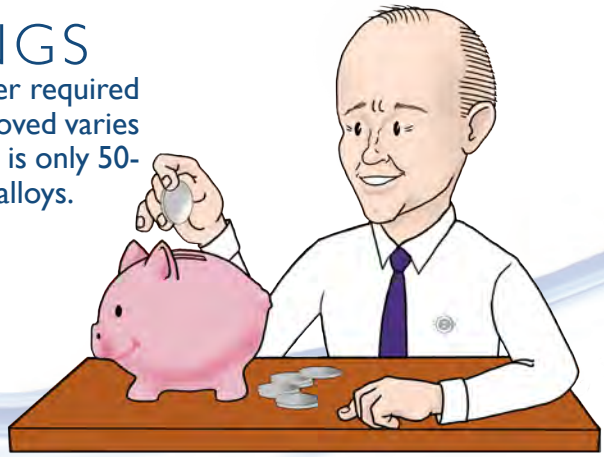
On the other hand, very fine dust and chips are highly flammable and can easily be ignited by spark, match or flame; therefore they must be handled with greater care. Due to the small size of the chip, heat cannot be conducted away. This results in the chip melting and catching on fire. The heat generated is then sufficient to ignite the neighboring chips and combustion spreads from chip to chip. Should fire occur, the developed white light sometimes alarms people unfamiliar with this effect. Properly handled chip fires are quite harmless. The turnings burn slowly and evenly provided they are dry.

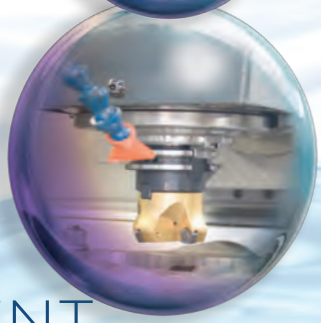
MACHINING

Metal	Relative Power
Magnesium	1.0
Aluminum	1.8
Brass	2.3
Cast Iron	3.5
Mild Steel	6.3
Titanium	7.6
Nickel	10.0

ENERGY SAVINGS

Depending on operation, the power required per cubic centimeter of metal removed varies from 9 to 14 watts per minute and is only 50-60% of that needed for aluminum alloys.



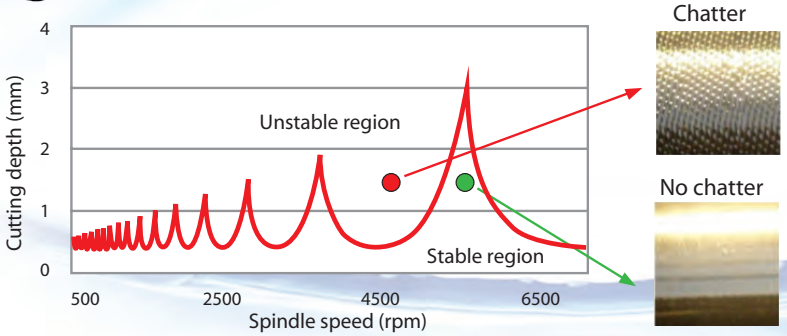


EXCELLENT SURFACE FINISH

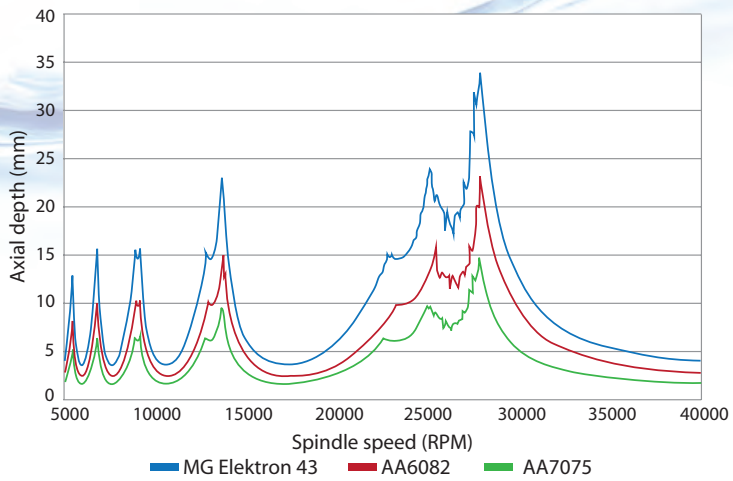
Extremely fine and smooth surface finish can be achieved. As most machinists understand the ability to obtain a good machined finish with no chatter in high speed cutting is dependent upon a number of factors including the resonant frequency of the tooling and the jigging arrangement.

LONGER TOOL LIFE

Standard cutting tools are suitable provided they are kept very sharp and with generous rake clearance angles. 5 to 10 times longer tool life can be expected over machining aluminum.



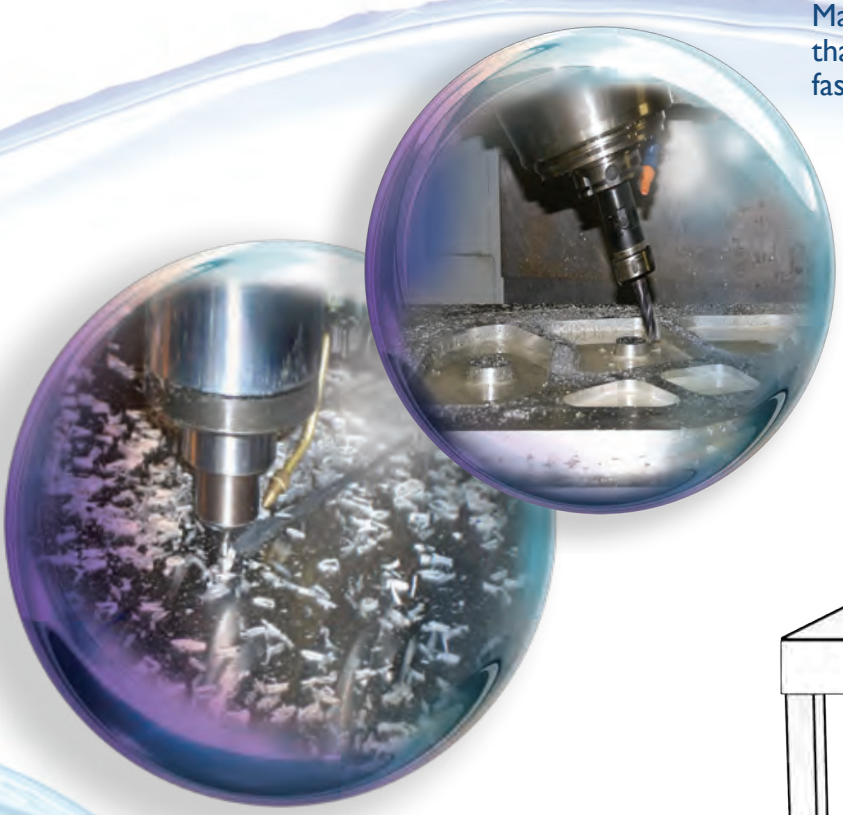
The Stability Lobe Diagram at right compares the cutting window available when using a 2 slot end mill to machine aerospace grade magnesium Elektron 43 with AW6082 and AW7075 wrought aluminium alloys. The absolute stability limit of Elektron 43 T5 is nearly 2.5 times higher than AW7075 T6, and it is clear that magnesium can be cut successfully with very high spindle speeds that exceed the capability of many CNC milling.

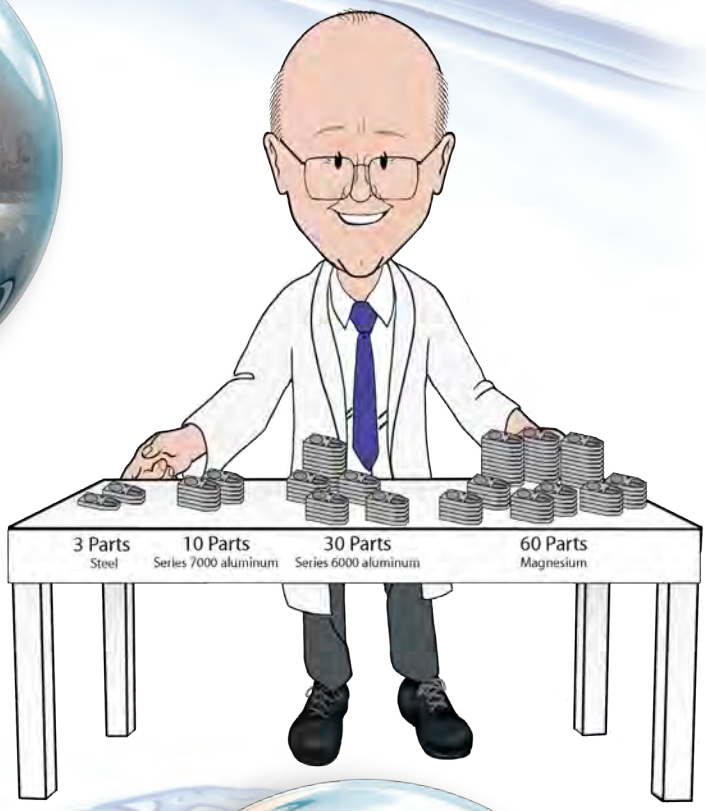


BENEFITS

FASTER MACHINING

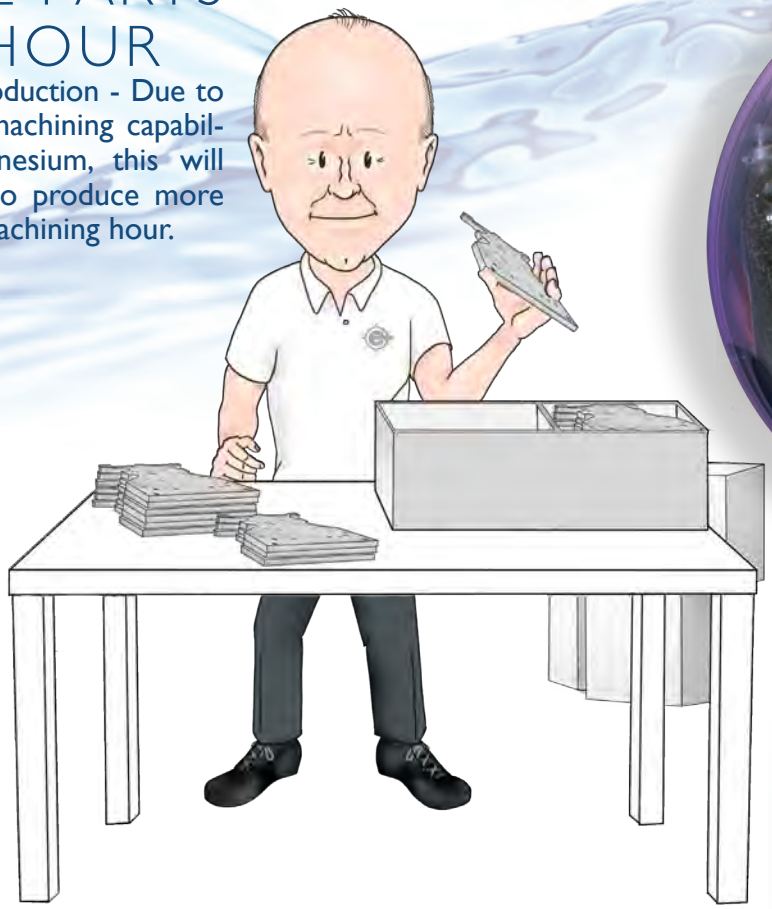
Magnesium alloys machine up to 40% faster than 6XXX series aluminum and up to 96% faster than 7XXX series aluminum.





MORE PARTS PER HOUR

Increase production - Due to the faster machining capability of magnesium, this will allow you to produce more parts per machining hour.



HOW TO

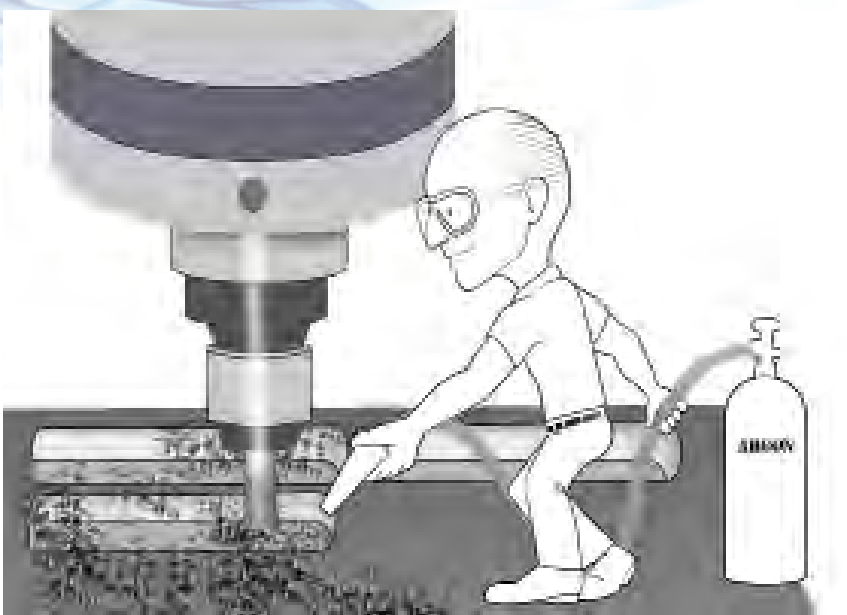
BENEFITS OF MACHINING DRY

Magnesium is an excellent material for machining dry. This is because of the low cutting pressures, free machining characteristics and high thermal conductivity. The high thermal conductivity allows heat to dissipate quickly through the part.

- Machining dry is easier, cleaner and more attractive. Using coolants, which add cost, require maintenance and can cause issues with chip storage.
- Dry magnesium chips can have value where wet and oily chips have very little, if any, economic value. Dry magnesium chips are also easier to transport.
- Dry machining chips are much easier to reclaim/recycle and also eliminate the chance of developing hydrogen gas. When machining dry, most machinists have way oil that keeps the machine moving smoothly on the ways. This heavy oil isn't a problem and can be used.

COOLING GASES

In addition to chip control and removal, compressed air, argon or nitrogen gas can be used to control temperature. The benefit of dry machining with gas is that the chips produced from the process are dry. This means storage and disposal are both safer and more economical than wet/oily chips.



MACHINE

MINERAL OIL

Mineral Oils (when coolant is needed) - When there is a chance of chip jamming in the machining operation, such as tapping, reaming for deep hole drilling, it is sometimes beneficial to use a coolant. Mineral seal oil and kerosene have been successfully used. Using mineral oils rather than emulsion type coolant has been shown to improve dimensional accuracy and surface quality in some machining operations. Although not as desirable as dry chips, chips that are covered in mineral oil are slight less of a problem compared to emulsion covered chips. This is due to the fact that no water is present in the oils and the chips will not give off a hydrogen by-product. Even so, it is recommended that the oil is removed from the chips before storage.

WATER MISCIBLE CUTTING FLUIDS

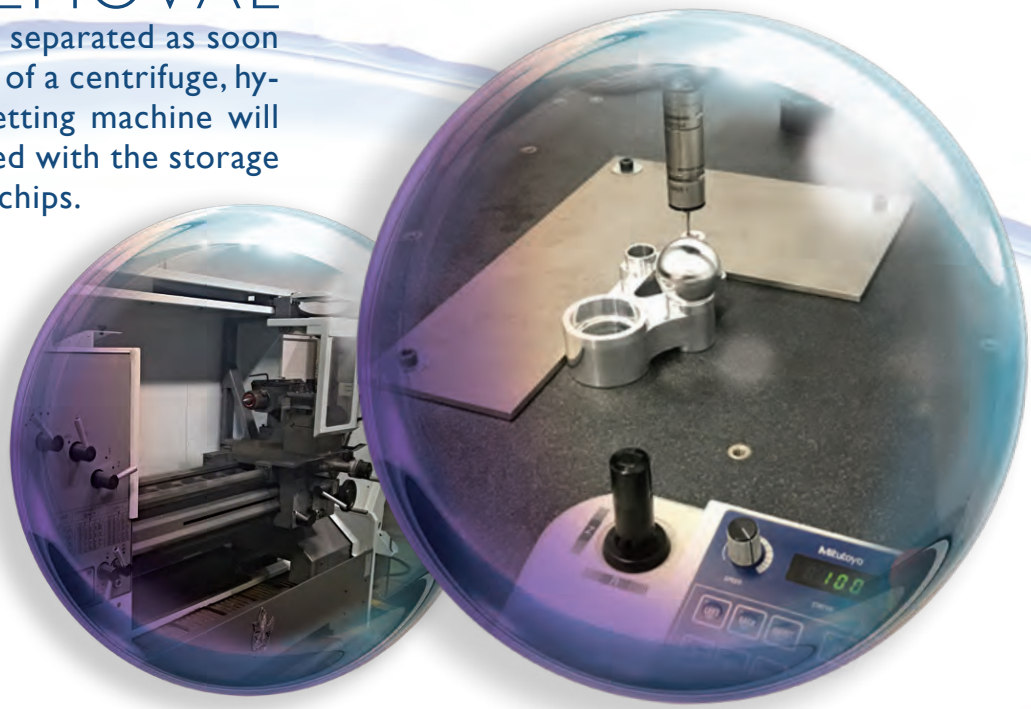
Traditionally, the use of water soluble oils and oil-water emulsions was not advised due to the risk of hydrogen gas development and the increased fire hazard should the chips ignite. However, developments in coolant technology have lead to a number of specified emulsions that are designed to deal with any hydrogen generation. Please consult with the coolant manufacturer if use on magnesium is acceptable. It is worth remembering that while cutting fluids may reduce the risk of fire during machining; they can cause problems during storage and recycling of chips. If machining with water-miscible cutting fluids, it is recommended that the area is well ventilated. MQL (minimum quantity lubrication) strategies may well be appropriate if suitable mist nozzles are available.

SAFETY, IT'S EASY

HERE ARE THE DO'S AND DON'T'S

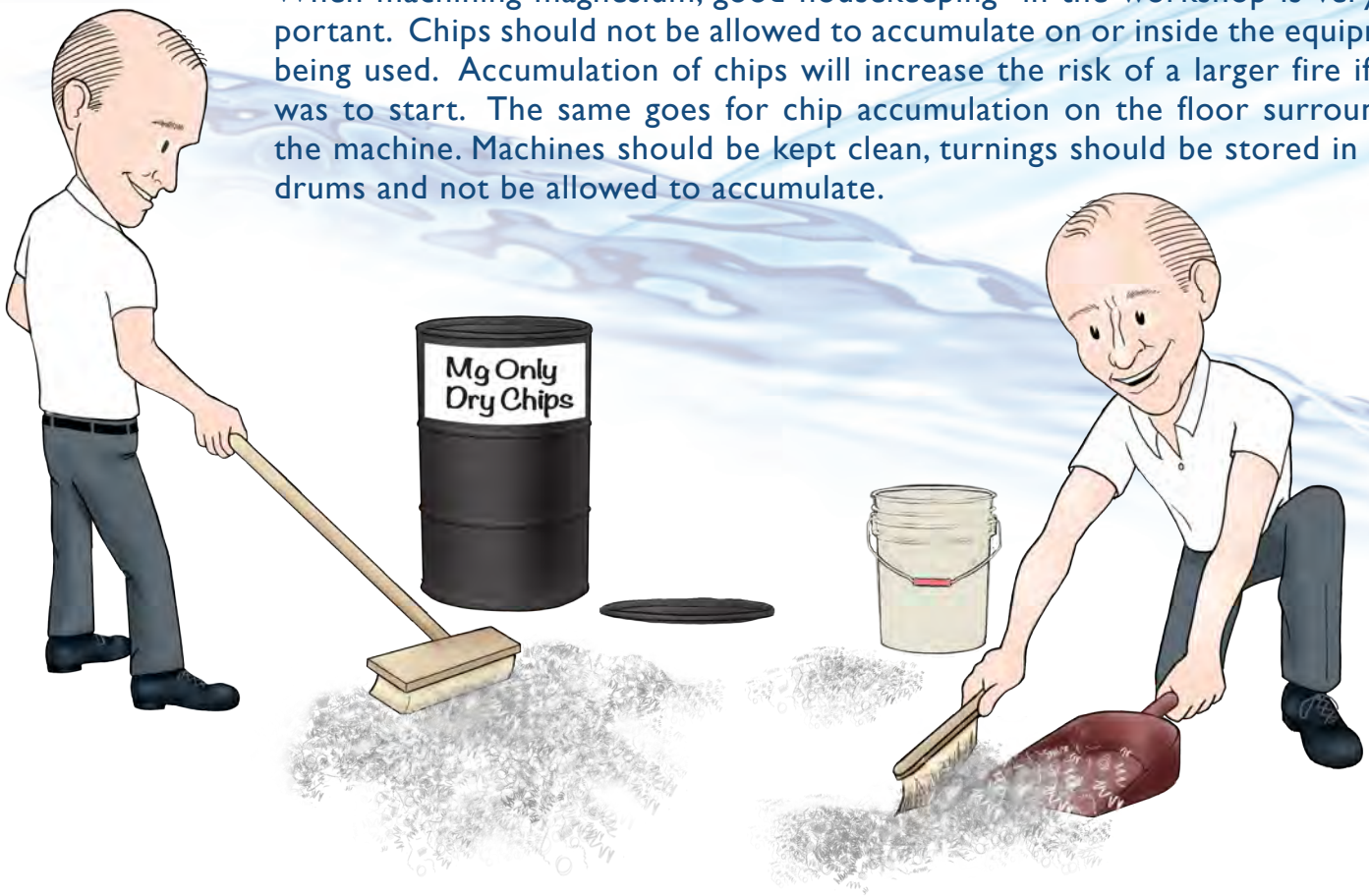
LUBRICANT REMOVAL

Fluid and chips ideally should be separated as soon as possible after machining. Use of a centrifuge, hydroclone, compaction or briquetting machine will help reduce the danger associated with the storage and handling of wet magnesium chips.



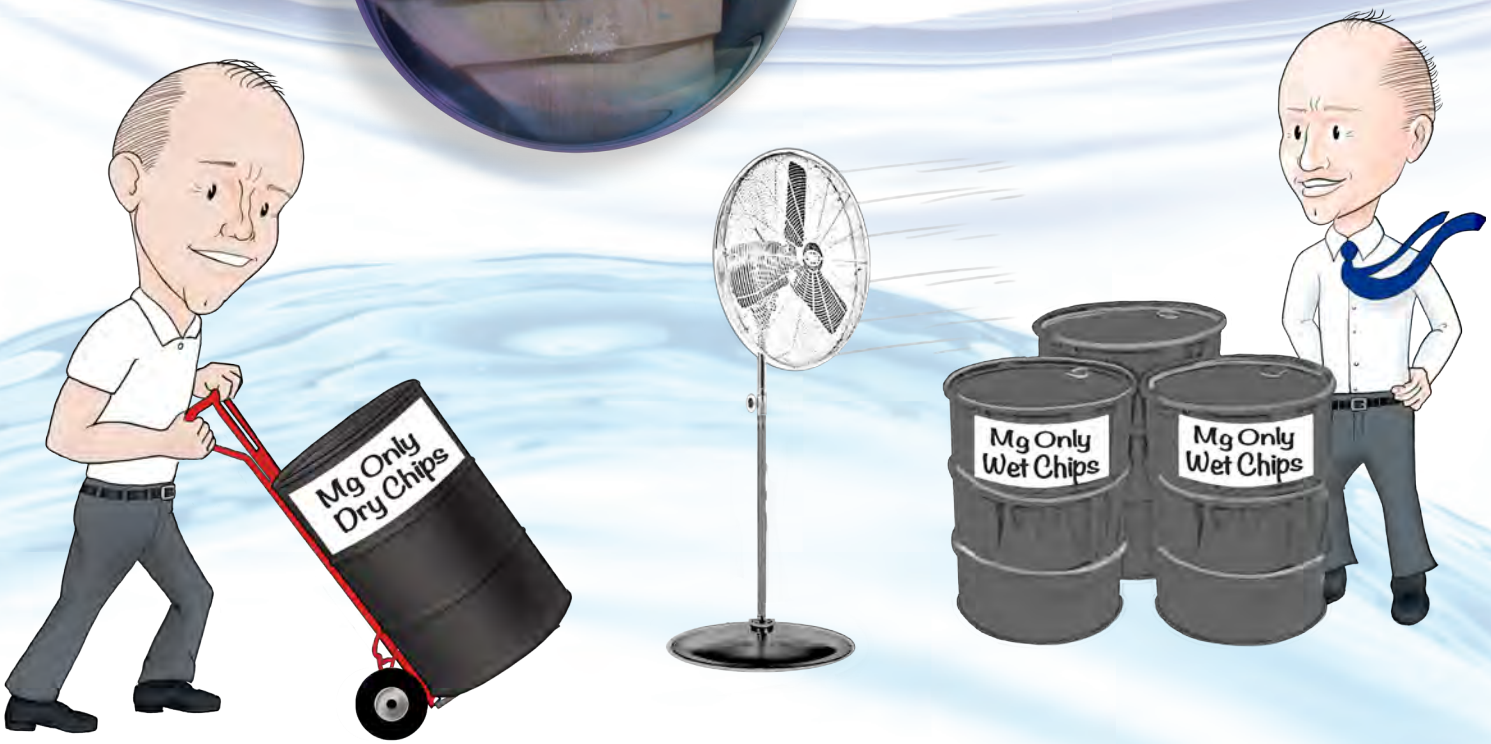
GOOD HOUSEKEEPING

When machining magnesium, good housekeeping in the workshop is very important. Chips should not be allowed to accumulate on or inside the equipment being used. Accumulation of chips will increase the risk of a larger fire if one was to start. The same goes for chip accumulation on the floor surrounding the machine. Machines should be kept clean, turnings should be stored in steel drums and not be allowed to accumulate.



SEGREGATION

It is important to segregate chips. Magnesium chips, rasping, and turning should never be mixed with chips of other types of material. Segregation of chips is crucial if any value is to be retained from recycling.



CHIP STORAGE

Chips should never be stored in sacks. Examples of suitable storage equipment are type 1A2 UN approved steel drums with removable lids.

• Wet/oily chips- These should be placed in covered but well ventilated non-combustible containers such as UN approved steel drums. Vents should allow hydrogen gas to escape and reduce the chance of buildup of pressure. The containers must be clearly labeled and stored in a remote location away from sources of ignition. Drums should not be stacked. The area must be well ventilated in order to avoid the buildup of hydrogen gas. Covered outdoor storage is preferred.

• Dry chips- These should be placed in dry, tightly closed, con-combustible containers such as UN approved steel drums. Safely stored, kept dry and clearly labeled. Storage should be in a dry atmosphere and in isolation from flammable materials. Chips covered in mineral oil can be stored the same way as dry chips.

MAGNESIUM

FIRE PRECAUTION

For magnesium to burn, it must reach its melting point of 650°C / 1202°F. Therefore, under normal machining practices, the chance of fire is virtually impossible.

Magnesium chips however can be ignited. All of these following precautions should be standard procedure to avoid the risk.

- Keep cutting tools sharp. Fires may be started from friction producing dust at the cutting edges of the tools.
- Use heavy roughing cuts where possible to produce a large chip.
- Machine dry if possible.
- Collect the turnings frequently and store in steel containers with lids.
- Keep the floor and all machines dry and free of turnings.
- Keep a suitable extinguisher on hand.
- Use non-ferrous metals as clamps to prevent sparks.

IS SAFE

NEVER USE WATER TO PUT OUT A FIRE

Should a fire occur, dry chips will burn slowly and evenly, but can flare up if disturbed. Fine chips will burn more quickly and vigorously. The way to tackle a magnesium fire is to cover and suppress rather than disturb the chips.

• DO NOT USE WATER TO PUT OUT A MAGNESIUM FIRE!!!!! Under no circumstance should water be applied to a magnesium fire. The presence of water will greatly accelerate combustion as burning magnesium will decompose water to form hydrogen, which is easily ignited.

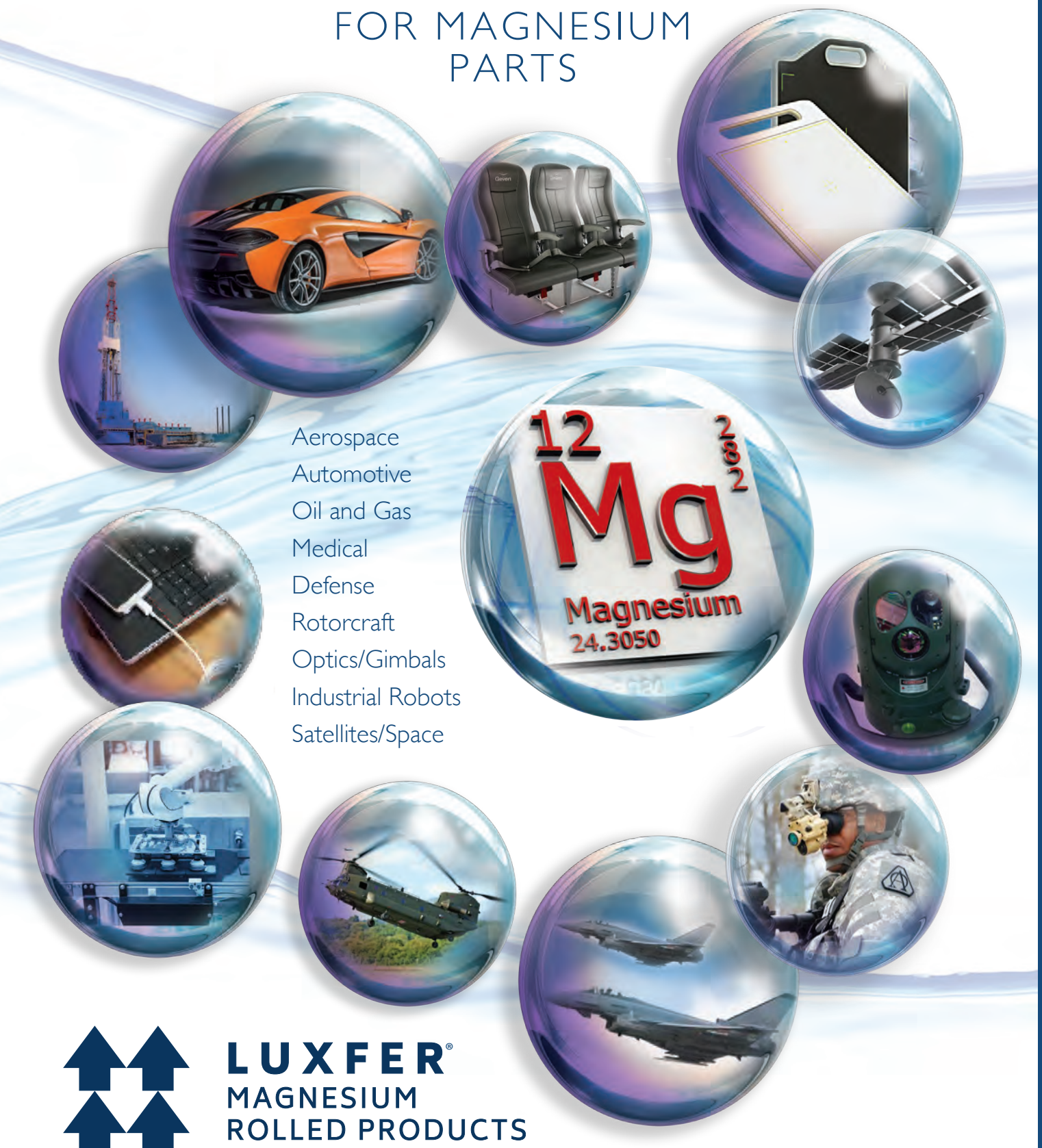
• Class D fire extinguisher- Potassium chloride fire extinguishing powder will quickly smother flames without damaging either the machinery or the non burning chips.

• G-1 Powder - Great smothering agent to put out small chip fires.

• Dry Sand - Sand can also be used as a smothering agent

• Argon - Argon gas can be used if applied by a purge system so that the fire is not disturbed or aggravated by high pressure gas bursts. This is limited to enclosed spaces.

OPPORTUNITIES FOR MAGNESIUM PARTS



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