

SF6 and Magnesium in Automotive Industry

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Int'l Conference on SF6

San Diego, CA

Nov 21-22, 2002

- **Mg applications**
- **SF6 and alternatives**
- **FMC's perspective and programs**

Why Magnesium?

- Reduce dependence on imported oil
- Improve driving affordability

Fuel Economy

- Federal & State
- Corporate Mandates
- Competitive Pressure

Emission Standards

- Federal & State Requirements

Safety

- Reduce Cg
- Brakes, Airbags
- Crash Structures

NVH

- Stiffness
- Insulation

Performance

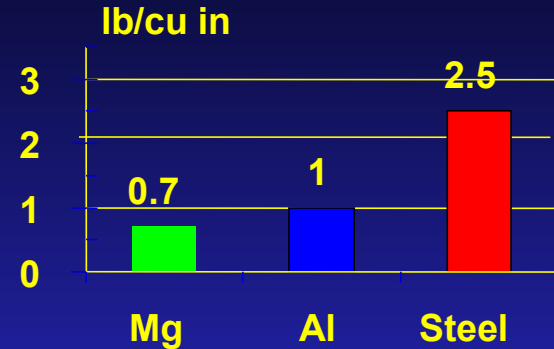
- 4W Drive
- Traction Control
- Powertrain Features

Heavy Extras

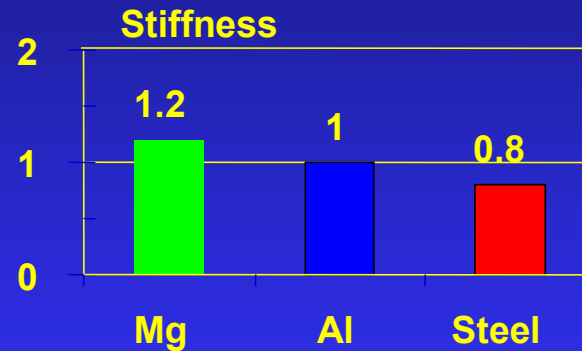
- Convertibles
- Power Accessories
- Electronic Devices

Material Comparison

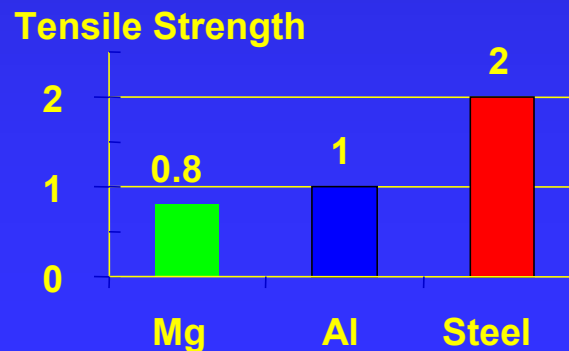
Light



Stiff



Strong



Magnesium Supply Base

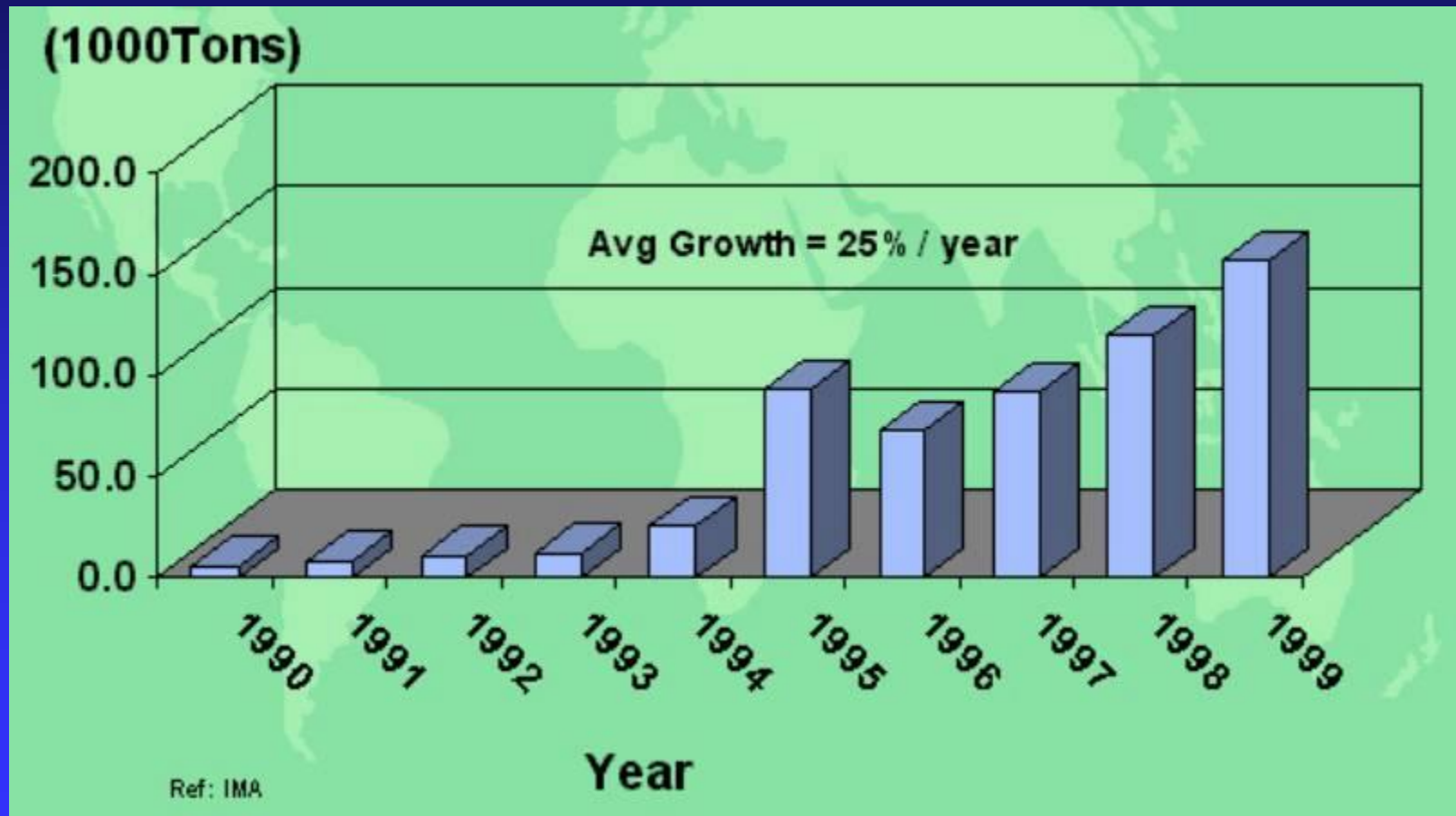
- Norsk Hydro, Norway & Canada
- US Magnesium, USA
- Timminco, USA
- Pechiney, France
- Brasileira de Magnésio, Brazil
- Dead Sea Magnesium, Israel
- Solikamsk, CIS
- Avisma, CIS
- Noranda, Canada
- Australia Magnesium Corp, Australia (2004)
- PRC, China

Total operating capacity 2000

380,000 tonnes

China Magnesium Production

– **the world's largest producer**

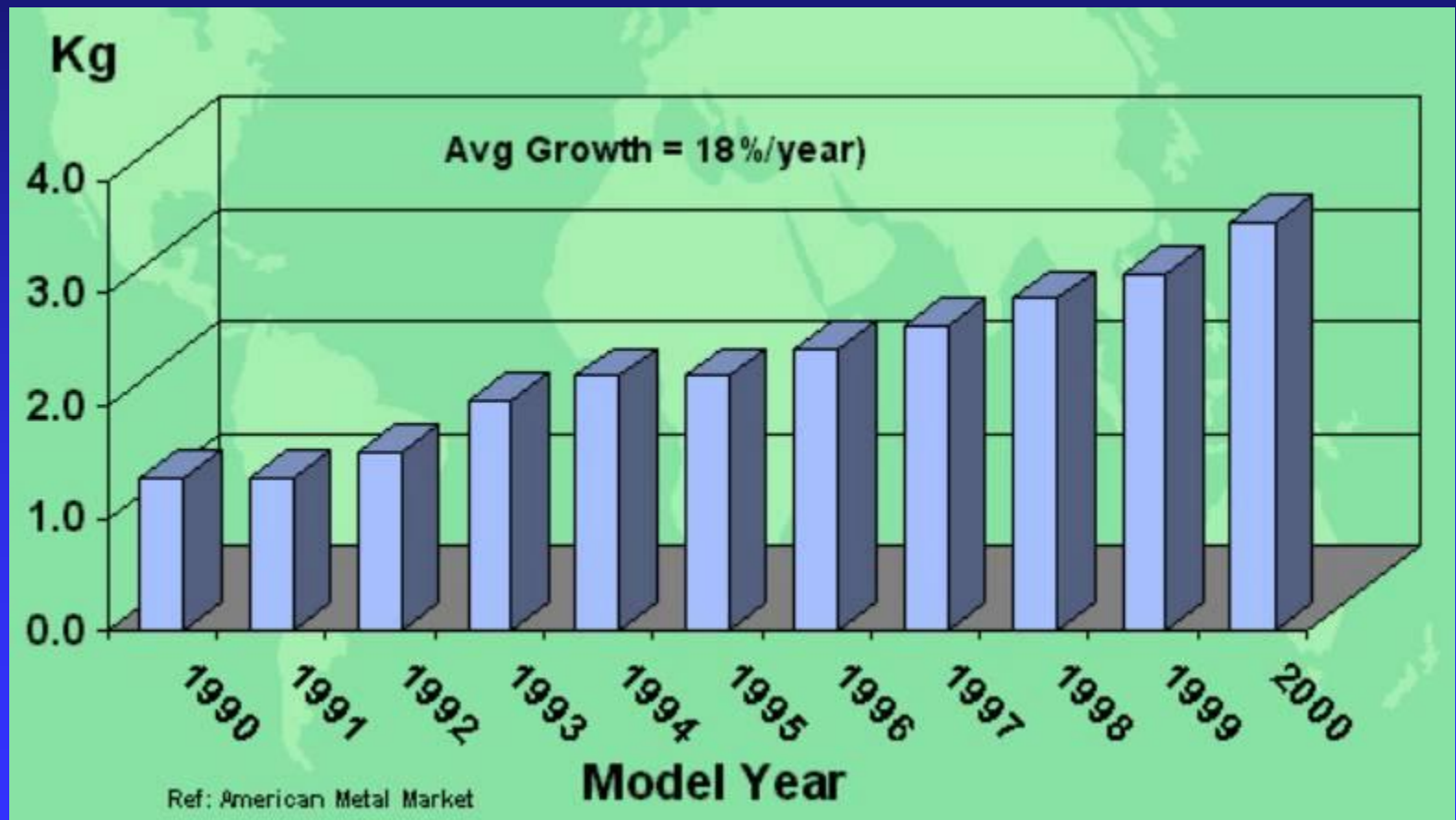


Average Magnesium Usage per Vehicle NA (Kilograms)

2000 MY (Kg)

Mg = 3.6

(Al = 111.6)

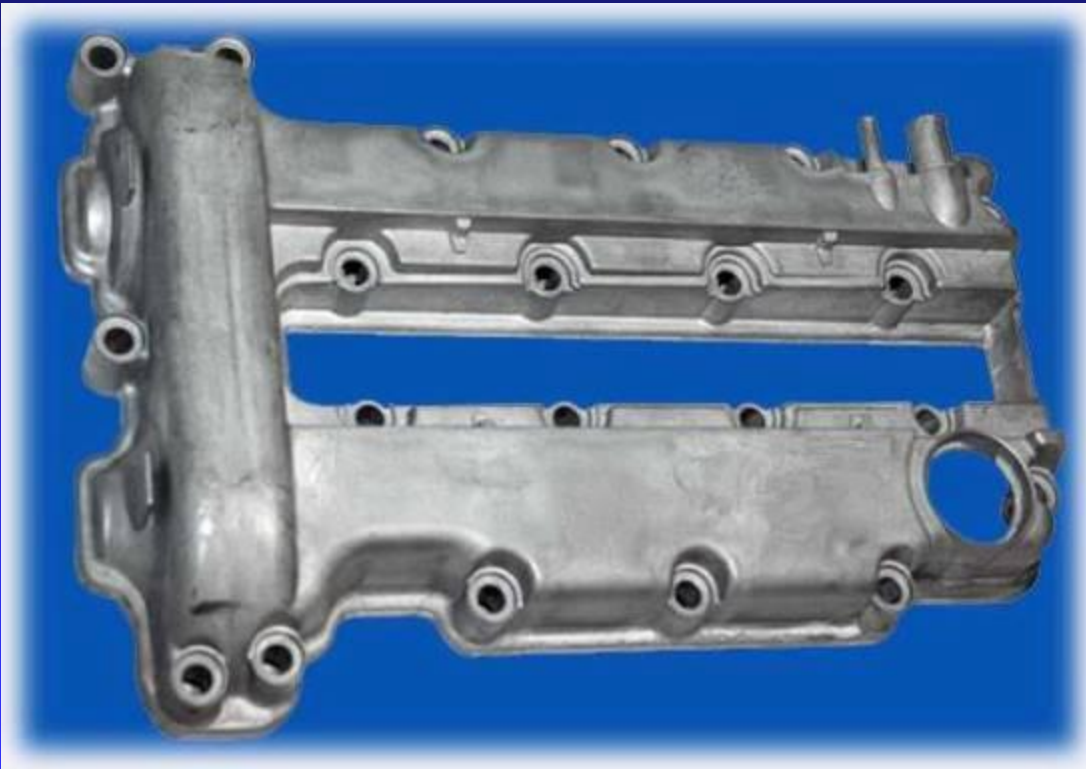


Potential Mass Reduction Opportunities with Magnesium

Subsystem	Potential replacement	Mass in Mg	Mass saved
Powertrain	88	58	30
Chassis	80	35	45
Body	12	5	7
Interior	31	21	10
Total (Kg)	211	119	92

•Based on P2000

•10/6 rule



Cam cover, AZ91D

450 x 185 x 60mm

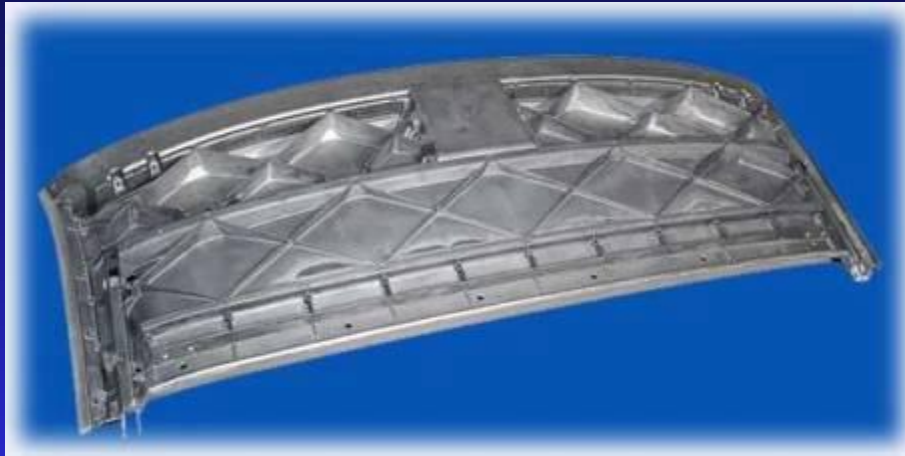
1.15 Kg



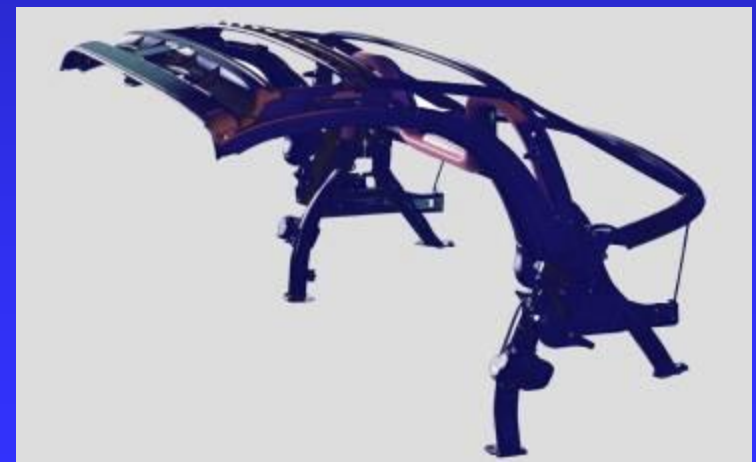
Transmission housing
AZ91D

320 x 400 x 370 mm

9.10 Kg



roof-system
convertible car
Magnesium & Aluminum
20 different parts
pre-assembled
with surface-treatment



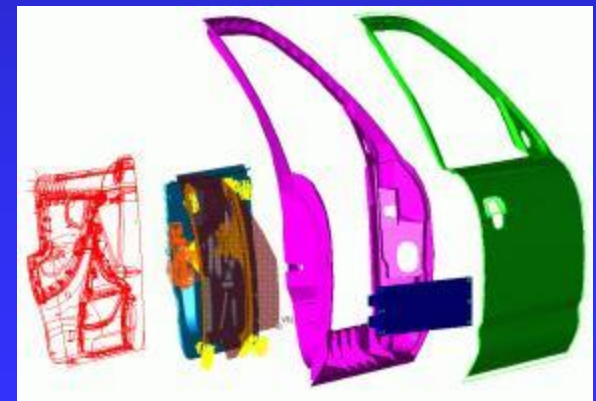


door inner, AM 50

4.5kg

1450x800x125mm

weight saving 45 %
over steel-version





Tailgate, AM 50

2.7kg

1400x800x130mm

weight saving 40 %
over steel-version





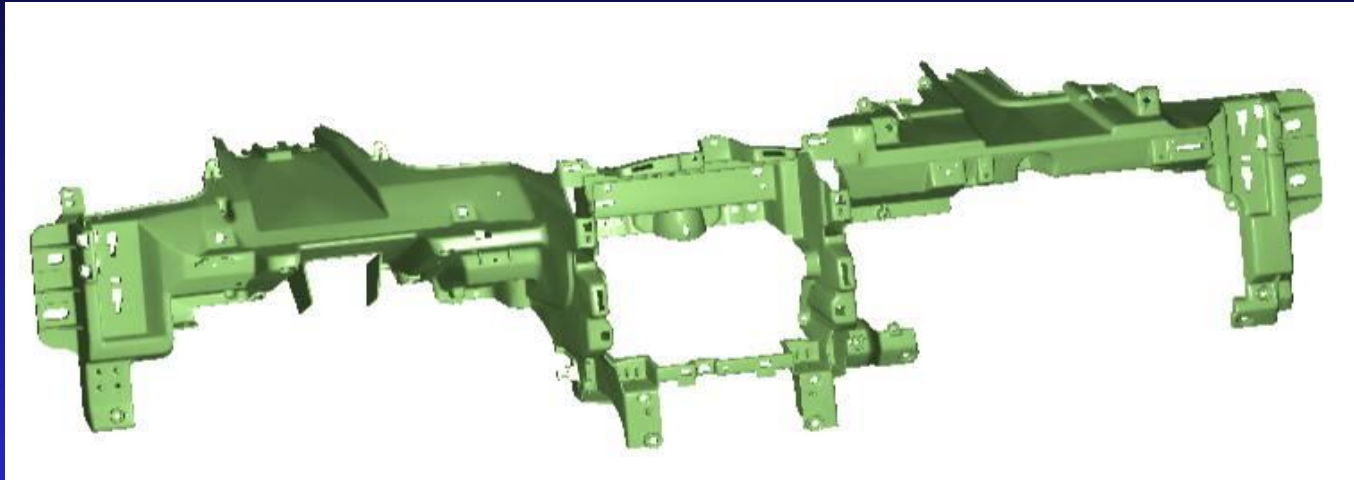
Bulkhead, AM 50

2.4kg

1250x500x70mm

weight saving 55 %
over steel-version





IP, AM 50

0.297 Kg

1300x200x25mm

w/o machining; citric-acid
cleaned

wall 0.9 - 1.1 mm

Steel/Al Hybrid Armature



Full Die Cast Al Armature



Steel Welded Armature



Full Die Cast Mg Armature



Electronics and Communication Industry



Major Technical Challenges

- **Alloys -**
 - Creep Resistance up to 200°C ($\pm\sigma$, Bolt-Load retention)
 - TYE up to 175°C
 - Salt-spray corrosion resistance (0.1-0.25 mg/cm²/day)
- **Product Design & Manufacturing -**
 - Integrated CAE
 - Cost Effective Manufacturing

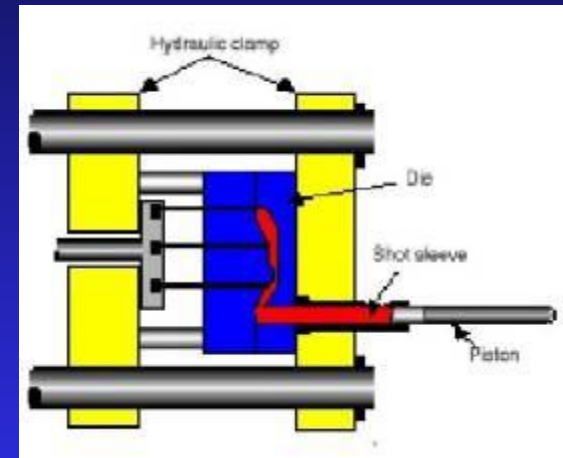
Manufacturing Aspects

- **High Pressure Die Casting Process or Others**

- **Rapid Tooling**

- **Fasteners (aluminum)**

- **Corrosion Protection**



FMC's Policy Letter No. 17

Protecting Health and the Environment

- Engineering Material Specification for
RESTRICTED SUBSTANCE MANAGEMENT
STANDARD, WSS-M99P9999-A1
- The requirements established by this Standard apply to all products supplied to Ford. They apply equally to Full Service Suppliers, proprietary, and Ford specified items.

TABLE 1 (Cont'd)
SUBSTANCE RESTRICTIONS

Row Number	Substance	Type of Restriction (a)	Threshold (not to be exceeded) (b)	Applications affected / Comments	Effective date
58	Polybrominated diphenylethers (PBDEs)	Prohibited		All products except those containing Decabromodiphenyloxyde	Immediate
		Restricted		Products containing Decabromodiphenyloxyde	Immediate
59	Polychlorinated biphenyls (PCBs)	Prohibited	0.001%	All Products	Immediate
60	Polychlorinated terphenyls (PCTs)	Prohibited	0.001%	All Products	Immediate
61	Polyvinylchloride (PVC)	Reportable		All Products	Immediate
62	Products of endangered species	Prohibited		All Products	Immediate
63	Radioactive substances	Restricted		All Products.	Immediate
64	Reproductive toxicants	Restricted		All Products	Immediate
65	Sensitizing substances	Restricted		All Products	Immediate
66	Sulfur hexafluoride	Prohibited		Open systems (a system where under normal working conditions a leakage rate above 1% per year occurs), e.g. tire inflation gas.	Immediate
		Prohibited		Processing (casting) of Magnesium	31 Jan 2004
		Restricted		Closed systems (a system that is normally hermetically closed), e.g. electrical installations	Immediate

Notes:

- a) "Prohibited"; "Restricted"; and "Reportable" substances are defined in Appendix 1, "Definitions".
- b) Certain substances are subject to a specified upper threshold, stated as weight percent content in a material (see the definition of "Material" in Appendix 1). Where no threshold is specified, the substance concerned should not be present in quantities greater than trace levels as established by best industry practice. Thresholds for heavy metals are to be calculated on the basis of the elemental form of the metal.

Prohibited		Processing (casting) of Magnesium	31 Jan 2004
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Current Advanced Programs

Powertrain program (USCAR consortium)

- Engine Block, Bedplate, Oil Pan and Front Cover for Ford
- Newly developed high temp Mg alloys (die and sand)

Chassis program (USCAR consortium)

- Engine Cradle for GM Corvette
- Commercial Mg alloys



Current Advanced Programs (cont.)

Casting Lab at Ford

- cold chamber (400 ton)
- hot chamber (300 ton)



Issues with Using Large Quantities of Magnesium in Auto Industry

The magnesium “industry” is unlike the polymer, aluminum, and steel industries:

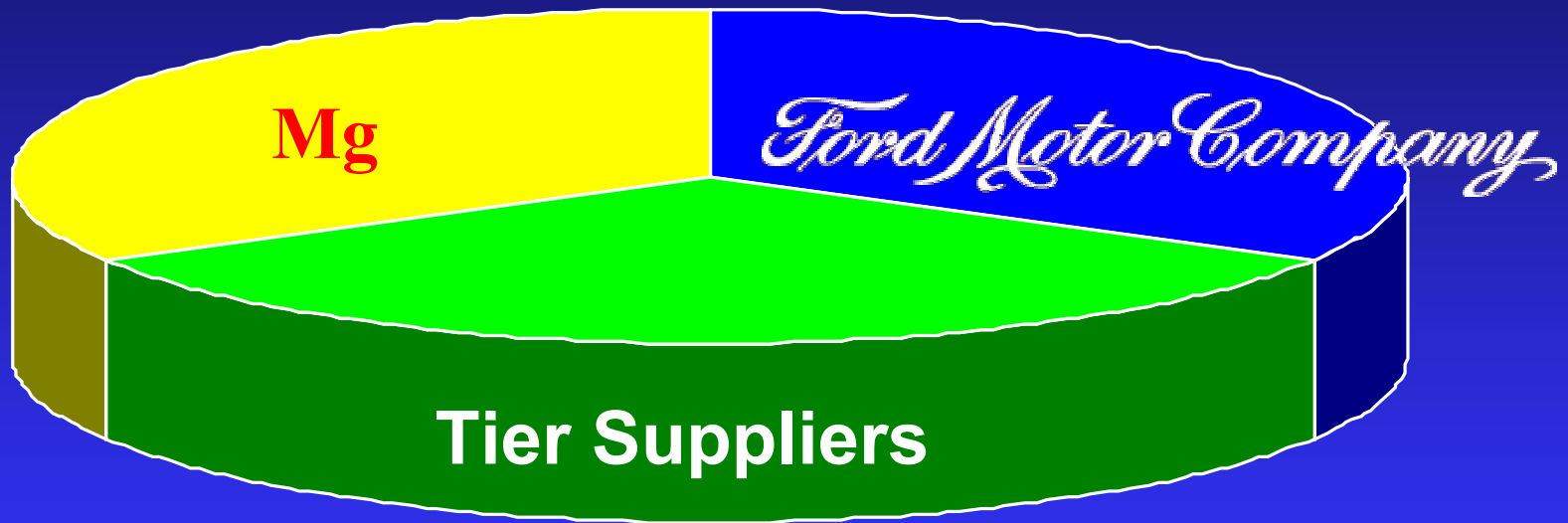
- ◆ **significant R&D**

- ◆ **full technical and commercial support**

alloy development, design & modeling, casting, manufacturing, failure analysis, corrosion, quality, training, etc.

Allies

Light Metals Industry



- **Implement more Mg applications**
- **Abandon SF6 at Ford**
- **Need alternative cover gases**
- **Develop strong Mg supplier basis**
- **Research programs with leverage**