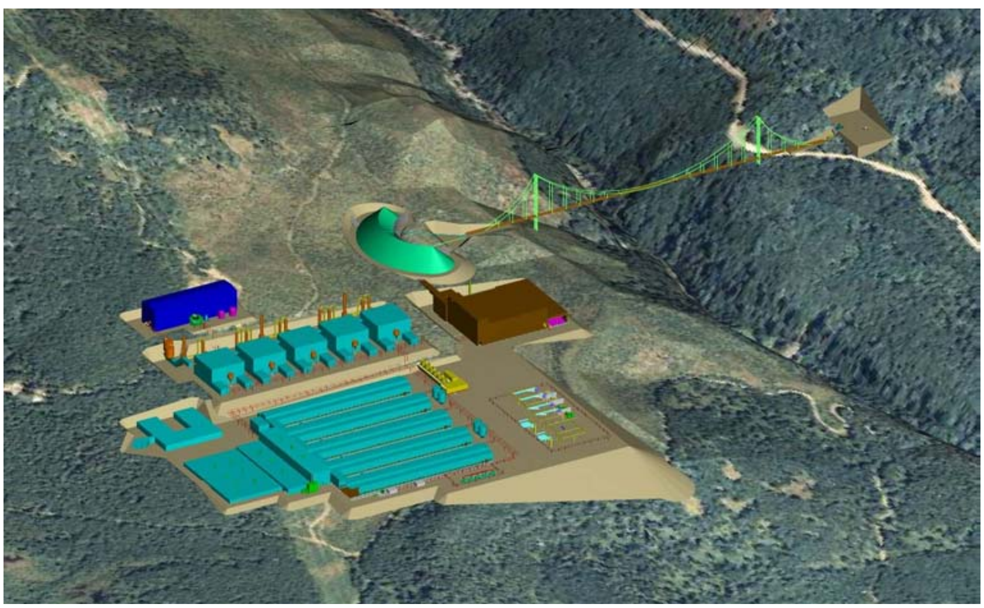
LEADER MINING INTERNATIONAL

BINDER NO. 2
MAGNESIUM MARKET STUDY

FOR

PRODUCTION FEASIBILITY STUDY FOR
COGBURN MAGNESIUM PLANT



HATCH

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Report to Leader Mining International Inc.

MAGNESIUM MARKET STUDY

February 25, 2003

Hatch Consulting

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CONDITIONS AND LIMITATIONS

This report has been prepared by Hatch Consulting (Consultant) for Leader Mining International (Client) as part of a Feasibility Study for the Cogburn Magnesium Project (Feasibility Study) and may be used by the Client in connection with the Feasibility Study and shall not be used nor relied upon by any other party nor for any other purpose without the written consent of the Consultant. The Consultant accepts no responsibility for damages, losses or claims of any third party resulting from decisions made or actions based on this report.

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The environmental review in this report does not constitute a legal opinion. The principles, procedures and standards applied in conducting any environmental investigation are neither regulated nor universally applied. The Consultant has conducted the investigation in accordance with the methodology outlined in its proposal. It is acknowledged that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems cannot guarantee their absence. While the information provided by the Client was reviewed, the Consultant was required to rely upon this information without independently verifying its accuracy. The disclosure of any information contained in this report is the sole responsibility of the Client.

1. Executive Summary

Demand for primary magnesium in the Western economies (excluding China and the CIS) reached a record high of 375,000 metric tonnes in 1999, and after a decline in 2000 and 2001 has resumed its growth trend. Over the past decade, western world primary magnesium demand has grown at a compound annual rate of 3.3%, substantially faster than more mature metals such as aluminium or steel.

The outlook for future growth is particularly strong in the automotive die-casting sector, where the unique combination of magnesium's lightweight strength, and castability make it ideal for production of complex parts that save weight and simplify assembly. The rate of penetration of magnesium into these applications will depend in part on the relative prices of magnesium and aluminium, developments in fabrication technologies that impact the final component complexity and cost, and the impetus for weight saving and fuel economy improvements from energy prices and government actions.

Growth of magnesium use in other markets is projected to be low, as these sectors are either mature or declining. Overall, Hatch Consultant's baseline forecast for western world magnesium demand is an average growth rate over the next decade of 4.9% per annum. This will result in the demand increasing from 355,000 tonnes in 2002 to 601,000 tonnes in the year 2012, an increase in demand of 246,000 tonnes, or 70%. Demand growth is also expected to occur in China and the CIS countries, and while this is not included in the detailed demand study, it has been assumed that this growth will impact on the availability of magnesium exports from these regions in the longer term.

It is possible that a significantly faster growth could occur if the conditions driving auto use of lightweight material are significantly stronger than in our Base Case. In an Optimistic Case, we believe that western world magnesium demand could reach 900,000 tonnes by 2012.

There has been a dramatic change in the primary magnesium supply sources in the last decade. Starting in the early 1990's, magnesium from Russia and China, which had never previously played any role in the Western markets, arrived on the markets at low prices. Initially, western producers believed that this was a temporary phenomenon, fuelled by the need for hard currency and the existence of inventories of metals on hand for which the local market, especially in Russia, had disappeared. However, the supplies from Russia and China have continued to increase, and a number of the important traditional western magnesium producers who were facing the need to make substantial investments to upgrade their old plant decided instead to exit the business. As a result, by 2002 magnesium metal supplied to the western markets was only 60% from western producers and 40% was from Russia and China.

In 2003 western world primary magnesium capacity fell to only 200,000 annual tonnes, compared to western demand of 355,000 tonnes in 2002.

There is currently only one new magnesium plant in the early stages of construction - the AMC facility in Australia, with a planned capacity of 90,000 tonnes per year (some capacity increases may be achievable at other existing plants through incremental changes). While other magnesium projects have been discussed in many locations, none are near coming to fruition today.

While actual capacity of the magnesium facilities in China is somewhat speculative, it can be reasonably estimated that functional capacity there will remain in the 300,00 to 350,000 tonne range, as older, high cost and small-scale plants are closed and replaced with more modern (though still old technology by western standards) plants.

Without the construction of any new western plants except for the AMC facility, by 2012 there would be a shortfall in magnesium capacity of nearly 130,000 annual tonnes using the Hatch Base Case demand forecast.

Under the more speculative Hatch Optimistic Case demand, the shortfall would increase to over 400,000 annual tonnes.

In order for even the base case demand to be satisfied, new primary magnesium plants will have to be constructed between now and the latter half of this decade.

Magnesium prices, as measured in the US, the largest market, have been highly volatile over the period from 1990 to 2002, ranging from an annual average high of US$ 2.06 in 1995 to a low of US$ 1.19 in 2002. The average, in nominal dollars, was US$ 1.52. In the last several years, even lower priced material imported from China has become a major factor in supplying the US and world markets. This imported material is not reflected in the price series cited, due to its short history.

In constant dollars, the price trend over this 13-year period was a 1.9% per year decline, and the trend line price in 2002 would have been US$ 1.48, versus the actual price of US$ 1.19 for US and Canadian material, and US$ 1.04 for Chinese material.

Based on our estimates of manufacturing costs for the various classes of producers, the sales and marketing costs to sell into the US market, and the need to achieve a return on capital (debt and equity), we estimate that the costs of the high cost producer, excluding any profit, for the mix of production serving the North American markets in the 2005 to 2010 period, will be approximately US$ 1.27 per pound, delivered to the Midwest, in 2003 US dollars. Coincidently, this is also the weighted average cost-plus profit for the industry in this period.

Based on the mix of supply, and the apparent need for new capacity, we recommend that for the base case analysis, a market price for 99.5% pure magnesium metal, delivered to the Midwest US (or Canada) of US$ 1.27 per pound be used. We would expect this price to decline in real terms over the life of the project, but for analysis purposes, it may be held constant, under the assumption that costs will be reduced over time as well. For the optimistic case, a price of US$ 1.34 per pound was developed using a similar methodology.

Die casting alloy prices have averaged about 10% higher than pure metal prices in the last two years, as measured by Chinese export prices (fob China), Rotterdam warehouse prices, and US spot import prices. We believe that this differential is a reasonable basis for viewing the price prospects for alloy material from the Cogburn Project.

The following table (Figure 1-1) contains the prices used in the financial analysis.

FIGURE 1-1: LONG TERM MAGNESIUM PRICES, 2003 US DOLLARS PER POUND, DELIVERED TO US MIDWEST

	99.8% Metal	Die Casting Alloys
Base Case	$1.27	$1.40
Optimistic Case	$1.34	$1.47

2. Introduction

This report on the current and future demand, supply, and pricing of primary magnesium was carried out by Hatch Consulting in early 2003 at the request of Leader Mining International Inc. Development of the Market report is based on prior magnesium studies undertaken by Hatch Consulting and Hatch–Beddows, published information from trade associations, companies and government agencies, and reports by industry experts which were available. Hatch has carried out a number of projects in magnesium over the past several years, which provide us with an extensive body of industry and market historical data. Industry experts and observers, especially as related to potential market growth in the automotive sector, updated this to reflect current conditions and recent projections.

Forecasts of growth in demand for magnesium were developed and outside sources of forecasts reviewed. Given the apparently close balance between current supply and demand and the expansions in capacity in Canada, Australia, and China that are either underway or announced, it would appear that the rate of growth in demand for magnesium and magnesium alloys over the next five to fifteen years is the most critical factor in determining the potential attractiveness of investments in magnesium.

Demand growth and changes in supply will determine future magnesium prices. We have utilised a cost curve-type approach to projections of the long-term trends in magnesium prices. Changes on the supply side will reflect the recent major reductions in capacity and production at several traditional North American and Western European facilities, increases in production and capacity at several new plants, and potential change in supply from China and the former Soviet Union into the Western markets. Our magnesium price projection is provided in constant dollar terms on a trend basis.

3. Demand

3.1 Demand Overview

The major markets for primary magnesium are North America, Western Europe and Asia, which account for approximately 40%, 28% and 18% of total global demand, respectively. In these economies, magnesium demand is very broadly based in consumer durables through aluminium consumption, steel making, castings for autos and other transportation equipment, and in high technology as castings for electronics and aerospace components.

There are four components of demand seen by a magnesium producer:

- **Aluminium Alloys** - 40% of 2002 demand. Almost all aluminium is sold with some magnesium as an alloy. Magnesium is generally purchased by aluminium producers and sold as a small but critical alloy in castings, extrusions and wrought aluminium. This is the largest demand for magnesium. On average, magnesium makes up 0.8% of aluminium consumed; given its low content and use in alloys, which are industry standards, this demand has limited price sensitivity.

- **Die-casting** - 36% of 2002 demand. Magnesium auto parts are a rapidly growing segment of the market. These castings are 97% or more magnesium. Demand is, however, very price sensitive to competition from aluminium castings, steel and plastics. Automakers speak of magnesium price in terms of price ratio with aluminium, its main competitor. There are, however, non-price advantages to the use of magnesium. This demand is also conditioned by security of supply and investment in technical developments in applications. Castings are also used in smaller volumes in aerospace and other end user industries.

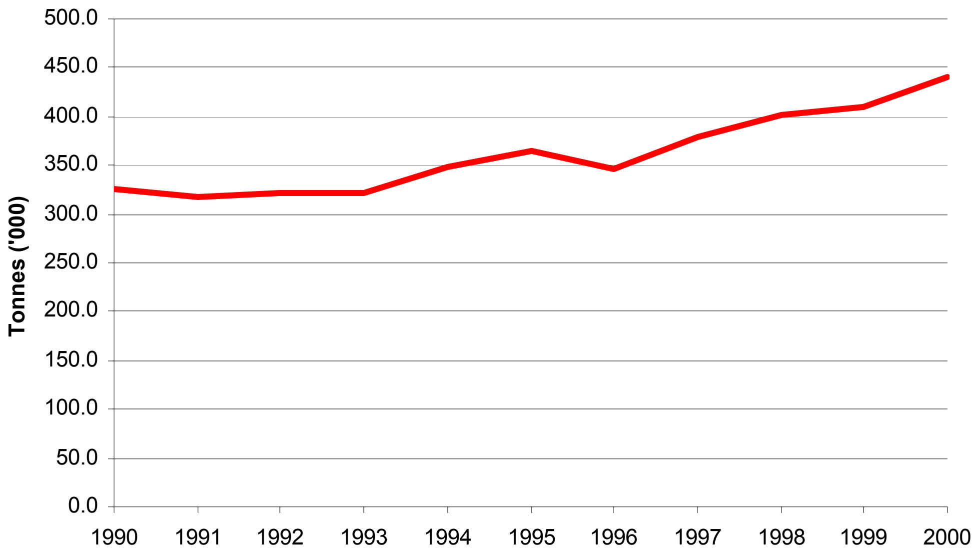
- **Desulphurisation** - 15% of 2002 demand. Desulphurisation is a standard element of the steel making process. Magnesium is one option in a selection of reagents to use. Under normal market situations, post-consumer magnesium scrap is the most cost effective source. Chinese magnesium has displaced this at times due to it being heavily discounted. Countervailing duties and trade agreements specifying minimum prices have somewhat restored the normal order to the market. Magnesium is granulised or formed as wire and introduced into hot metal (liquid iron) to remove sulphur. Magnesium competes with calcium carbide primarily, but also calcium silicate and soda ash. Magnesium is not the cheapest means, but is very effective if used with the right technology in conjunction with other reagents. This use is very price sensitive, but its penetration has been growing as a result of increasing demand for lower sulphur levels in steel plus declining supplies of low sulphur coking coal.

- **Other** - 9% of 2002 demand. A mixture of historic uses including the production of nodular iron, electrochemical, reagents and other wrought products and castings. This is a declining category, many of the uses involving old technologies. These are generally not price sensitive as they are very specialized chemically with limited substitutes.

3.2 World Demand

Between 1990 and 2000, the global demand for primary magnesium grew at an annualized rate of 3.1%, and in 2000, world demand for primary magnesium was estimated to be approximately 440,000 metric tonnes (refer to Figure 3-1).

FIGURE 3-1: ESTIMATED WORLD DEMAND FOR PRIMARY MAGNESIUM



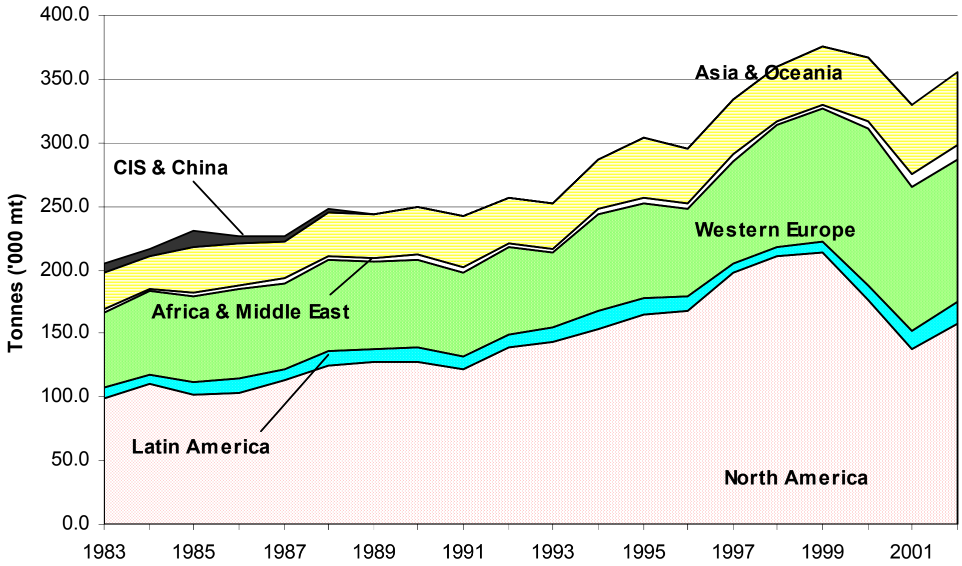
Source: CRU International Limited, 2001

3.3 Regional Demand

The International Magnesium Association (IMA), an association of magnesium producers and consumers, compiles statistics on primary magnesium production, shipments and inventories from figures submitted by magnesium producers. These figures, when combined with IMA estimates of primary magnesium imports from the Commonwealth of Independent States and the People's Republic of China, provides an IMA estimate of total western demand. Between the period of 1990 and 2000, the IMA's estimate of western demand represented 83% of global demand as estimated by CRU International.

As outlined in Figure 3-2, western world demand for primary magnesium increased between 1983 and 2002. Since 1999, however, demand has fallen in the western world. Some of this decline can be explained by the fact that the IMA changed its statistics to eliminate secondary magnesium alloy shipments from demand in 2000. By correcting for this change, 2000 represented an increase in demand over 1999, but demand in 2001 and 2002 is still considerably less than 2000 demand.

FIGURE 3-2: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM BY REGION



Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

As presented in Figure 3-3, North America accounts for the largest share of western world demand, with approximately 44% of 2002 demand. This is followed by Western Europe at 32% and Asia (mostly Japan) at 16%.

FIGURE 3-3: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM BY REGION

Region	% of 2002 Demand	Annualized Growth (1983 to 2002)	Annualized Growth (1992 to 2002)
North America	44%	2.5%	1.2%
Western Europe	32%	3.5%	5.2%
Asia & Oceania	16%	3.7%	5.1%
Latin America	5%	3.0%	5.0%
Africa & Middle East	3%	7.9%	10.3%
Total	**100%**	**2.9%**	**3.3%**

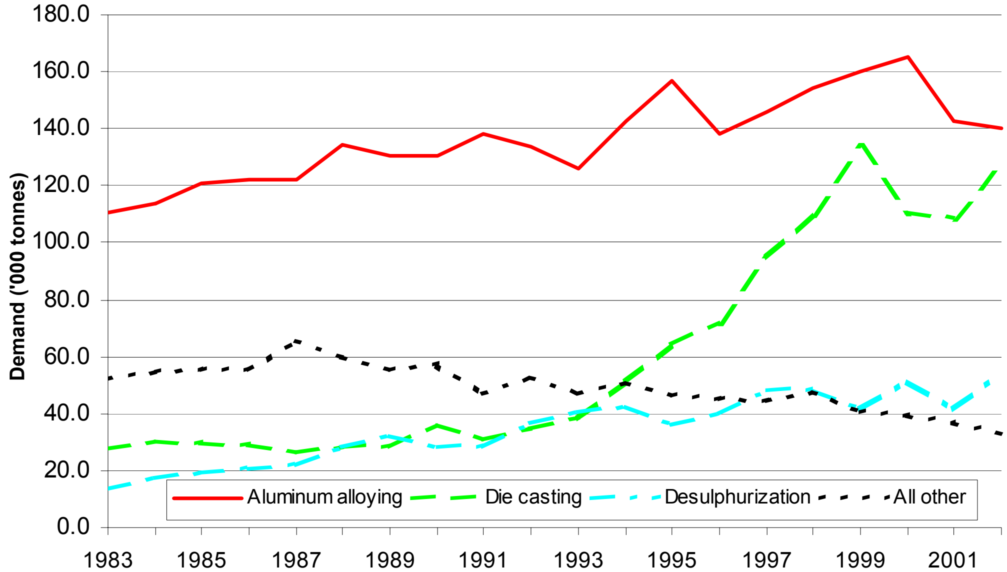
Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

Between 1983 and 2002, western world demand grew at an annualized rate of 2.9%. This growth, however, was not distributed evenly across regions, and growth in North America lagged the average for the western world. This trend was also evident in the last decade, with annual western world growth of 3.3%, driven largely by the non-North American regional markets.

3.4 Consumption of Magnesium by Application

As outlined in Figure 3-4, alloying with aluminium was the largest component of magnesium demand in 2002.

FIGURE 3-4: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM BY USE



Source: International Magnesium Association

It is interesting to note that relative to total magnesium demand, the percent destined for aluminium alloy applications has declined from a high of 57% in 1991, to a low of 40% in 2002, while magnesium destined for die casting use has increased from 14% of demand in 1983, to 36% of demand in 2002 (Figure 3-5).

FIGURE 3-5: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM BY USE

Use	% of 2002 Demand	Annualized Growth (1983 to 2002)	Annualized Growth (1992 to 2002)
Aluminum alloying	40%	1.3%	0.5%
Die casting	36%	8.3%	13.9%
Desulphurization	15%	7.7%	4.1%
All other	9%	-2.5%	-4.6%
Total	**100%**	**2.9%**	**3.3%**

Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

Uses of magnesium with significant growth rates in tonnage and share are for die-casting and steel desulphurisation. These have grown annually by 8.3% and 7.7% respectively between 1983 and 2002, and the growth rate for die casting over the past decade has averaged 13.9% annually. Looking at Figure 3-4, if the automotive industry is to extend its use of magnesium cast parts, die-casting could surpass aluminium alloying as the largest single consumer of magnesium within the next few years.

Each of these three principal applications is discussed in detail below.

3.4.1 Aluminium Alloying

Almost all aluminium is produced with at least small magnesium content. The exceptions are electrical applications, where electrical conductivity is the significant issue, some general-purpose applications, foils for food packaging, some aerospace applications and items such as kitchen utensils, again where malleability is the overriding issue. Exact figures are not available, but Hatch estimates that 90% or more of aluminium alloys contain some magnesium.

It is also worthy of note that the aluminium alloys quoted on the London Metal Exchange are not the only alloyed production of aluminium. These would generally contain the highest proportion of alloy constituents, averaging approximately 5%, but going as high as 10%. These LME aluminium alloys only make up 10% of total aluminium production.

To observe simply that 40% of magnesium is consumed in aluminium alloys is not sufficient for a proper understanding of the drivers of magnesium demand. Few hard statistics are available however, and those that do exist were found to be seriously flawed upon close examination. To this end, Figure 3-6 contains estimates created by Hatch of the general consumption pattern within aluminium alloying. These estimates are indicative only for the purpose of connecting with end application drivers of consumption. The three largest consumers are transportation equipment, packaging and building and construction products, collectively making up 88% of magnesium consumed in aluminium alloys.

FIGURE 3-6: ESTIMATED WESTERN WORLD DISTRIBUTION OF PRIMARY MAGNESIUM USED IN ALUMINIUM ALLOYING, 2000

Application	Percent of Aluminum Consumption 1.	World Primary Aluminum Production ('000 t) 1.	Magnesium Content Range, %	Selected Magnesium Content	Estimated Magnesium Content ('000 t)	Estimated Magnesium Percent of Total Alloying
Transportation 2.	37.0%	7,841	0.5% to 4.5%	1.00%	78	47.3%
Packaging 3.	23.0%	4,874	0.0% t0 4.5%	1.10%	54	32.3%
Building and construction 4.	15.0%	3,179	0.0% to 1.0%	0.50%	16	9.6%
Electrical 5.	8.0%	1,695	-	0.00%	0	0.0%
Machinery and equipment 6.	7.0%	1,483	0.0% to 4.0%	0.50%	7	4.5%
Consumer durables 7.	8.0%	1,695	0.0% to 4.0%	0.50%	8	5.1%
Other	2.0%	424	0.5%	0.50%	2	1.3%
Total	**100.0%**	**21,191**	**0.0% to 4.5%**	**0.78%**	**166**	**100.0%**

Source: Hatch estimate

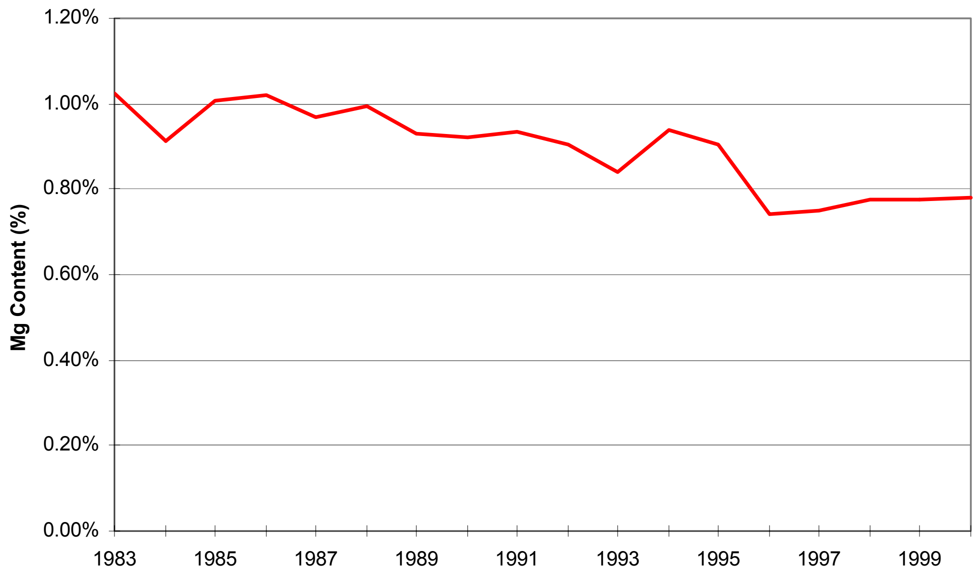
Notes:
1. 2000 from USGS (for Distribution of End-Use Shipments of Aluminium Products in the US) and International Primary Aluminium Institute (for World Primary Aluminium Production)
2. Autos, commercial vehicles, aerospace, assumed to average 1% Mg
3. Beverage cans, foil, flexible packaging and semi-rigid food containers, assumed to average 1.1% Mg (cans contain around 1% to 2%, other packaging such as foil rap contains little or none)
3. Mostly sheet and other rolled products, assumed to average 0.5% Mg
4. Electrical cables and high voltage bus bars, assumed to contain no Mg, conductivity the only important property
5. Assumed to average 0.5%
6. Assumed to average 0.5%

As presented in Figure 3-6, the largest single end-use of magnesium in aluminium alloys is for transportation equipment (autos, commercial, aerospace). This is believed to be approximately

47% of magnesium tonnage. Beverage cans and other packaging is the second largest consumers, with 32% of magnesium tonnage. The lids of beverage cans can be in the range of 2% to 5% magnesium, while the bodies of cans are in the 0.8% to 1.3% range. Other uses of magnesium alloys include roofing/architectural sheet which is about 1% magnesium, sheet products for marine and other transport applications which are 2% to 5% magnesium and other architectural applications such as extruded door and window frames that are 0.5% to 1% magnesium. The addition of magnesium imparts work hardening to the alloys, upon rolling or other mechanical deformation.

Although the annualized growth rate of primary aluminium production averaged 4.0% between 1983 and 2000, magnesium growth in aluminium alloying averaged only 2.4% over the same period. This is due to the fact that application rate of magnesium in aluminium alloying declined over this period (refer to Figure 3-7), probably due to one or more of the following factors: improvements in manufacturing processes which result in declining uses of magnesium; the applications of magnesium in aluminium alloying is shrinking as a whole; and the mix of aluminium uses is shifting from applications that use more magnesium to those that use less.

FIGURE 3-7: MAGNESIUM USE IN ALUMINIUM PRODUCTION 1.



Source: Hatch, Based upon data from the IMA and the International Primary Aluminium Institute

Note: 1. Calculated as primary magnesium shipments to aluminium alloyers as a percentage of total primary aluminium production

As detailed in Figure 3-8, North America, Western Europe and Asia are the dominant regional markets for magnesium used in aluminium alloying, collectively accounting for nearly 90% of western world demand. Annualized growth rates for the ten and nineteen year time frame were 0.5% and 1.2% respectively, indicating that growth in demand has declined, or shrunk in the case of North America, over the last decade.

FIGURE 3-8: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM USED IN ALUMINIUM ALLOYING

Region	% of 2002 Demand	Annualized Growth (1983 to 2002)	Annualized Growth (1992 to 2002)
North America	39%	0.2%	-1.9%
Western Europe	29%	1.3%	1.8%
Asia & Oceania	21%	1.8%	1.0%
Africa & Middle East	7%	7.5%	10.2%
Latin America	4%	4.9%	6.4%
Total	**100%**	**1.2%**	**0.5%**

Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

3.4.1.1 Aluminium in Transportation Equipment

Between 1985 and 2001, the growth rate in the US aluminium transportation end-use segment averaged 6.5% annually. Aluminium use in transportation is principally in commercial vehicles, however the use of aluminium in autos is increasing as well. Fuel efficiency is the issue for both, but most acutely felt in the commercial vehicles. The average North American vehicle contained 112 lbs of aluminium in 1978, and by 2002 it contained 268 lbs, a growth rate of 3.7% annualized. This is a strong trend that is expected by some forecasters to continue into the foreseeable future.

Commercial vehicle applications include truck and trailer bodies, engine parts and drive train parts. It is estimated that 80% to 90% of trucks on the road contain significant amounts in the form of aluminium body sheet and extruded sections in structural applications, although figures were not available. In some applications glass fibre reinforced composites compete, for example in truck body shells, as this material also offers low thermal conductivity.

Aluminium used in automotive and commercial applications contains 0.5% to 4.5% magnesium. The higher magnesium content parts are in the engines, pistons and cylinder heads that contain 3.0% to 4.5% magnesium. Body sheet and similar application contain 1.5% or less.

3.4.1.2 Aluminium in Containers and Packaging

Between 1985 and 2001, the growth rate in the US aluminium container and packaging end-use segment averaged 2.4% annually. Containers and packaging covers a wide range of aluminium alloys as a result of diverse needs, including:

- Beverage cans, on average these are 1% to 2% magnesium to impart strength and rigidity. Hatch estimates that 60% of the aluminium used in packaging in the U.S. is for the manufacture of beverage cans.

- Foil, this contains little or no magnesium, as malleability is the most important quality, allowing the foil to tightly wrap food and other items.

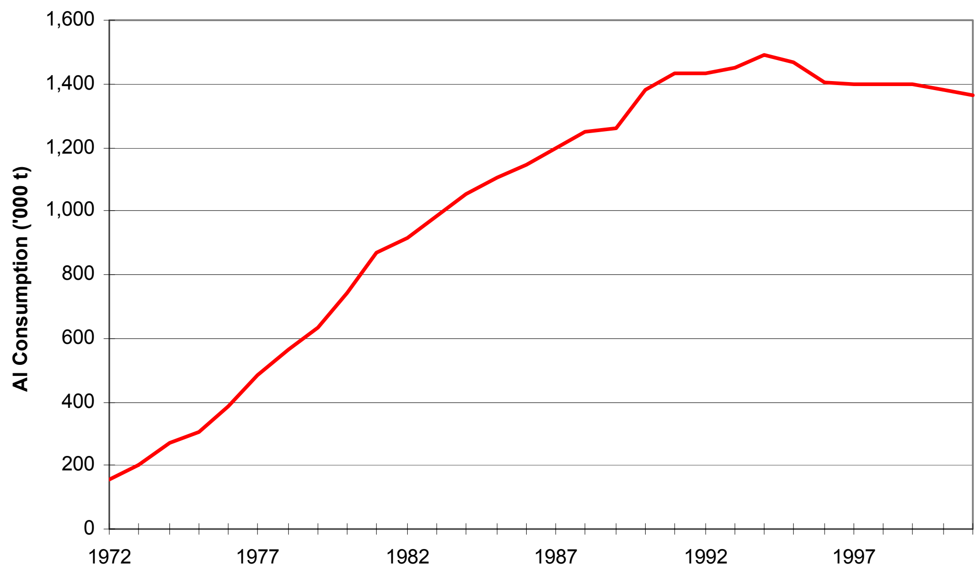
- Flexible packaging, various magnesium contents, and

- Semi-rigid food containers, which contain 1% to 4% magnesium.

Since a significant proportion of magnesium demand is tied to the demand for aluminium cans, the future of the aluminium can industry is of interest to a new producer of magnesium. As outlined in Figure 3-9, aluminium consumption in aluminium cans in the US grew by a dramatic 12.4% annually between 1972 and 1991. Since then, however, aluminium consumption for cans has declined by 0.5% annually, even though the demand for soft drinks, beer, and fruit juice has grown over the same period. This decline in aluminium consumption can be explained by two main reasons:

- growth in the aluminium can market has been constrained due to competition from polyethylene terephthalate (PET) bottles in the soft drink market, and from glass bottles in the beer market.
- the average weight of a typical aluminium can has decreased by 1.5% per annum between 1991 and 2001.

FIGURE 3-9: ALUMINIUM USED IN UNITED STATES ALUMINIUM CANS PRODUCTION



Source: Hatch, Based upon data from the IMA and the International Primary Aluminium Institute

3.4.1.3 Aluminium in Building and Construction

Between 1985 and 2001, the growth rate in the US aluminium building and construction end-use segment averaged 1.0% annually. Building and construction material is generally sheet material for exterior cladding of buildings and extrusions to produce windows and doors frames, with magnesium content between 0% and 1%. This is a well-established use that is expected to grow with the economy.

3.4.1.4 Other Aluminium Applications

Between 1985 and 2001, the growth rate in the US for other aluminium applications averaged 2.3% annually. Other aluminium applications include electrical, machinery and equipment, and consumer durables. Electrical demand for aluminium rarely contains any alloying metals, as pure aluminium has the best conductivity. Consumer durables include a wide range of products from kitchen utensils that contain virtually no magnesium to other articles that can have high amounts in the 4% range.

3.4.2 Die-casting

It is in die-casting that the most significant growth in the use of magnesium has taken place in recent years. Typically, die-cast parts of this sort have been 90% Mg, 9% Al and 1% a variety of alloy constituents. More recently, new alloys have entered the market with 95% magnesium. The majority of die-cast parts are for the auto industry, but consumer items such as hand tools are making up a significant proportion judging by the range of products from die-casters. In addition, there are limited military uses, for example helicopter gear box casings and seat frames. Historically, users had corrosion problems from impurities in the metal, but producers have improved process quality and the metal is now more widely accepted.

As magnesium is a recent use and small volume metal, there are only about 6 important magnesium alloys, while there are several thousand aluminium alloys. There appears to be consensus that increasing demand is leading to development of improved mechanical properties and corrosion resistance through higher purity and alloying with other metals. An example would be demand for alloys with a higher temperature tolerance for engine parts.

Die-casting generates a substantial yield loss to scrap. This is gates and spurs, trimmings, bad castings and spillage. Historically, casting scrap has generally been sent to a secondary recovery facility for re-melting and refining, often in a tolling relationship. There have been significant economies of scale in one large facility servicing a number of die-casters, and the process requires skills that are very different from that required for die-casting. However, this may be changing as new technologies allow casters to recover more magnesium scrap internally, reducing the availability of scrap for outside processing.

Referring to Figure 3-10, North America and Western Europe were the dominant regional markets for magnesium use in the die-casting sector, accounting for 48% and 33% of 2002 western demand respectively. Note that growth in magnesium demand for die casting actually accelerated over the last ten years when compared to the nineteen year average growth rate.

FIGURE 3-10: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM USED IN DIE CASTING

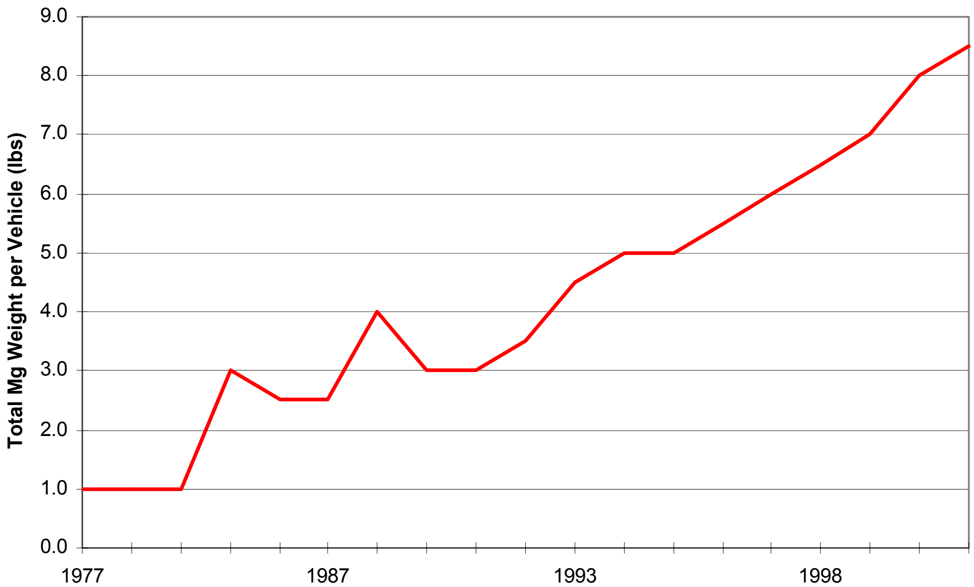
Region	% of 2002 Demand	Annualized Growth (1983 to 2002)	Annualized Growth (1992 to 2002)
North America	48%	14.3%	11.1%
Western Europe	33%	6.0%	20.6%
Asia & Oceania	14%	14.4%	29.1%
Latin America	5%	-0.8%	0.8%
Africa & Middle East	0%	N/A	N/A
Total	**100%**	**8.5%**	**13.9%**

Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

3.4.2.1 Automotive Consumption

Magnesium applications for the automobile industry account for the lions share of the magnesium demand in the die-casting sector. Driven primarily by the need to reduce weight to gain fuel efficiency, automakers have been using an increasing amount of magnesium and aluminium. Between 1978 and 2002 there has been a 9-fold increase in magnesium and a doubling of aluminium usage per vehicle. Figure 3-11 illustrates the trend of increasing magnesium die-casting use in North America over the last nineteen years.

FIGURE 3-11: USE OF MAGNESIUM DIE-CASTINGS IN NORTH AMERICAN PRODUCED VEHICLES



Source: USGS, from American Metal Market

The largest end-users of magnesium die-castings in North America are General Motors Corporation (GM) and Ford Motor Company (Ford). In 2001, GM's North American Operations (NAO) used approximately 28,000 tonnes of magnesium castings; principally in instrument panel (IP) support beams, transfer cases, and steering column support brackets. Hatch believes that IP beams are one of the largest markets for structural magnesium casting alloys in the world.

North American vehicle manufacturers consume higher quantities of magnesium for die-casting than their European or Japanese counterparts. In 2001, BMW estimated magnesium die-casting consumption in automobile manufacturing to be roughly 55,000 tonnes in North America, compared to slightly less than 40,000 tonnes in Europe, and 20,000 tonnes for the rest of the world. Hatch believes that because North American vehicles are roughly 1.5 times larger, on average, than European or Japanese models, the incentive weight reduction through magnesium is greater for the former given that the later fleets already have a fuel efficiency edge resulting from lower weight. Japanese autos, the lowest consumers of magnesium, also already contain a significant amount of highly engineered steel components, a successful approach designed to reduce weight.

The use of magnesium in autos is not new. In the 1920's, magnesium was the metal of choice for components like racing car engine pistons. Fiat first used magnesium in wheels in 1967, although Volkswagen was the first to use extensive magnesium alloy castings. The use by Volkswagen dropped in the 1970's, when its then new Golf model was developed with reduced magnesium usage because of the doubling of the price of the metal. The world demand for magnesium in autos dropped after this 1970's price hike, not to be regained until 1995.

3.4.2.2 Technical issues

Substituting one metal for another in any manufacturing process requires considerable re-design as a result of strength, formability and other considerations. In a joint project between Audi and Alcoa, they developed a "space frame" from fewer than 100 extrusions and castings compared with as many as 300 for the same body made out of stamped steel. These changes to fewer parts are not simply desirable, but aluminium cannot be assembled using the myriad of small parts that is typical of steel. Aluminium and magnesium require entirely different manufacturing process. Further, the technology for using aluminium is not fully developed and the process engineering has not yet been developed for cars produced at a rate of more than 100,000 units per year. Alcan has stated they expect the mass-production technology to develop to allow large-scale production in the next five to ten years. Norsk Hydro has also been involved in a similar program with Renault, Porsche and Pininfarina since the mid-1980.

Corrosion resistance has been an important quality of magnesium. The development of the AZ91D alloy has allowed the expanded use in autos.

Ford has identified over 100 kg of potential applications, but they have experienced problems in obtaining appropriate and qualified engineering designs and prototypes at a competitive price, and in a timely manner. The magnesium industry lacks the great resources for development efforts with automakers that the steel and aluminium industries have.

In automotive applications, magnesium has advantageous weight, but has disadvantages in the lack of high temperature strength, creep strength, corrosion resistance, recyclability and cost. The competitors of magnesium include steel, aluminium, TSOP (The Superior Olefin Polymer) and other materials. Magnesium has the same heat resistance as resins, but is inferior to aluminium. It is inferior to resin and aluminium with respect to corrosion resistance. As a result, magnesium is used mainly in the passenger compartment and under hood areas where corrosion may not be as severe. Alloys and anticorrosion measures can offset some of the problems associated with magnesium. These add cost however. At this time it tends to be used for parts where there is no concern for strength or corrosion resistance.

The most promising applications for magnesium are those where aluminium or plastic are not desirable substitutes for steel. In the past 10 years, the magnesium focus has been on instrument panels, steering wheels, steering columns and seat risers, where magnesium's strength to weight performance and excellent ductility combined with its high energy-absorbing characteristics were noteworthy advantages.

Most magnesium die-casters are small volume producers and have less than full service engineering capability. They are generally unable to provide complete design and analysis capability to demonstrate that their designs have low engineering risks (road-worthiness). Even Ford product engineers have found that they do not have sufficient financial, engineering and time resources to translate current ferrous/aluminium designs to magnesium.

3.4.2.3 Competitiveness issues

In the past 30 years, magnesium price increases have caused major reductions in the use of magnesium. In 1973 to 1975, the price of magnesium increased from about US$ 0.40 per lb to over US$ 0.80 per lb in the space of 2 years. At that time Volkswagen were introducing their then new Golf models to replace the Beetle. They dropped their historical usage of magnesium, reducing their worldwide consumption of magnesium from 42,000 tonnes in 1971 to 9,000 tonnes in 1975. This was in the order of a 10% reduction in world demand. In 1995, after a run-up in prices from the US$ 1.40 per lb level to the US$ 1.80 per lb level, Ford announced that it was reconsidering its commitment to magnesium. It then announced plans to convert the previously magnesium transfer cases in their four wheel drive vehicles to aluminium. They also cancelled plans to use magnesium in the seat risers of their F-series pickup trucks and seat posts and stanchion in their Windstar vans. These last three decisions took 7,000 tonnes of demand (2%) out of the market. Automakers consistently cite problems with reliability of supply and price instability preventing them from using magnesium more in their products.

Recently, GM announced that it is planning to replace the magnesium IP support beams in its 2006 line of Chevrolet Silverado and GMC Sierra pickup trucks with all-steel IP support beams. GM indicated that changes in other areas of the trucks made it unnecessary to use the magnesium IP beams for weight-reduction purposes.

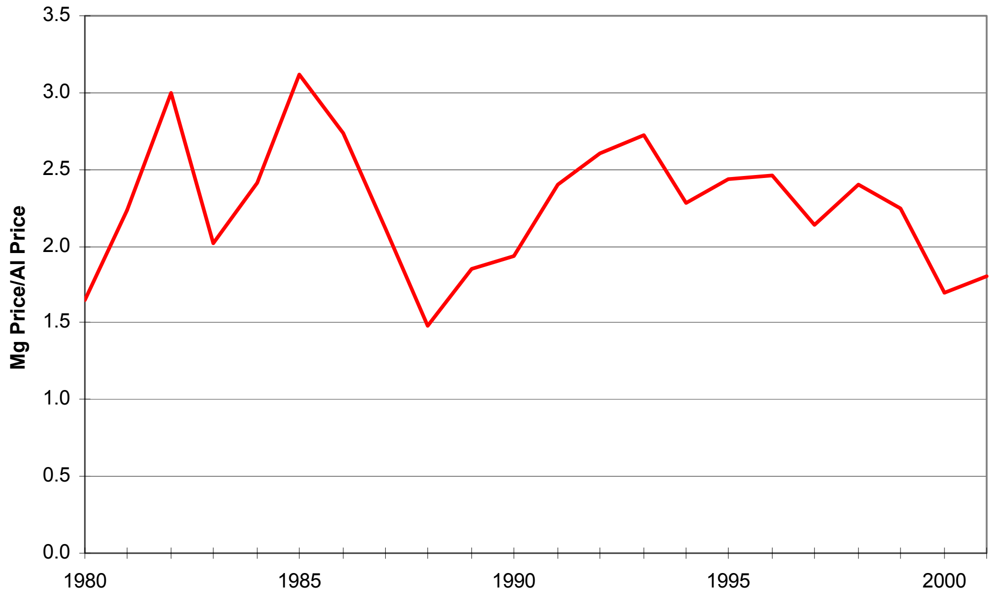
3.4.2.4 Automakers

From a weight-saving standpoint, there are clear advantages to replacing heavier materials such as cast iron, cast zinc, and low-strength forged, machined or stamped steel with light metals in autos. The cost impacts of such changes, however, are generally quite complex. When light metal, especially in the form of a casting, seems appropriate, then there may be competition between aluminium and magnesium for the application. This competitive relationship is often discussed in terms of the ratio between aluminium and magnesium prices.

On a volume basis, one kilogram of magnesium will make 1.6 times as many parts as the same mass of aluminium. Thus, in theory, the part-maker would find that in the absence of any other benefits, and all things being equal, if the price of magnesium was 1.6 times the aluminium price, the part material cost would be the same whether made of one material or the other. Thus, the auto producer would be able to reduce the auto weight with no penalty in cost. Historically, the major changes in auto designs and material selection arose when regulations and fuel prices drove auto companies to be willing to pay a premium for weight reduction or improved fuel economy. In the 1980’s, when aluminium and magnesium use in autos increased significantly, the ratio of magnesium to aluminium price was consistently over 2.0, and averaged close to 2.5.

Figure 3-12 illustrates the historical ratio of magnesium to aluminium. As presented, the ratio is trending downwards, driven largely by declining magnesium prices. In 2001, the average magnesium/aluminium price ratio was 1.8. At this ratio, auto producers have expressed a great deal of interest in magnesium, providing that reliable sources of supply at predictable and stable prices are developed.

FIGURE 3-12: RATIO OF MAGNESIUM PRICE TO ALUMINIUM PRICE



Sources: USGS

If a long-term price forecast of US$ 0.70 to US$ 0.75 per lb of aluminium is used, at a ratio of 1.8 to 1.0, competitive magnesium prices would be US$ 1.26 to US$ 1.35 per lb (of course, this is only a rule of thumb, and actual parts costs would be analyzed in detail before a decision was made).

3.4.3 Desulphurisation

To control the typical 11 kg per tonne of sulphur contributed from coal and other feed stocks, the average steel plant will spend over $5 per tonne (in addition to capital charges for equipment).

In most North American steel plants, hot metal leaves the blast furnace containing 0.04% to 0.07% sulphur, while the oxygen converters must be charged with hot metal containing as little as 0.010% to 0.001% sulphur to conform to limits set by caster operations and final product quality requirements. Magnesium is added to steel in the form of a powder, salt-coated granules, or as a mixture with calcium carbide. Competing reagents are calcium carbide, calcium silicate and soda ash.

The importance of sulphur removal and the huge costs involved have led the worldwide efforts to develop and implement an array of different desulphurising technologies. Different reagents and delivery systems are used as a result of local economic and environmental factors and the preferences of technical and operating management at individual plants. Aside from local economic and environmental conditions (disposal of soda ash laden slag has become environmentally unacceptable), other important factors include the reaction vessel selection, cycle time required, and slag management.

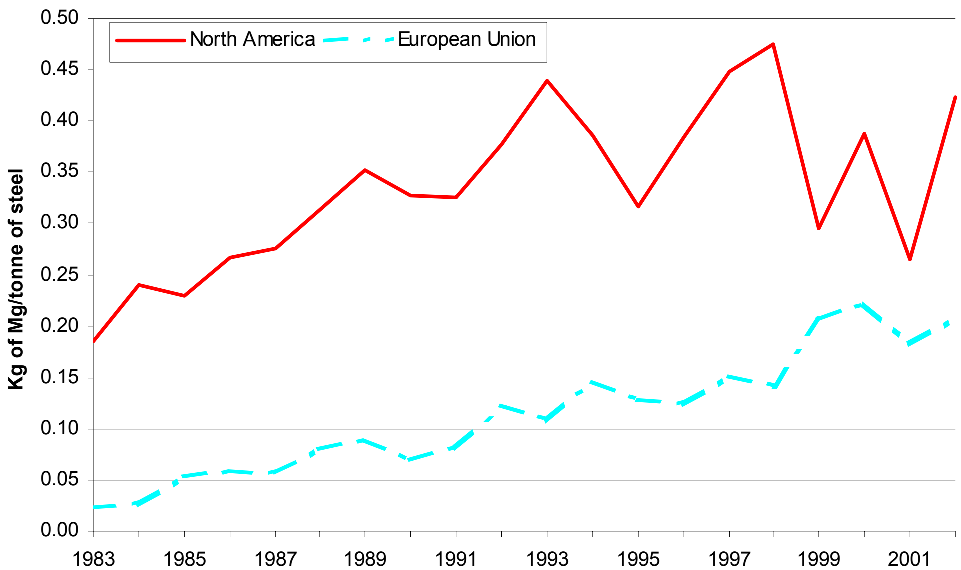
In the 1980's, typical steel products (flat rolled steel, etc) had a sulphur content of 0.015%. Those same products in the 1990's have a sulphur content of 0.010%. At the same time, steel which could generally be classified as low sulphur made up about 60% of the market in the 1980's, and now makes up close to 80%. The amount of magnesium required to desulphurise steel increases exponentially with the sulphur content. There have been three parallel drivers:

1. Improved technology has reduced the costs of desulphurising steel.
2. Increasing demand for lower sulphur content steel.
3. Increased tolerable use of higher sulphur coal as a result of availability, lower cost and technology being available to desulphurise hot metal at lower cost.

The increased use of magnesium has not been the result of it replacing a less effective reagent. It is the result of advancing technology allowing the more economic reduction of sulphur in all grades. This has increased the use of reagents generally. Most steel producers can and do readily switch between calcium carbide and magnesium according the cost and technical considerations. In fact many steel makers use both in fuel injection systems. The use of magnesium in desulphurisation is thus very price sensitive.

Figure 3-13 shows the consumption of primary magnesium for steel desulphurisation relative to the total production of steel in North America and Europe. Since the early 1990's, there has been little growth in North America's rate of consumption, primarily because advances in desulphurisation methods have resulted in the use of lower quantities of magnesium. In Europe, however, there has been considerable growth, and application rates are now approaching those used in North America.

FIGURE 3-13: CONSUMPTION OF PRIMARY MAGNESIUM FOR STEEL DESULPHURISATION



Source: Hatch, from IMA and IISI data

As outlined in Figure 3-14, North America and Western Europe are by far the largest regional markets for primary magnesium used in steel desulphurisation, and collectively account for 85% of this use. The strong growth in desulphurisation by magnesium is the result of growth in all regional markets, but particularly in Western Europe. Note, however, that western world growth slowed in all regional markets during the past decade.

FIGURE 3-14: WESTERN WORLD DEMAND FOR PRIMARY MAGNESIUM USED IN STEEL DESULPHURISATION

Region	% of 2002 Demand	Annualized Growth (1983 to 2002)	Annualized Growth (1992 to 2002)
North America	49%	5.2%	0.8%
Western Europe	36%	11.9%	5.0%
Latin America	8%	N/A	N/A
Asia & Oceania	6%	8.1%	N/A
Africa & Middle East	1%	N/A	N/A
Total	**100%**	**7.7%**	**4.1%**

Source: International Magnesium Association (2002 demand estimated using actual data for Q1, Q2, Q3 plus an estimate for Q4 based upon the average of Q1, Q2, and Q3)

3.4.4 Other

Other uses of magnesium are declining in total, over the period 1983 to 2002 they declined by 2.5% per year on average. Uses such as wrought products are increasing slightly, but all other applications, such as nodular iron, electrochemical, chemical, metal reduction, and gravity castings are declining.

3.4.4.1 Nodular Iron

Magnesium demand for nodular iron applications was 3,200 tonnes in 2002. The addition of magnesium to molten cast iron causes the graphite to be precipitated as small spheres (nodules). Magnesium is added to molten iron normally in the form of ferro-silicon magnesium, nickel-based magnesium alloys, salt-coated magnesium granules and pure magnesium. Nodular iron is used in the manufacture of ductile iron pipes and die-cast parts for machinery. This product area is facing serious competition from plastics in particular. The amount of magnesium used to make nodular iron appears to be dropping. The decline in consumption rate is the result of using cerium that is more expensive, but allows an individual heat of iron to be held longer without deterioration.

3.4.4.2 Electrochemical

Electrochemical applications consumed 5,300 tonnes in 2002, 1.5% of total western magnesium demand. Magnesium has a very high electronegative potential (-2.4 volts) that makes it ideal for sacrificial anodes to prevent corrosion in pipelines and other steel installations and various types of batteries (including seawater/magnesium batteries for use in life vests). Batteries account for approximately 10% of electrochemical use. Magnesium is not practical for consumer batteries, as the voltage generated is 25% too high. They do have advantages for special battery application including long shelf life.

3.4.4.3 Chemical reagents

Chemical reagents consumed 4,600 tonnes in 2002, 1.3% of total western magnesium demand. Reductants are used in the production of titanium, beryllium, zirconium, hafnium, and uranium. Magnesium plays an irreplaceable role in the production of these metals, but is recyclable. It is also used in the Grignard process in the production of perfumes, pharmaceuticals, and organometallic compounds, most notably tetra-ethyl lead. This last use has fallen dramatically and has been the major cause for the drop in magnesium chemical applications.

3.4.4.4 Wrought products

Automotive after-market, primarily high performance wheel rims that are 97% magnesium. This category represents 2.3% of magnesium shipments, 8,100 tonnes in 2002.

3.4.4.5 Gravity casting

Large, limited run moulds, often sand casings producing parts that are 95% to 99% magnesium. This category represents 0.5% of total magnesium shipments, 1,700 tonnes in 2002.

3.4.4.6 Other minor applications

Magnesium also sees applications in photoengraving plates, hydrogen storage, and flameless heaters. This category represents 2.4% of total shipments, 8,600 tonnes in 2002.

3.5 Future Demand Assessment

Geography and application areas of demand for magnesium have been considered and observations have been made on what appear to be the underlying drivers of greater or lesser use over time. This section provides an assessment of the likely future course of demand.

One can examine the aggregate trend in demand for a metal and seek to forecast the extension of this trend into the future. However, this takes no account of the impact of the different drivers of consumption either by application or by geography. In order to create an informed view of demand one must examine the constituent elements. In the case of magnesium, the place to start is to look at the dynamics of usage growth in each area of application, because these are very different.

There are four distinct application areas that have been identified and discussed:

- Inclusion as a constituent of aluminium alloys
- As die-cast magnesium
- As a reagent in the desulphurising of steel
- In sundry other uses

3.5.1 Aluminium Alloys

This presently accounts for the largest proportion of use of magnesium. It is used in most aluminium alloys but in content ranging from less than 1% up to 5%. The principal segments of application of the subsequent alloys are in automotive, packaging, construction and other uses.

The automotive industry has been rapidly switching parts to aluminium alloys over the last ten years. North America has been the leader in terms of growth and volume of such alloy use in its pursuit of reduced weight and better fuel consumption. Since 1985, U.S. aluminium growth in automobiles has averaged 6.5%. However, between 1991 and 2001, growth in the U.S. market was 8.1%. The rest of the world has lower weight intensity per vehicle of such alloys, in large part because of smaller vehicles. On balance, the world growth rate is likely to be around 7.0%.

Packaging has seen a domination of metal drinks containers in North America by aluminium but a more even split with steel in Europe and Asia, where the steel companies are stronger in resisting the challenge. The US alone accounts for one in two of every canned drink consumed in the world and are disproportionate in its impact. Other materials for containers have gained ground rapidly however. Plastics (PET) and coated card have taken a large slice of the market for glass in North America and nibbled away at the cans segment. This trend will continue across the world, but conditioned by the container production and distribution infrastructure available in each country. Growth in Asia is likely to be matched by decline in Europe and North America in aluminium use. On balance the world growth rate is likely to be around 1.0%.
Use of aluminium in construction is well established in window and doorframes, cladding and a variety of other applications. Some penetration growth can be expected but not dramatic. Overall growth tends to shadow GDP with mature countries behind GDP growth and newly industrialising and developing countries ahead. On balance worldwide, this is likely to yield a growth rate around 2.0%.

All other segments of use have been growing moderately. This strength in growth is likely to be similar to the growth rate experienced over the last decade of 2.0% per year.

Our assessment of the relative growth rates in each and the aggregate impact on demand are detailed in Figure 3-15:

FIGURE 3-15: FUTURE DEMAND GROWTH FOR MAGNESIUM IN ALUMINIUM ALLOYS

Aluminum Alloy Application Segement	Proportion Of Aluminum Use Accounted For	Assessed Growth Rate of Aluminum	Weighted Growth Rate for Aluminum	Weighted Growth Rate for Magnesium with Constant 0.78% Mg Content	Weighted Growth Rate for Magnesium with Mg Content Declining by Historical 1.9% per Annum
Transportation	35.0%	7.0%	2.5%	3.9%	1.9%
Packaging	25.0%	1.0%			
Building and construction	15.0%	2.0%			
Other	24.0%	2.0%			

Source: Hatch

The weighted growth across all the aluminium alloys sectors comes out at 2.5%, and the weighted growth rate for magnesium in aluminium alloys is estimated to be 3.9% if the current application rate of 0.78% magnesium is maintained. However, if the magnesium application rate continues to decline at its historical rate of 1.9% annually, the weighted growth rate for magnesium in aluminium alloys is estimated to be 1.9%. Hatch estimates that the growth rate for magnesium in aluminium alloys is likely to be 2.9%.

3.5.2 As Die-Cast Magnesium

The automotive industry dominates the use of die-cast magnesium in alloy form. The interest in North America has been strong. The price of magnesium is the greatest restraining influence on automotive demand, together with the need for new alloy and application development. Its use is still only about 3% of that of aluminium in North American automotive.

Nevertheless, its use in North America is more intense than in Europe and Japan. Its penetration is growing at around 10% to 15% in the former, 10% to 20% in Europe, and perhaps 15% to 30% in Asia. Although historical growth has been stellar, GM's recent announcement about replacing the magnesium IP support beams in its 2006 line of pickup trucks is cause for reduced optimism. On average, the weighted impact was assessed at 10.0%. The automotive output as a whole is expected to grow at the same rate as GDP, and hence aggregate growth is estimated to be 10.0%.

3.5.3 As a Reagent in Desulphurising of Steel

This third significant usage has also grown strongly over the last decade. It is effective and quick as a reagent but there are competitive alternatives. There is price sensitivity here too. An equilibrium point has already been reached in North America and Europe.

Future demand is thus dependent on the volume growth of steel production. As the most mature of the metals applications and with greater efficiency in reduced weight per application the growth rate lags behind GDP in the mature economies leaving faster growth in Asia after the recovery to provide some counterbalance.

Overall the assessed growth here is around the 1% to 2% mark and a figure of 1.5% was adopted.

3.5.4 Other uses

Demand here has been in decline. Historic materials and applications are slowly eroding. There is no reason to expect any change in this decline running at –4.5% per year.

3.5.5 Western World Magnesium Demand Forecast

These various application areas are brought together to construct a world forecast (Figure 3-16). This takes these assessed growth rates and presumes they will apply for the next 10 years.

FIGURE 3-16: WESTERN WORLD MAGNESIUM DEMAND FORECAST

Application of magnesium	Assessed growth per year (%)	2002 Base Demand ('000 t) 1.	Forecast consumption ('000 t) 2007	Forecast consumption ('000 t) 2012
Aluminium Alloys	2.9%	140.3	161.9	186.8
Die-casting	10.0%	127.3	205.0	330.1
Steel Desulphurisation	1.5%	54.8	59.1	63.6
Other	-4.5%	32.6	25.9	20.6
Total	**4.9%**	**355.1**	**451.9**	**601.1**

Note: 1. IMA shipment statistics

Over the next 10 years, the aggregate growth rate for western world primary magnesium demand is projected to be around 4.9%, from 355,000 tonnes in 2002 to 452,000 tonnes in 2007 and 610,000 tonnes in 2012. This is a healthy rate of growth. This forecast does not address the impact of changes in magnesium price.

Across the four application areas there is a very different sensitivity to price. This is normally referred to as the elasticity of demand to price. In aluminium alloying, the use of magnesium is to make industry standard alloys. Some minor switching is possible between alloys with different percentages of magnesium but similar attributes. However the real elasticity of demand is small. In the declining other historic uses it is also small. However, in die-casting the end user has alternative material choices available if he can overcome the time and expense of switching. This presents little problem to the steel maker either. The automotive manufacturer or first tier supplier has higher barriers to cross to switch. And this extends the reaction time before magnesium demand is affected. But if the price movement in magnesium is sustained in either direction then there is a significant elasticity of demand.

In our estimations of elasticity, given the current split of consumption across the applications, a 10% move up or down in the price of magnesium could result in a matching fall or rise in demand of 7%. However, the elasticity is probably not linear and a greater fall in price would likely lead to a much greater demand from die-cast use in automotive.

There has been recognition for many years that magnesium has the physical characteristics and properties to allow auto producers to achieve significant savings in vehicle weight, resulting in improved fuel efficiency. To date, auto producers have mainly focussed on other, more cost-effective approaches to this problem, including changes in engines, use of aluminium in place of cast iron, and other design changes. In the upcoming decade, there could be a much greater interest in magnesium use even that has been projected in the consumption forecast above. While this greater growth is speculative, given the appropriate driving factors (e.g. much higher fuel costs, increasing government fuel efficiency mandates, more competitive magnesium prices) magnesium demand in the 2012 period could be at least 50% higher than our best estimate. This would result in a western world demand of over 900,000 annual tonnes.

4. Supply and Price

4.1 Supply Overview

Supply of new magnesium into the western world markets comes from primary producers in the west, and exports from the CIS and China. The statistics of primary (new) magnesium supply are developed by the IMA and are generally believed to be meaningful but not necessarily exact on a year-to-year basis.

In addition to primary magnesium, there is a certain amount of recycling of magnesium wastes and scraps in several forms, including new industrial scrap from the production of magnesium mill products and castings, old, post consumer scrap from discarded items such as cars, and magnesium contained in aluminium alloys which is recycled in the aluminium industry. The recycling of magnesium in these forms is not considered part of the market for primary magnesium, but as part of the underlying demand equation. Thus, scrap is not considered a part of supply in the context of this analysis.

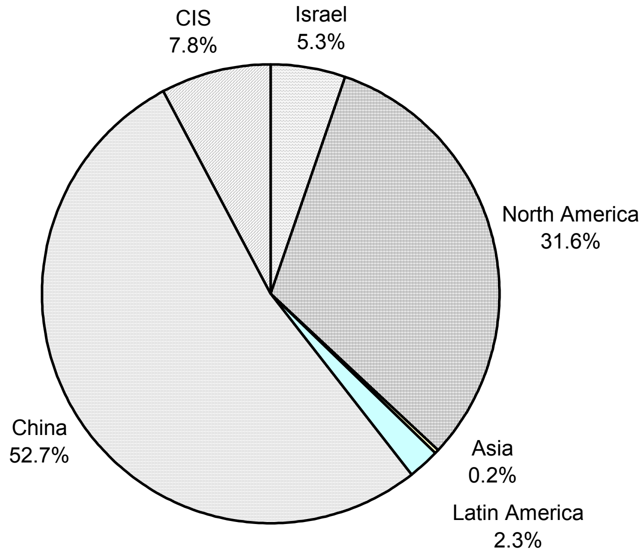
Over the past decade there has been a dramatic alteration in the supply situation for primary magnesium, and this change has reached a peak in 2002-2003. In the 1990s, old plants producing magnesium by a variety of technologies in both the west (US, Western Europe, Japan) and in the CIS were closed. The traditional western world leader in magnesium production and market development, Dow Corporation completely exited the business in 1998. In the last two years, important, long time producers in Norway, France, and the US have permanently ceased production. Meanwhile, increasing supply to the western markets from China and the CIS has altered the traditional business relationships in the magnesium markets.

4.2 Current and Historical Supply

The world supply of primary magnesium is small compared to industrial metals such as aluminium. Western world primary supply of 355,000 tonnes in 2002 is only about 1.7% of that of aluminium, its most important competitor. Primary magnesium is produced by only five western-world companies, the largest of which has a capacity of approximately 45,000 tonnes per year (or, at current market prices, about US$ 100 million in product value). For all except one of the large western producers, magnesium is a minor part of their overall corporate activity.

The recent growth in capacity, output, and supply to the western markets from China has been dramatic in the last five years. As shown in Figure 4-1, China represents over 50% of an estimated world primary magnesium capacity of 512,000 tonnes per year today.

FIGURE 4-1: REGIONAL DISTRIBUTION OF MAGNESIUM CAPACITY, 2003

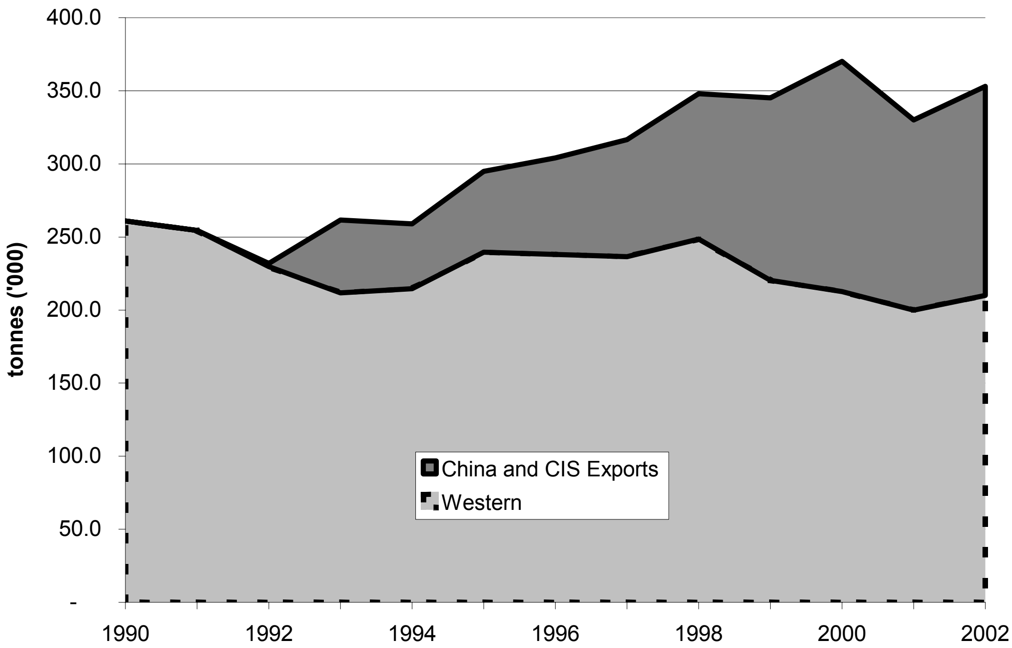


Source: Hatch Estimates

As shown in Figure 4-1, China has the largest primary magnesium capacity, and based on available statistics, is also the largest producer and supplier to the western markets. Western European capacity has been completely eliminated by plant closures. North American capacity, which was reduced by approximately 50% by the closure of Dow in the 1990's, was in the process of being increased back to near the earlier levels by the start-up of the new Noranda Magnola plant and incremental expansions (the chart above includes the Magnola capacity, although the company has announced its intention to cease production and mothball the plant until market conditions improve).

The history of the supply of primary magnesium is shown in Figure 4-2.

FIGURE 4-2: REPORTED WESTERN WORLD SUPPLY OF MAGNESIUM



Sources: USGS, CRU, Hatch Estimates

Estimated supply has grown on average by 3.5% per year over the period 1985 to 2002. There were 355,000 tonnes of primary magnesium reported to have been supplied to the western markets in 2002, including 210,000 tonnes (or 59 %) from western producers and 143,000 tonnes (41%) from Chinese and CIS producers.

Since the early 1990's there has been considerable movement in plant closures and openings for such a small industry. Driving the closures has been economic collapse in the CIS and unsustainably high production costs and pollution problems at older Western plants. Many of these reductions were in the early 1990's recession and manifest themselves in the drop in total production from 1991 to 1993. The largest losses of capacity, however occurred in the period 1994 to 2002 with the closure of Dow Chemical's US plant, plants in Norway, France, and the US, and specific plants in the CIS, as shown in Figure 4-3. Of all the major Western primary magnesium plants active in 1990, only two continue to operate, and these were built in the late 1980s.

The closures of western and CIS capacity has been more than offset by increases in capacity in China, one medium sized plant In Israel, and the Noranda Magnola plant in Canada.

FIGURE 4-3: PLANT CLOSURES AND NEW CAPACITY, 1991 TO 2002

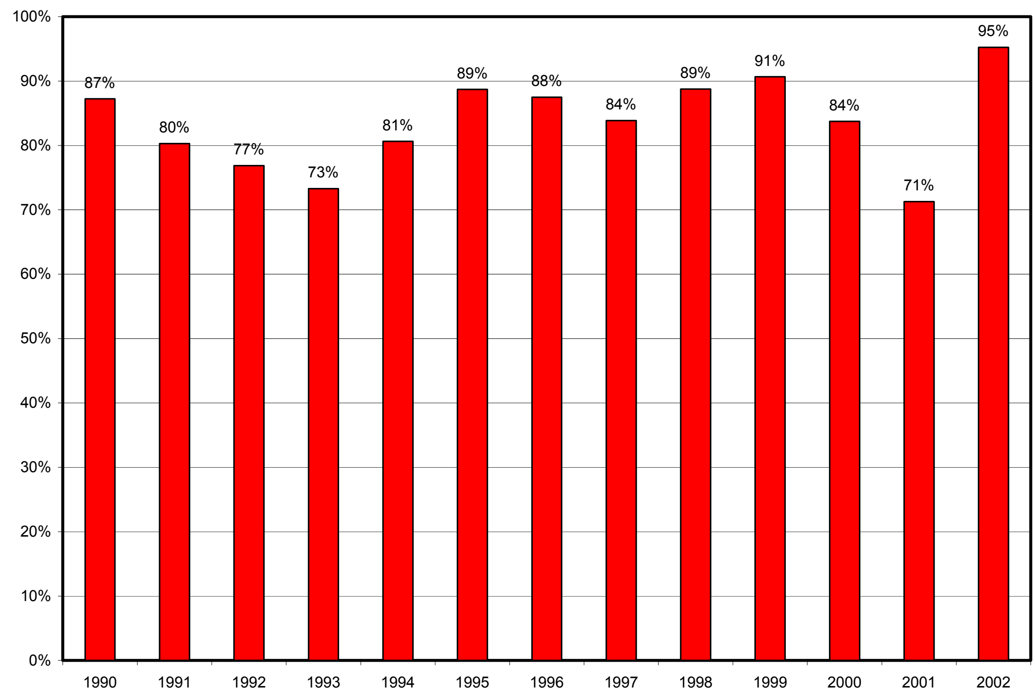
Company/Plant	Country	Tonnes ('000)	Year
Closures			
Magnesium Corp.	Canada	13	1992
Timminco	Canada	3	1992
Zaporozhyre Works	Ukraine	2	1992
SAIM	Italy	8	1992
Nichija Magnesium	Japan	6	1993
Norsk Hydro	Norway	6	1993
Tamil Nadu	India	1	1994
Ube	Japan	8	1995
Dow Chemical	United States	35	1995
Ust Kamenogosk	Kazahkastan	5	1997
Avisma	Russia	15	1994
Kaluzh	Ukraine	20	1998
Dow Chemical	United States	65	1998
Bela Stena	Yugoslavia	5	1998
Pechiney	France	17	2001
Norsk Hydro	Norway	42	2002
Alcoa NW Alloys	US	43	2001
Total closures		192	
New Capacity			
China	China	300	1995-2002
Noranda Magnola	Canada	63	
Mag Corp	United States	4	1995
DSM	Israel	25	1997
Total new capacity		392	
Net Change		**200**	

Source: Hatch Estimates

4.3 Capacity Utilisation

Capacity utilisation in the western world primary magnesium industry has varied between 71% and 95%, with the average being 84% since 1990. This historical trend is shown in Figure 4-4. This statistic may actually understate the percent of practical capacity being utilised, as new western plants have had protracted start-up periods. This cyclicality in utilisation has been the result of year to year changes in magnesium demand, in supply from China, and of particular importance, closures of western primary capacity in particular periods, such as 1998 (Dow) and 2002 (NW Alloys, Norsk Hydro Norway).

FIGURE 4-4: WESTERN WORLD PRIMARY MAGNESIUM INDUSTRY CAPACITY UTILISATION



Source: Hatch estimates

Note: Utilisation calculated as production as a percent of estimated capacity

4.4 Supply Issues

The major increase in primary magnesium supply to the western world markets from China is the result of a large number of capacity additions at many relatively small plants using an old technology which is considered obsolete and uneconomic in the west. This silico-thermal process (Pidgeon Process) is labour intensive and small scale. On the other hand, it has the advantages of great simplicity, direct utilisation of low cost thermal energy (coal in China) rather than electricity, and very low capital cost for expansion or new plants, both in terms of cost per unit capacity and absolute dollars.

Older western plants, both thermal and electrolytic, became obsolete and unsustainable in the 1990's because of environmental problems requiring investment, high-energy costs at certain locations, overall age of some major plants, and the need for reinvestment. Of course, these were exacerbated by the construction of new capacity using improved technology and achieving lower operating costs in the west, the increasing competition from low priced exports from Russia and China, and a lower rate of market growth than had been forecast by many industry participants.

Even before the recent severe price competition in the western markets, expansion of capacity utilising new and improved electrolytic technologies in the west were held back by three significant factors:

- Magnesium production creates CFC's, chlorine gas and a number of other residues that can enter the environment. Permitting of large plants has been difficult as a result of it being a large point source of pollutants. For example, Norsk Hydro encountered this problem in Quebec, and Dead Sea Magnesium is also expected to encounter problems as it attempts to carryout its expansion plans.
- Magnesium production on any scale tends to be difficult technology to operate profitably. There have been failures in the past, and Hatch is of the opinion that a number of the plants currently in the planning stages now will not come to production due to financial and technical hurdles.
- Magnesium has in practice proved to be far more capital intensive than its chief competitor, aluminium. New large electrolytic magnesium plants are being completed for approximately US$ 12,000 to US$ 14,000 per annual tonne compared to US$ 6,000 to US$ 7,000 per tonne for aluminium (including the alumina production plant). In comparison, steel mini-mills can be as low as US$ 250 per tonne. Raising capital for production of a metal with awkward technology and a very small market is difficult.

4.5 Developing Supply

Figure 4-5 shows some potential new entrants and expansions currently being proposed. Of these, only the Australian Magnesium (AMC) project and the US Magnesium capacity addition are actively under way.

FIGURE 4-5: POSSIBLE NEW ENTRANTS/EXPANSIONS

Company	Capacity Added ('000 t)	First Year of Production	Comments
AMC, Australia	90	2004	Construction started
Chinese Producers	50	2003	Continuing additions
US Magnesium, US	10	2002	Move to larger cell size continuing
Cogburn, Canada	131	Na	Project under development
SAMAG, Australia	70	Na	Project under development
MAC, Rep. Of Congo	60	Na	Project under development
Mt. Grace, Malaysia	90	Na	Project under development
Others	-	-	Other proposals for new projects in Australia, Iceland, Canada and expansions and restarts in the CIS have been announced.

Source: Hatch

There are a number of significant barriers to entry associated with a new green field magnesium plant. The technology is complex, and failed attempts have often involved an inability to operate the technology economically. Complexities also come into play during construction, and budget and schedule overruns are frequent. Related to the complexity issue is also a lack of skilled engineering and operator personnel. This impacts all parts of the operation from commissioning and start-up, through operating and maintenance and to product quality issues. Marketing can be difficult as the most rapidly growing sectors of demand are very price sensitive. Environmentally, magnesium plants have serious pollution problems.

Current western world capacity is approximately 200,000 tonnes per year, and including estimated capacities of China and the CIS, world capacity is estimated at approximately 500,000 tonnes per year. Projects listed in Figure 4-5 that are being implemented currently represent an additional 150,000 annual tonnes at eventual capacity, and would bring western capacity to about 300,000 tonnes, and world capacity to just over 750,000 tonnes.

However, it is also likely that additional capacity may be removed from the industry. We believe that it is likely that the higher cost segment of the Chinese industry will be unable to compete, or will be simply replaced by the more cost-effective capacity being built. This will result in the about of 100,000 annual tonnes being taken out of the industry, leaving a world capacity of 650,000 tonnes in 2010, assuming no other magnesium project proceed. Hatch believes that this represents a reasonable basis for estimation of the opportunity for additional production to enter the market.

Based on the demand forecasts discussed earlier, the magnesium supply-demand situation in circa 2010 is presented in Figure 4-6:

FIGURE 4-6: MAGNESIUM SUPPLY/DEMAND CIRCA 2010

	Hatch Most Likely Case	Hatch Optimistic Case
Western World Demand	600,000	900,000
Western World Production	270,000	270,000
China, CIS, and FCC Demand	100,000	100,000
China, CIS Production	315,000	315,000
Total World Demand	700,000	1,000,000
World Production	585,000	585,000
Additional Capacity Required, World	115,000	415,000

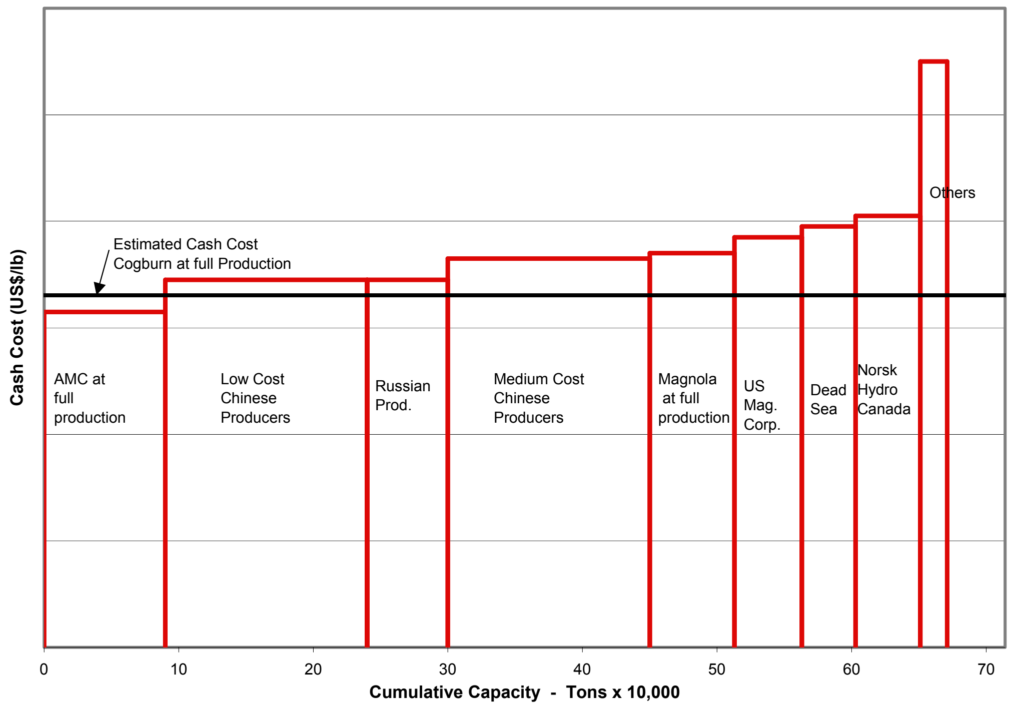
4.6 Primary Magnesium Capacity and Operating Costs

In addition to the assessment of future primary magnesium supply for the purpose of evaluating the likely supply-demand conditions for a new entrant in the middle of this decade, it is also important to examine the estimated production costs of the various existing and likely producers. In an industry such as primary magnesium, this is no easy task. However, Hatch, with inputs from a wide variety of published and unpublished sources has made estimates of production costs for major producers and producing locations. In each case, these estimates are based on an understanding of the processes being utilised, the input requirements per unit of production (e.g. raw material, process materials, energy, manpower, maintenance materials, etc.) and the unit costs of these inputs.

While we believe that the estimates are useful for setting the industry's costs in perspective, it should be noted that the degree of confidence one can have in the absolute costs vary significantly. Costs of producers in the US and Canada are likely to be more accurate than costs in Russia or China. These cost assume facilities are operating at near full capacity levels, and are not in a start-up situation. There are significant costs, especially in the large, modern electrolytic plants that are fixed over a substantial range of volumes, and unit costs at reduced output and during start-up are significantly higher. In addition, these cost reflect exchange rates of 2001, and major change in exchange rates would affect relative costs in a significant manner.

The capacity and cost graph presented in Figure 4-7 is based on estimated cash costs of production in 2001 US dollars per pound, in the 2005 time frame. The producers included are those currently in place, with incremental capacity increases in some cases, plus the Australian Magnesium Corporation facility, and with the highest cost portion of the current Chinese industry replaced by the lower cost capacity currently being built or starting up.

FIGURE 4-7: PRIMARY MAGNESIUM CAPACITY AND COST CURVE



Source: Hatch estimates

These cost are at the point of production, and do not include the cost of packaging and shipping the materials to markets, including freight, insurance, taxes and duties, and broker or trader commissions. In the case of all producers, but effecting AMC in particular, this cost does not include the cost of servicing the substantial debts that will be in place when the facility starts up.

On a cash cost basis, the range of costs is relatively small for the industry as a whole, with a difference between the lowest and highest cost major producers (ignoring the "Other" category) of fewer than 30%.

Based on the preliminary cost estimate for the Cogburn Project, its cash operating cost at full production can be estimated to be in the lower half of industry costs, somewhat above the costs of AMC, the lowest cost Chinese producers and the Russian producers, but below the costs of the medium cost Chinese producers and the other western world (Canadian, US, Israeli) producers.

4.7 Magnesium Prices

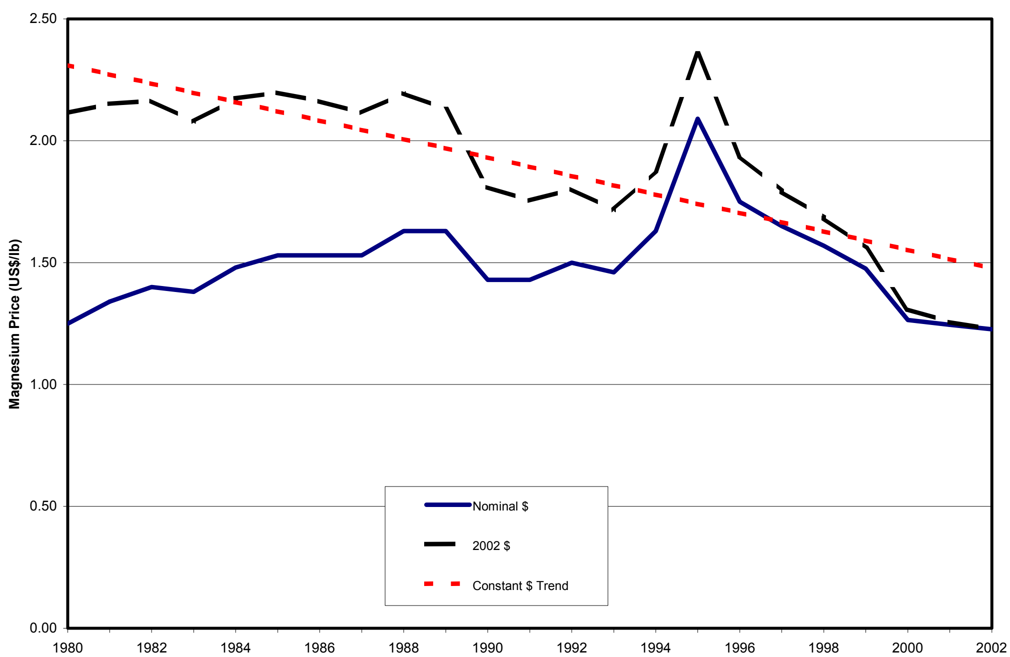
Until the early 1990's magnesium prices were effectively set by the major producers; Dow in the US, and Norsk Hydro in Europe. There was little if any export of magnesium from China or the USSR/CIS. Actual magnesium transaction prices between the major producers and major customers were not transparent (known to the outside world). There has never been a terminal market (e.g. LME, Comex) price for magnesium.

In the mid 1990's magnesium from the new sources began to have a significant impact on transaction prices. As is typical in the introductory phases of exports from new sources unfamiliar with the western markets, producers, and more importantly, traders, acted based only on short-term factors in order to move the volumes available to them, and to obtain the best prices they believed were possible at the moment. As the volume of material available for export increased, especially from China, the major western producers were forced to react to the imported prices, and so-called "free market" pricing became significant and published.

4.8 Long Term Pricing in the US

The following graph (Figure 4-8) shows the US price for magnesium, as published by the USGS, from 1980 to 2002. In nominal (dollars of the day) terms, magnesium prices showed a steady, slow, increase from 1980 to 1990, a modest decline in 1991, steady until 1994, when prices, now transaction based instead of producer list based, surged to an historic peak in 1997. This peak was driven by both strong real demand and short term concerns. Interestingly, other metal commodities such as pig iron, aluminium ingot and copper cathode also peaked in this period.

FIGURE 4-8: U.S. MAGNESIUM PRICE HISTORY



Source: USGS

In constant 2002 dollar terms, the US magnesium price was essentially flat in the 1980's, and has been highly cyclical in the 1990's and the first three years of the new century. The steep decline in both current and constant dollar terms since 1996 has brought magnesium prices to a low point in 2002, which is below even the nominal dollar price in 1980.

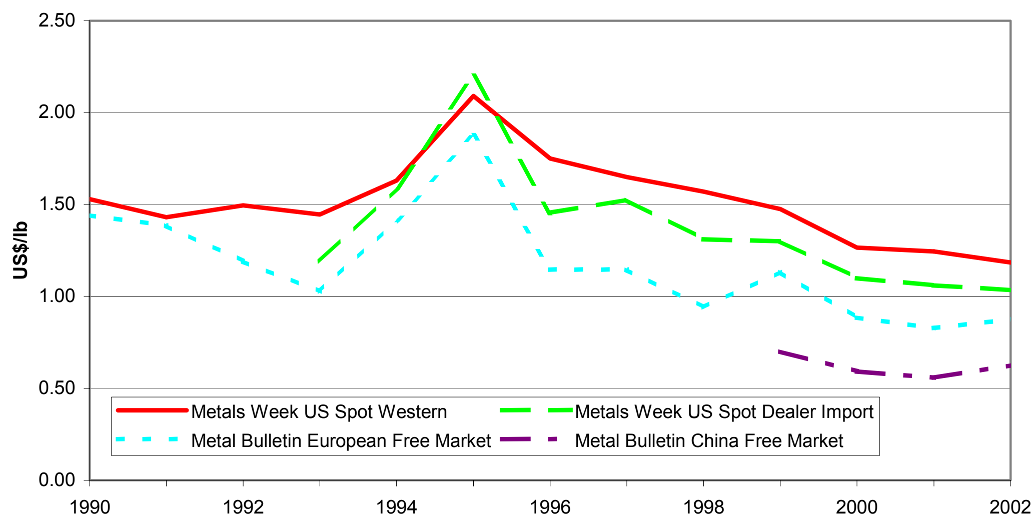
In constant dollar terms, the long-term trend in magnesium prices over the period shown in the graph is a decline of 1.9% per annum. While the extreme volatility in price over the last decade is, perhaps, the characteristic of the magnesium price that stands out, this longer-term trend is not unusual for metal commodities.

It should also be noted that the 2002 trend-line price, based on the constant dollar trend, is US$ 1.48 per pound, substantially higher that the actual price of US$ 1.23. In a cyclical business, it is certainly to be expected that actual prices will be substantially below and above the trend price depending on market and supply conditions.

4.9 Other Published Price Series

In addition to the US nominal, constant dollar, and trend prices discussed above, the emergence of new magnesium sources, especially trading companies selling Chinese, and to a lesser degree other material, has resulted in several price series being published by metals industry periodicals, specifically Platt's Metals Week in the US, and Metal Bulletin in Europe. Some of the price series go back to 1990, while others have only started in the last several years. These price series are shown in Figure 4-9.

FIGURE 4-9: PRIMARY MAGNESIUM PRICES IN VARIOUS MARKETS



Sources: Metals Week, Metal Bulletin

The prices graphed in this chart show two significant facts in addition to the general up and down movement of magnesium prices over the last decade. These are:

- prices in the US have been consistently higher than prices in Europe. This may well be due to the presence of various special (antidumping and countervailing) duties on imports from various countries at different times, which were much higher than duties in Europe.

- prices specifically for imported material, which are believed to particularly reflect Chinese material, have been consistently below the general "spot market" prices in both the US and Europe. This may reflect differences in perceived material quality or value, as well as commercial factors related to the rapid growth in Chinese export material over the past several years.

- Chinese magnesium prices began to turn up slightly in 2002, increasing almost 10% in Europe between June 2001 and January 2003.

4.10 Future Magnesium Prices

At the published market prices for magnesium of early 2003, no producers, including the lowest cost Chinese, can make a profit on a full cost basis. The current prices are unsustainable, and further capacity reductions are inevitable unless prices begin to increase soon.

Existing plants represent sunk investment cost, and many have either been written down in value or depreciated to the point where there is little in the way of financial cost or depreciation to be covered. The Chinese plants have small investment levels, as the technology has a very low capital requirement. On the other hand, new large electrolytic plants, such as the AMC plant under construction now have large investments, and will have large financial costs to cover.

Magnesium production costs in the middle part of this decade (2005-2007) were estimated on a cash cost basis. Adding other corporate costs, freight, duties as appropriate, trader margins, and return on capital employed (interest and profit) gives a range of minimum acceptable selling prices for different producers.

We have examined the prices at which the projected suppliers to the US market achieve, on average, their full costs and some profit margin, and, the price at which the highest cost supplier achieves coverage of its costs, but no profit margin. This was done for each of the Base Case demand and the Optimistic Case demand.

The result of this analysis is that under the base case conditions, the weighted average cost plus profit, and the high cost without profit are both at a price of US$1.27 (2003 dollars) per pound, and under the optimistic conditions (which includes higher production and lower average costs for the producers), the average cost plus profit and the high cost, with less profit, are both at US$ 1.34 per pound. These prices are delivered to the Midwest US markets, and represent an average over time in a market, which will be cyclical, and will vary above and below these figures from year to year.

As indicated in the prior section, growth in demand for magnesium will require construction of new capacity, and major production facilities using modern technology at large scale will be necessary to satisfy sophisticated users such as the auto industry in the future, as such users are not likely to be willing to rely on production from small scale facilities such as those in China for major segments of their requirements. Based on recent experience, the production costs at such new, large scale facilities must be significantly lower than those of existing western capacity in order to offset their high capital-related costs and still be successful in the market environment expected.

We recommend that for planning purposes, a magnesium price, delivered to the Midwest US, of US$ 1.27 in 2003 dollars be utilised in the base case for the life of the project, with the recognition that in reality the price will decline slowly, and that the projects operating costs will need to be reduced over time in order to maintain operating margins. For the optimistic case, the average price would be US$ 1.34.

Examination of recent price differentials between pure metal and specification casting alloys shows a consistent premium of about 10% for the alloy material. This difference has held in China (export, fob port), in Europe (fob warehouse, Rotterdam) and in the US spot market). Therefore, we recommend using this 10% premium to determine the alloy prices in both the base and optimistic cases.