IMOA®
INTERNATIONAL MOLYBDENUM ASSOCIATION

NEWSLETTER

JANUARY 2007

Membership

Welcome to:

- **Baltic Enterprise Ltd**,
a Russian company involved in producing Mo Oxide and Ammonium Molybdate and in processing Mo- spent catalysts.

- **Cronimet Suisse AG**,
a Swiss company purchasing and selling molybdenum concentrates and ferro molybdenum.

- **Grand Build Metal International Co Ltd**,
a metal trading company based in Hong Kong distributing ferro alloy products for the Mo metallurgical and Mo chemical and metal industries.

- **Mitsubishi Corp**,
a Japanese company importing and exporting Mo Oxide and Ferro Molybdenum.

- **Moly Mines Ltd**,
an Australian company which owns 100% of the Spinifex Ridge Molybdenum/Copper Project, located in the Pilbara Region of Western Australia.

Readers' Email Addresses

We have plans for the electronic distribution of these Newsletters. Please send us the email address of anyone in your company or organisation who might be interested in receiving the link every six months by which access to copy on our website may be made.

18th Annual General Meeting, Vienna

Held in the home of the café, the waltz and the Heurigen (and, on a more exalted level, home for most of their lives to Mozart and Beethoven), the 18th AGM was hosted in Vienna by Plansee and Treibacher Industrie and attended by 140 delegates.

Bernhard Schretter, our host at the Palais Ferstel

In the stylish surroundings of the Palais Ferstel and to the delicate sound of Schubert stunningly played by a string quartet, Plansee entertained delegates to a feast in which any Habsburg would have been proud to share.

Delegates from Luoyang Luanchuan Molybdenum, Sheng Tong and Wogen at the Heuriger

By deliberate contrast, the next evening was celebrated by courtesy of Treibacher in the Heuriger "Mayer am Pfarrplatz", one of the famous wine gardens in Vienna. The informality did not in any way diminish the quality (or, indeed, the quantity) of the fare and stories are told of some delegates missing the bus and wandering back in the small hours of the morning.

Rainer Schmidtmayer welcoming delegates to the Heuriger

Many thanks to both companies for their kind generosity; and to Bernhard Schretter of Plansee and Rainer Schmidtmayer of Treibacher Industrie in particular for acting as hosts.

The first day of the AGM itself was devoted to HSE issues, notably the formation of a Consortium to administer the necessary procedures, including the collection of scientific data, to assist compliance by the molybdenum industry with impending REACH legislation (see page 7). At this time, the final touches are being put to the Agreement, particularly to the sections covering molybdenum products and financing, but all companies will be welcome to join (non-members on equal terms with IMOA members) if manufacturing in, or importing into, the EU.

On the second morning, the presentations covered a variety of topics and included:

- "Traditional and New Applications of Molybdenum Metal and Alloys" Dr Hermann Walser, Managing Director, Plansee Metall GmbH

- "Steel Production at Voestalpine Stahl Linz with Aspects of Using Molybdenum in Steel Plant" Mr Andreas Gantner, Voestalpine Stahl Linz

- "Current and Future Uses of Stainless Steel in Structural Engineering" Mr Graham Gedge, Associate Director, Arup Materials Consulting

- "Volatilities of the World Molybdenum Market" Mr George Song, Managing Director, Shangxiang Minmetals Inc

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Molybdenum – Uses, Consumption, Sources and Prices

As the moly market began to heat up at the end of 2003 after nearly twenty years in the doldrums (apart from a spike of activity in 1995), consumers inevitably began asking questions about a material they had for so long taken for granted and boards of directors began to take notice of a metal whose name was barely familiar but was now playing a substantial part in their companies' finances.

Whilst it is generally true (as George Song pointed out at the IMOA AGM in 2006) that 'prices will be up if supply cannot meet demand and will be down if the market is over-supplied', there is a duty on IMOA as an industry body to inform consumers as far as it can about what is happening in the market in terms of supply and demand. This article reviews the facts and figures available to IMOA itself in pursuit of transparency and the Association's goal to be the principal educational source about moly.

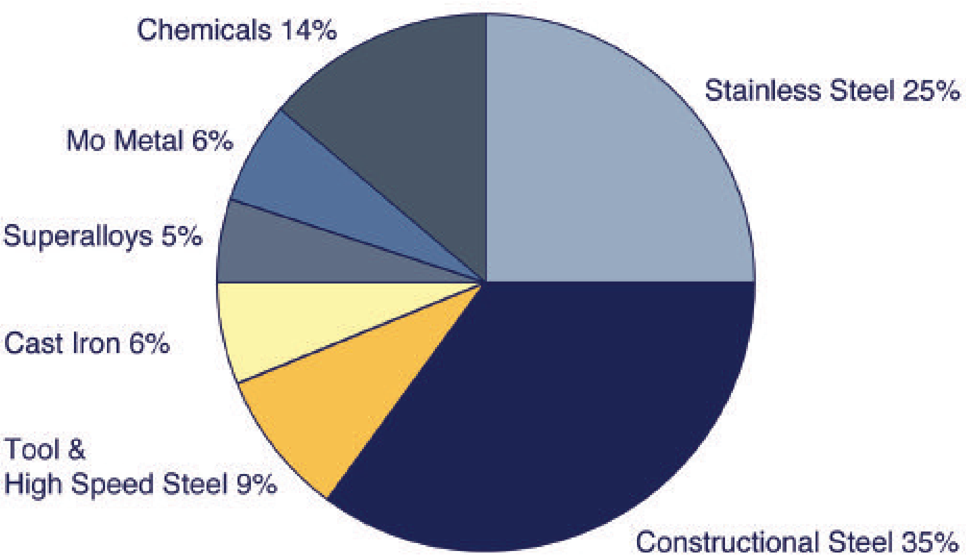

Figure 1:
First Use of Molybdenum. Total demand in 2005 was approximately 400 million pounds (180,000 t) (Source: IMOA estimates)

Figure 2:
TZM piercing plug for the production (rolling) of stainless steel tubes
(Photo courtesy of Plansee).

The article was originally prepared in response to requests from various organizations and companies that IMOA make a presentation to cover not only the usual technical side of moly but also an update on the market. Given the sensitivity of the Association to addressing any market issues because of antitrust considerations, IMOA is limited in its ability to comment on certain areas, but this article has proven successful in providing consumers with a clearer picture of the market.

Thanks are due to Dr Hans Imgrund for preparing the article, to the IMOA Technical Director, Dr Nicole Kinsman, for additional contributions ….. and to Counsel.

Effects and Uses

First use

About 75 percent of molybdenum is used in the form of technical grade products, i.e. technical molybdenum oxide and ferromolybdenum. These products are used as alloy additions to stainless steel, constructional steel, tool and high-speed steel, and cast-iron.

The other 25 percent is further processed and upgraded into chemical grade products for use as catalysts, lubricants, flame retardants, corrosion inhibitors and pigments. Pure molybdenum metal is also produced in this way and is, therefore, usually included in the category "chemicals".
It is not only used by itself as moly metal or in molybdenum alloys, but also as a high-purity alloying addition to super alloys.
In ***Figure 1***, however, the approximate distribution of first uses of moly separates "Mo metal" and "chemicals".

Figure 3:
Corrosion staining on stainless steel due to incorrect grade selection in a demanding environment

Effects and End Uses of Molybdenum

The most important properties of **pure molybdenum metal and molybdenum alloys** are their high melting point (in the order of 2600°C), high hot strength, high wear resistance, and good corrosion resistance. These products are often used in applications that require high strength at high temperature, whilst their coefficient of expansion and thermal conductivity also make them valuable to the electronics industry.

Examples of end uses include parts of industrial furnaces, support wire for tungsten filaments in light bulbs, glass melting equipment, electronic equipment, and metal and plastic forming equipment. ***Figure 2*** shows an example of metal forming equipment: a piercing plug for the production of stainless steel tubing made of TZM (a molybdenum alloy, dispersion strengthened with titanium carbide and zirconium oxide). The piercing plug has to have high strength and high wear resistance at the high rolling temperature of stainless steel.

Molybdenum as an alloying element in steel is almost always used in combination with other alloying elements such as chromium, nickel, vanadium, tungsten, or niobium.

In **Stainless Steels**, molybdenum is used in addition to chromium to increase corrosion resistance and about 10 percent of world stainless steel production contains molybdenum with an average molybdenum content of around 2.2 percent. The most important moly-grade stainless steel is the austenitic Type 316 (18% Cr, 10% Ni and 2 or 2.5% Mo) which represents about seven percent of global stainless steel production. In recent years, moly-grade ferritics have grown the fastest and now represent almost two percent of stainless steel production. Moly-grade ferritics include Types 444 (18% Cr, 2% Mo), 436 (18% Cr, 1.25% Mo) and 434 (17% Cr and 1% Mo).

The most important end uses of moly-grade stainless steel are industrial. The chemical and petrochemical, oil and gas, paper, power, water, food, and pharmaceutical industries use processing equipment made of moly-grade austenitic and duplex stainless steels.

Moly-grade stainless steel is also used in large quantities in architectural applications. The correct selection of stainless steel in these applications is essential to avoid unpleasant surprises such as shown in ***Figure 3*** where a moly-free grade was used next to the ocean. Because the stainless steel selected here is not corrosion resistant enough for this difficult environment, this sculpture has to be cleaned from superficial corrosion staining every year. This will not happen to the famous Atomium structure in Brussels (shown in ***Figure 4***) as the original aluminum cladding, which had deteriorated over the years, was replaced with long-lasting Type 316 moly-grade stainless steel in 2006.

In **Constructional Steels**, molybdenum enhances hardenability, strength and toughness, and elevated temperature strength. It is often used in combination with chromium and/ or nickel and

Figure 4:
The Atomium in Brussels is clad with Type 316 moly-grade stainless steel (Courtesy of Nickel Institute)

other alloying elements, with the molybdenum content typically between 0.2 and 1.2 percent. The steel categories include heat treatable engineering steels, case hardened steels, high temperature steels, oil country tubular goods and HSLA (High Strength, Low Alloy) steels. End uses of these grades cover the whole world of engineered products for automotive, shipbuilding, aircraft and aerospace industries; drilling, mining and processing industries; and energy generation. Parts include vessels, tanks and heat exchangers, gears and shafts, piping (***Figure 5***) and many more.

In **Tool Steels**, molybdenum contributes to secondary hardening (in combination with vanadium). It also separates the pearlite and bainite reactions, and therefore allows step quenching. Products made of tool steels include hand tools, knives and saws, forging dies, pressure casting moulds and molding plates; the typical molybdenum content in tool steels is around 0.8%.

In **High-Speed Steels**, molybdenum contributes to secondary hardening and is an important constituent of the primary M^6C carbide, which gives wear resistance to the steel. Principal uses are for cutting tools and saws for steel, cast and nonferrous materials, twist drills, milling cutters (***Figure 6***) and pushing tools, with an average molybdenum content around 5%.

Figure 6:
Mill cutters made of High Speed Steel with 5% Mo (Courtesy of Boehler Edelstahl)

Global consumption

As indicated already, the end-uses for molybdenum – containing products are mostly industrial and include energy generation, oil and gas, chemical processing, transportation, mechanical engineering, building and construction and fabrication. Global molybdenum consumption has increased at a pace of 3.5 percent per year over the last 15 years; but, in the last five years, it has accelerated to 6 percent per year (***Figure 7***).

Figure 5:
Pipelines made of High Strength Low Alloy Steel (Corbis)

Sources of Molybdenum

The main regions of molybdenum production (***Figure 8***) include South America, North America, and China. These regions accounted for 93 percent of global production in 2005 which was estimated to be 416 million pounds (190,000 metric tons).

By-product molybdenum

Roughly 60 percent of molybdenum produced is the by-product of another mining operation, most commonly copper production. Copper mines producing molybdenum as by-product usually have ore grades falling between 0.5 and 1.5 percent Cu (5 to 15 kg/t) and between 0.01 and 0.05 percent Mo (0.1 to 0.5 kg/t). Major operations mine more than 50 million tons of ore per year, producing in excess of 200,000 t of copper and between 5,000 and 15,000 t of moly (contained in MoS^2 concentrate) as by-product. For many copper producers, it is a small added step to extract molybdenum from the ore that is already ground up to extract copper. As the revenues from molybdenum are usually less than 10 percent of total sales, the molybdenum output of these mines typically follows the copper market rather than the demand for molybdenum.

Primary molybdenum

The other 40 percent of molybdenum produced comes from primary production, which in turn can further be divided into 25 percent located in China and the CIS and 15 percent in the West. Here the situation is fundamentally different: the initial investment for a primary mine in the West, with an annual production capacity in the order of 10,000 t of molybdenum (22 million lbs), requires several hundred million US Dollars. With ore grades running between 0.12 and 0.20 percent Mo, the production of 10,000 t of Mo contained in MoS^2

concentrate require mining and milling in excess of 5 million tons of ore per year. In other words, the production of primary molybdenum is significantly more costly than the production of by-product molybdenum. It is thus no surprise to observe that primary mines are the swing producers.

Market Observations

The movement of the molybdenum price has traditionally shown close correlation to the movement of the price for energy and to global investment cycles. More recently, increased demand from China has also played an important role. The development of the molybdenum price since the 70s is shown in ***Figure 9*** and it may be noted that the price was below four dollars per pound in ten of the last fifteen years.

In the twelve years between 1990 and 2002, global demand for moly increased by 58 million pounds (23%), as shown in ***Figure 10***. In the three years since, there has been an unusually strong increase in demand, plotted in ***Figure 11***. The increase in yearly demand of 90 million pounds between 2002 and 2005 corresponds to almost 30 percent of the annual demand in 2002.

Copper companies, as by-product producers, usually credit revenues from molybdenum sales against the cost of copper production. To improve their competitiveness, many copper producers have managed to increase the recovery yield of their molybdenum production and as a result, the amount of by-product molybdenum produced has increased significantly in the last 15 years. During that same time, domestic production in China and the availability of Chinese molybdenum for export to the West have also increased.

Meanwhile, production of Western primary molybdenum decreased by 25 million pounds, from some 90 million pounds in 1990 to 65 million

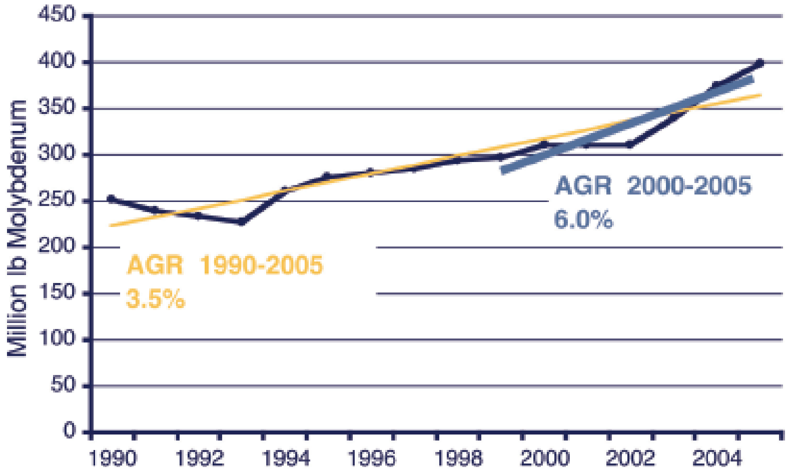

Figure 7:
Global molybdenum consumption between 1990 and 2005 (Source: IMOA)

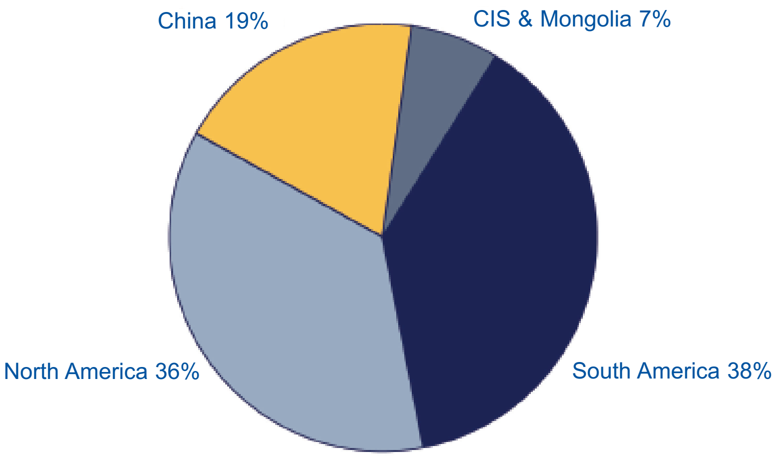

Figure 8:
Geographical distribution of global production (Source: IMOA)

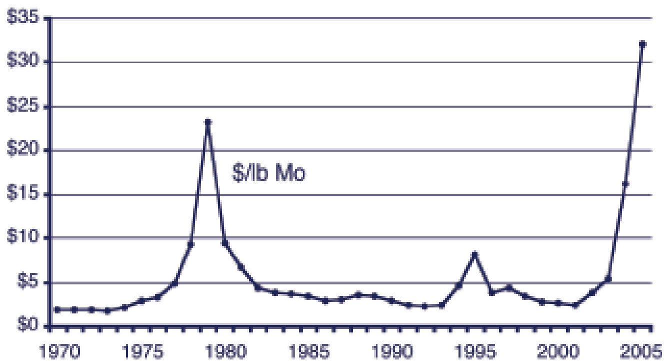

Figure 9:
Development of price of molybdenum between 1970 and 2005.
(Source: Metals Week)

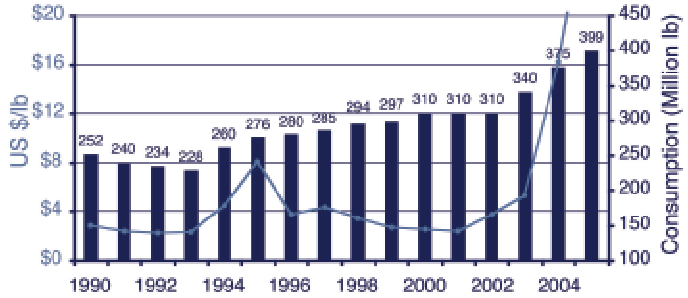

Figure 10:
Molybdenum demand and price from 1990 to 2005
(Source: IMOA, Metals Week)

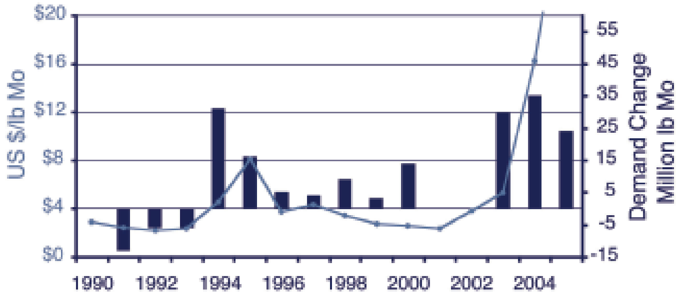

Figure 11:
Year-on-year change in demand and price between 1990 and 2005
(Source: IMOA, Metals Week)

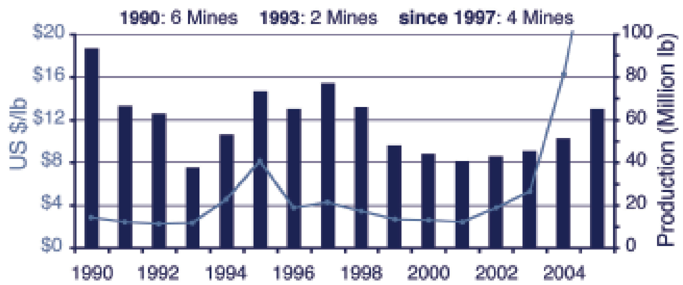

Figure 12:
Production of Western primary mines between 1990 and 2005
(Source: IMOA, Metals Week)

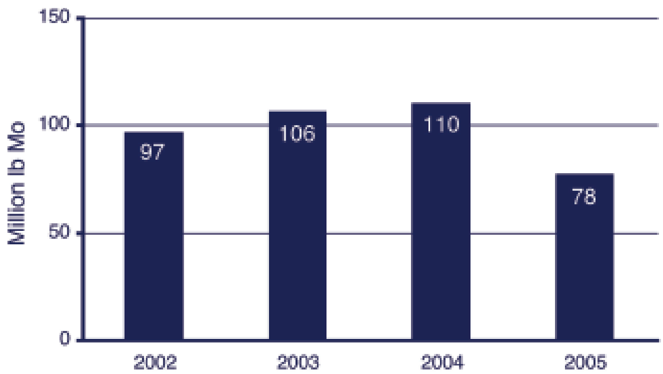

Figure 13:
Molybdenum production in China between 2002 and 2005
(Source: IMOA)

pounds in 2005, and the share of supply from Western primary molybdenum decreased from 36 percent to 15 percent. ***Figure 12*** shows how primary mine production follows the demand for molybdenum. Primary mines are only able to increase their production, or come back on-stream, when the market demand requires their additional, more costly, molybdenum.

Thus, the increase in demand of some 175 million pounds between 1990 and 2005 was largely filled by increased production from by-product producers and from Chinese primary producers.

Nevertheless, the sharp rise in demand in the last three years overwhelmed the supply side, which is usually able to react to small changes in demand. The estimated Western roaster utilization rate increased from 77 percent in 2003 to 94 percent in 2004 and reached 100 percent in 2005 according to estimates by Climax Molybdenum, presented at the 2005 Ryan's Notes Conference. At the same time, molybdenum production in China (with its own roasting capability) was not able to compensate for this limitation, because its production decreased in 2005 (***Figure 13***), mainly because the Chinese government had to close some mines due to safety concerns.

This combination of circumstances led to the current - and unexpected - tight supply of molybdenum.

Mine and Roasting Expansions

The tight supply situation and the relatively high market prices of molybdenum have led to numerous investment projects in mines as well as in roasting facilities. The Table shows a few of the projects that are currently under consideration according to www.infomine.com (the long lead times to production may be noted). Western world roasting capacities are also projected to increase from today's 340 million pounds to 410 million pounds by 2010.

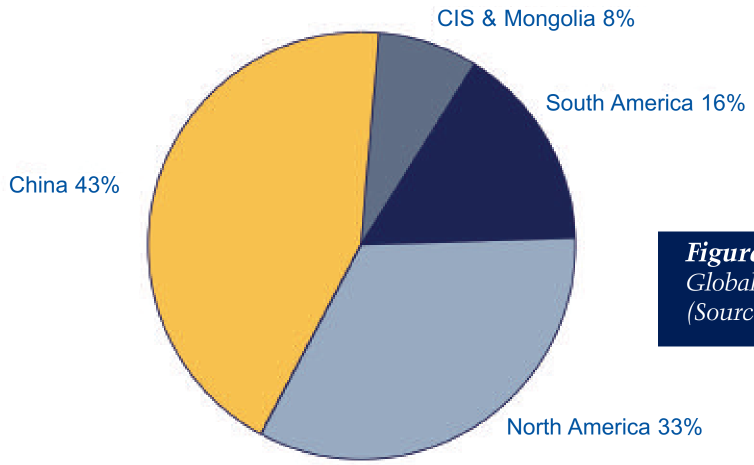

Figure 14:
Global Molybdenum Reserves
(Source: US Geological Survey 2006)

Global Reserves

According to the US Geological Survey of 2006, known reserves for molybdenum amount to 19 million metric tons, sufficient for 100 years at present consumption levels.

Mine		Announced Annual Capacity	Status	Production Start Indicated
		(Million lb Mo)		
Roca Mines - Max Moly	Canada	2.5	Under construction	end 2006
Bluepearl Davidson	Canada	5 to 10	Feasibility study	end 2007
Moly Mines -Spinifix Ridge	Australia	20	Feasibility study	end 2008
PD Climax mine	USA	20 to 30	Conditionally approved	2009
Mt. Hope Nevada	USA	35	Currently being permitted	2009
Adanac - Ruby Creek	Canada	10	Feasibility study	2009

Table *: Some new primary molybdenum mine projects.*
(Source: www.infomine.com)

REACH legislation adopted ....
prepare for 1 June

By a substantial majority, the European Parliament approved REACH legislation on 13 December after several years of lobbying and compromise. The new laws will come into force on 1 June 2007 and apply to all chemicals – some 30,000 substances reportedly – which are produced in, or imported into, the EU in quantities of 1 tonne per year or more. Essentially, the burden of proving that substances are safe will now fall on industry, rather than the regulatory authorities having to prove that they are dangerous. Estimates of costs to industry vary between Euros 3 and 5 billion.

There remain some grey areas, as Eurométaux has pointed out, such as the treatment of alloys and the definition of waste. Areas of compromise include substitution of high-risk substances, which was initially proposed as mandatory. Producers may now have the chance to demonstrate that they effectively and safely control the substance and prove an economic case for its authorisation.
There has also been common ground negotiated between the Council and Parliament on:

- *Information-sharing about substance testing so that use of animal tests is minimised;*
- *Inclusion of a duty-of-care for manufacturers, importers, and downstream users to prevent and remedy adverse effects from chemicals;*
- *Arrangements to protect commercially sensitive information; and*
- *Details relating to the setting up of a European Chemicals Agency, to be located in Helsinki.*

As indicated on Page (1), IMOA has practically completed its proposals for a Consortium which will enable companies in the Molybdenum industry to fulfil their obligations under REACH legislation to obtain the necessary licences to continue to produce or trade their products within the EU.

The 19th Annual General Meeting,

will be hosted by the world's largest molybdenum producer, Climax Molybdenum Company. This meeting of IMOA's members will be held in Denver 9-12 September, followed by a visit to the Henderson primary mine and mill.

Election to the Executive Committee

Ms Elisabet Alfonsson, Marketing Manager of Outokumpu Stainless Tubular Products, was unanimously elected as a member of the Executive Committee.

Stainless Steel World Conference

As an official "Supporter" of these conferences which are organised every two years by "Stainless Steel World", IMOA draws the attention of readers to the 2007 event which will be held from 6-8 November in Maastricht. For further information, visit their website - www.stainless-steel-world.net, or contact them by email: ssw2007.conf@kci-world.com or fax No: +31 575 511099

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