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# IMOA Annual Review 2015/2016

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# IMOA Annual Review Overview from the Secretary-General



Tim Outteridge Secretary-General MO Å

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Welcome to IMOA's Annual Review, summarizing the work of the Association over the past year, and giving an insight into the activities of our Committees, staff and consultants. We work exclusively in support of our members as the voice of the molybdenum industry.

### **Health, Safety and Environment**

The Health, Safety and Environment Committee carries out important work, protecting members' access to markets by promoting evidence-based regulation, engaging with authorities and commissioning research on the effects of molybdenum on human health and the environment.

This year, the Committee has submitted evidence or engaged in dialogue with regulators in a number of areas to challenge decisions which were based on poor quality science and inaccurate data. In the U.S, molybdenum has been included on 'chemicals of concern' lists in some states implementing the Children's Safe Product Rule, which can involve a phase-out period and an eventual ban of listed products. The Secretariat responded by providing up-to-date and robust toxicological data to several states, to deter adoption and to seek de-listing where it has already been included.

In Massachusetts, the Committee has drawn on the scientifically robust Molybdenum Consortium (MoCon) molybdate effects dataset in support of raising the maximum value for molybdenum in biosolids. A positive outcome will benefit both the State and users of molybdenum products in the



area. Additionally, the Secretariat is providing datasets to the Agency for



Toxic Substances and Disease Registry in advance of its forthcoming review of molybdenum.

In Europe, current drafts of the latest EU Water Framework Directive now reference the MoCon REACH value for molybdenum, placing it in the lowest categories of priority for potential regulation, after the Committee led a challenge on the use of non-REACH values in the initial drafts.

The HSE Committee has commissioned research to meet specific regulatory requirements, from flammability and selfheating tests on ferromolybdenum powder for EU regulations, to gathering data to enable the use of the more scientifically robust U.S. methodology for calculating safe concentrations of molybdenum in freshwater.

MoCon's work continued with the updating of all 12 REACH technical dossiers and further compliance checks required by the European Chemicals Agency (ECHA). In November 2015, another milestone was achieved with the publication of the last tranche of MoCon REACH data in a peer-reviewed journal.

### **Market Development**

IMOA's Market Development Committee aims to raise the profile of molybdenum and increase global demand by promoting its use in new and existing applications.

In the carbon steel sector, our consultant met steel producers, manufacturers and engineering companies, offering technical advice on molybdenum-alloyed grades and participating in workshops and other knowledge-sharing events. We continued to highlight the results of the IMOA gear steel project – demonstrating that molybdenum-alloyed steel outperforms traditional steels without increasing alloy cost – at metallurgical conferences and in a paper published in the Journal of Advances in Manufacturing.

In the stainless steel sector, our program of engagement with the Architecture, Building and Construction (ABC) community continued with workshops, seminars and project meetings on all aspects of specification, design and use. Over the year, IMOA's consultant worked to promote stainless steel and sustainability, alloy selection and longevity.



China is an important area for market development, with molybdenumcontaining steel grades expected to play a greater part in addressing China's economic and environmental needs. IMOA co-founded the China Stainless Steel Cooperation Promotion Group, (CSCPG) to further the use of stainless steel in the region. Focusing on ABC, the group was successful in introducing a dedicated session on stainless steel at China's premier sustainable building conference in Beijing in March 2016, reaching an audience of key industry practitioners.

The Market Development program sponsors research to develop and demonstrate new or expanded uses for molybdenum. A project, shortly to be published, validated the benefits of molybdenum in improving strength without negatively impacting toughness or weldability in high-strength pipeline steel grades (X80 and higher). Another study demonstrated that molybdenumcontaining grades of stainless steel are beneficial in biodigesters and storage tanks. We are supporting two further studies aimed at developing cost-effective design rules and guidance for highstrength steel members and stainless steel slip-resistant connections for use in construction. All projects are generating case studies, data and evidence to increase the use of molybdenum-alloyed steel.

### Communications

Communications plays a vital role in raising awareness of molybdenum's properties, its applications and its contribution to sustainability. Our media program targets key industry audiences with news releases on research, market statistics and industry events, while our contact program builds stronger relationships with specific trade media outlets. This year we produced a range of topical news releases and generated coverage in a number of industry titles and technical journals, including articles on durability, corrosion resistance, stainless steel specification and whole building life cycle analysis. In addition, two editions of MolyReview have been published and individual articles on the role of molybdenum in desalination, biodigestion and water distribution technologies were successfully placed with trade media titles.

Our online presence is an increasingly important part of our overall strategy.

We continued to promote molybdenum's contribution to sustainable development, placing several articles in trade media and including sustainability messages in presentations at industry conferences and events.

A new program has been developed this year to highlight the essentiality of molybdenum, exploring its role in human, animal and plant life. Underpinned by robust, fully referenced scientific data, a new area of the website entitled 'Molybdenum for life' tells the essentiality story through a series of illustrated messages. Additional communications



The website now attracts an average of some 14,000 visitors per month, with a steady growth in traffic especially from the U.S., India and the U.K. Our Twitter and LinkedIn pages continue to grow in popularity and enable us to reach a wider potential audience.

In December 2015, we launched an education section on the IMOA website. Designed principally for those studying or newly qualified in architecture or engineering, the pages host links to relevant resources covering stainless, duplex and alloy steels and their uses in architecture, building and construction. material building on these messages is being developed.

### **Statistics**

As an ongoing service to our members, we collate and publish global molybdenum production and use statistics in the members' area of the website. Annual and quarterly summaries are also released to the media, generating further coverage and further fulfilling our strategic aim to be recognized as the most reliable source of information on molybdenum.

# Health, Safety and Environment (HSE)



Sandra Carey IMOA HSE Executive



## Health, Safety and Environment Key activities and achievements in 2015/2016

### REACH Molybdenum Consortium (MoCon)

Activity levels over the last year within the MoCon Technical Working Group significantly surpassed our expectations and intentions. The previously stated aim of ramping down to a 'care and maintenance' basis until 2018 was rather washed away on a tide of European Chemicals Agency (ECHA) compliance checks for three MoCon substances, and the need to review and update all 12 MoCon substance technical dossiers, to ensure continued technical compliance with the REACH Regulation.

### ECHA compliance checks

These checks come in various formats and can escalate in intensity. MoCon therefore seeks to respond with the fullest available details at the earliest opportunity. This is to minimize the possibility of escalation to the next level of formal dossier evaluation by an EU member state competent authority – the 'E' in REACH.

A compliance check (CC) starts with an ECHA invitation to the Lead Registrant and co-registrants to update the technical dossier within a specified timeframe. MoCon received three such invitations, in varying formats and timeframes for the substances listed in the table below.

The REACH regulation requires technical dossiers to be 'living documents' and not simply a snapshot of the science at a single point in time. Responding necessarily involves a thorough review of the complete technical dossier, updating where appropriate, with particular attention to the indicated ECHA focus area.

### Voluntary dossier updating

In addition to the above, MoCon was already going through the voluntary

process of updating all the MoCon substance dossiers to respond to another recent ECHA requirement. For the endpoint of Prenatal Developmental Toxicity (PND), ECHA has clarified that either data or a data waiver are required for a second species when test data on a first species is negative. Since noncompliance with that PND requirement means a dossier is technically incomplete, MoCon TWG was already working to address that endpoint with a science-based waiver statement.

The PND issue was the primary driver for the MoCon dossier updates, but the process also included adding further information to:

- Strengthen the *substance identity* information to ensure unambiguous substance characterization.
- Facilitate a more immediate ECHA understanding of the *analytical data* by adapting its presentation, including fuller analytical methodologies.

#### **ECHA CC requests**

Substance	ECHA focus area	Dossier update request received	MoCon update submitted
Sodium Molybdate	CMR endpoints (i.e. carcinogen, mutagen, reproductive toxicant)	June 2015	October 2015 & December 2015
Molybdenum Trioxide	Dossier evaluation compliance checks (i.e. presence of data for all required endpoints)	December 2015	February 2016
Ammonium Octamolybdate	Suspected carcinogen (within Common Screening Round 3)	January 2016	March 2016

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- Provide more detail about the manufacturing process(es) for each substance, particularly feedstock inputs and process control parameters.
- Give greater insight where possible about *identified uses and potential exposure*, either by workers or the general public, to MoCon substances.
- Extend the dossier content with summaries of *recently published relevant studies* now available in existing scientific literature.

This 2015–2016 update of the technical dossiers for all 12 MoCon substances, completed in June 2016, is the second such update since submitting the original dossiers in 2010. The first update was primarily required to include significant new scientific data for the endpoints of repeated dose toxicity and the first PND study.

The RMC/technical grade molybdenum oxide dossier was also updated in August 2015. The main update drivers were more ECHA-required detail about the known individual constituents of this UVCB substance, and the outcome of MoCon test work into precisely which copper species are minor constituents of RMC. More details are available in the IMOA Annual Review 2014/2015.

### Elsewhere in our MoCon REACH activities:

- In November 2015, we achieved the milestone of peer-reviewed publication of the last tranche of MoCon data from our research and testing programme: the terrestrial toxicity dataset. The paper 'Derivation of ecological standards for risk assessment of molybdate in soil' was published in Environmental Chemistry, a technical journal. Regulatory authorities are more receptive to data published in peer-reviewed publications.
- The results from a recent marine species study, conducted by IMOA for U.S. regulatory purposes, required



the recalculation of our REACH PNEC marine value from 1.91 to 2.28 mg Mo/L. The study contributed further robustness to the data underpinning the aforementioned increased safe concentration level of molybdate in the marine environment.

• The Consortium remains open to new members, and in April 2016 we welcomed our 61st member company, Centrum Metal, based in Poland.

MoCon is participating in an ECHAsponsored project aimed at encouraging the alignment of an agreed hazard classification, in the EU Classification & Labelling Inventory, by all companies that made CLP notifications back in early 2011. The majority of all listed substances in the inventory currently have several disparate hazard classifications that work to undermine its authority as a definitive hazard classification summary. For MoCon, the project is an opportunity to potentially diminish the number of non-aligned classification entries to the MoCon hazard assessment outcome of 'No classification' for molybdenum

and for calcium molybdate. It draws attention to reproductive effects studies conducted post-2011 to encourage a rethink by notifiers who reported a hazard classification for reproductive toxicity endpoints.

### Other recent ECHA initiatives currently commanding MoCon attention include:

### The inclusion last year of molybdenum trioxide on the ECHA Public Advisory Communication List (PACT)

This means that MoCon will consider conducting a Risk Management Option Analysis project (RMOA). Such an exercise is called an 'industry shadow RMOA' as it follows the same process as EU regulatory authorities. It seeks to identify if there could be any intrinsic hazards and exposure risks that are not already adequately managed in the supply chain, and if there are, to determine the industrypreferred risk management measure (RMM). Usual RMM options range from an EU-wide harmonized hazard classification, or a substance-specific EU occupational exposure limit in workplaces, through to usage constraints under the Authorisation/ Restriction component of the REACH regulation.

The Implementing Regulation 2016/9 on joint submission of data and data sharing under REACH

ECHA had concluded that existing guidance was insufficient, and produced this recent legislation aiming to better ensure that costs associated with data sharing are determined in a 'fair, non-discriminatory and transparent manner'. It is particularly intended to assist small and mediumsized companies needing to register small tonnages in 2018.

#### ECHA infocards

A recently implemented two-tier information system providing a high level summary, and then a brief substance profile, where the target audience is the general public. It is a chemicals awareness-raising initiative that can be useful, provided the manner in which the data is disseminated does not lead to inaccurate summaries, particularly for UVCB substances. Accordingly, we are checking MoCon's UVCBs, which are RMC and ferromolybdenum slags.

• The significant redesign of the IUCLID software program

The redesign is scheduled to be implemented in 2016. The program is used to generate and update REACH technical dossiers and by all co-registrants to prepare and submit their REACH registrations. User challenges will arise until the new design becomes familiar, similarly for the ECHA upgrade to REACH-IT 3 that is due to be implemented in parallel to IUCLID Version 6.

All in all, as summarized above, both the MoCon Technical Working Group and the Steering Committee continue to work unabatedly to benefit and safeguard MoCon members' interests throughout the lifetime of the REACH Molybdenum Consortium.

### **IMOA HSE Committee activities**

IMOA's HSE Committee constantly scans the regulatory horizon, actively seeking to ensure all developing legislation concerning molybdenum and its compounds is fair, appropriate and justified by scientific evidence. During 2015/16, the HSE Committee has been particularly focused on the following aspects:

### **Regulatory issues**

EU Water Framework Directive: Where monitoring data for a particular substance (e.g. molybdenum) is available for the surface waters (lakes and rivers) of at least three EU countries, it can become a candidate for substance occurrence monitoring. This in turn can be a precursor to regulation if concentration levels are found to be above those determined as safe values. It is therefore critical that this latter value is accurate. The EU Joint Research Centre (JRC) unfortunately elected to compare monitoring data for molybdenum against a safe concentration value of just 3.6 micrograms (µg) Mo/L calculated by Romania, instead of the REACH Predicted No Effect Concentration (PNEC)



(freshwater) of 12.7 milligrams (mg) Mo/L that was derived by MoCon based on recent robust aquatic effects data. Furthermore, the Romanian value was referred to as a PNEC, but was not derived in accordance with PNEC methodology – thus inferring a scientific robustness which it very much lacked.

IMOA responded in September 2015 by addressing a communication with both technical and legal content to DG Environment (Water Group) and JRC, explaining the severe shortcomings in the approach to date, and requesting that specified improvements be made. Although the final version of the JRC document is still awaited, subsequent drafts now state the MoCon REACH PNEC value of 12.7 mg Mo/L as the safe concentration reference value, meaning that molybdenum is now in the lowest categories of priority for potential regulation.

Massachusetts Land Application of Sludge: The MoCon molvbdate effects datasets have featured in recent IMOA efforts to assist in assessments relating to the maximum permissible value for Mo in biosolids in the U.S. state of Massachusetts (MA). Indications are that the maximum value will be uplifted from 25 to 40 mg Mo/kg. The key benefit for the state is that Boston will no longer have to (expensively) export its biosolids out of state for treatment. It is also very helpful for our purposes as a higher limit value acknowledges a lower toxicity value, and one that is more scientifically robust than that presently used. It should also help to discourage publicity campaigns against the use of Mocontaining solutions for corrosion control. TRAC, a Toxic Reduction and Control program, had implemented a voluntary program to encourage users of molybdenum-containing solutions to use an alternative corrosion control agent.



*Children's Safe Products Rule:* Molybdenum and its compounds are appearing on the Priority Chemicals of Concern lists in several U.S. states. An annual reporting requirement to the state is placed on manufacturers and importers, and the rule can include a phase-out period that bans the substance. The scientific rationale for listing

#### **Targeted testing**

When IMOA undertakes any HSE research and testing, it is targeted to meet a specific regulatory need (as distinct from purely academic interest). Since the previous Annual Review our focus has been on the following aspects:

The HSE Committee protects access to markets by promoting evidence-based regulation and commissioning research on the effects of molybdenum.

molybdenum and its compounds is based on outdated and sparse data. Through the provision of more recent and robust toxicological datasets, we are proactively making data available that seeks to deter a 'cut/paste' list transfer approach between states; and where already listed, working towards applying for a de-listing. To date, we have made technical submissions and met with the regulatory authorities in Washington and Vermont; engaged with authorities in New York State; and submitted a position paper to Oregon Department of Health. Washington State was the originator of the brief scientific rationale document about molybdenum and compounds as chemicals of concern, so it is the main focus of IMOA's interventions to achieve a review of the science to include more recent and sound scientific data.

Agency for Toxic Substances and Disease Registry (ATSDR): This federal agency is preparing a toxicological assessment of molybdenum. Having provided data in November 2015 to contribute towards the initial drafting of the assessment, we are now awaiting the opportunity to receive and scrutinize the draft when the public commenting period is announced, expected during 2016. Flammability and self-heating tests on ferromolybdenum powder: Since mid-June 2015, data on these endpoints has been required for compliance with the EU Classification, Labelling & Packaging (of substances and mixtures) Regulation No. 1272/2008 (EU CLP) for the hazard identification and risk assessment of chemical mixtures. Alloys are defined as mixtures under EU CLP, so ferromolybdenum (FeMo) is in scope. The results for the tested FeMo powders meant no hazard classification for those two endpoints.

The HSE Committee also produced a guidance document for IMOA members, explaining the methodology to hazard identify and risk assess ferromolybdenum. This is valuable as substantiating documentation for workplace inspections by national competent authorities, and for facilitating industry awareness, where it is intended to be particularly beneficial for:

- FeMo producers; so they can perform and document an assessment on their own FeMo product. Each producer should assess if the assumptions and arguments used in the document can be applied to their own product.
- Those trading/distributing/placing FeMo on the market in the EU; who also have obligations under CLP,

e.g. to make sure that the label and packaging are compliant.

 FeMo consumers; as an insight into how the assessment is conducted, and how any hazard classifications are derived.

Hyallela Azteca (HA) freshwater species testing: Thanks to a recent IMOAcommissioned test on the endpoints of reproduction and survival for HA, we now have sufficient data to use the U.S. derivation methodology to calculate a safe concentration for molybdate in freshwaters. Prior to this test, the existing (MoCon) dataset was one species short to use that methodology. Generating the HA data has thereby added further value and utility to the existing dataset.



Biological monitoring (BM) is a topic in which IMOA currently has several aspects of involvement. BM is the measurement and assessment of chemicals or their metabolites (substances the body converts the chemical into) in exposed individuals. These measurements can be made on samples of breath, urine or blood. The measurements reflect the total uptake of a chemical from inhalation, ingestion, through the skin or by a combination of these routes.

Firstly, IMOA is currently undertaking a project to assess worker exposure to molybdenum, by gathering BM data in a voluntary program by various





IMOA-member companies representing different areas of the value chain. Secondly, IMOA has critically evaluated a paper, by means of independent statistical analysis, which ventured a potential link between molybdenum and testosterone levels in males. The paper was found to be methodologically flawed in a number of significant ways. Lastly, we are cooperating with the US-Canada Regulatory Cooperation Council Initiative in a second phase project to assess the feasibility of using BM data in substance risk assessment, using molybdenum as the example substance.

### Life cycle activities

Turning to issues linked to Life Cycle Assessment (LCA), IMOA supported two multi-metal initiatives where the aim was to achieve peer-reviewed publication of technical papers in the International Journal of Life Cycle Assessment (IJLCA). The resource depletion paper *'Mineral resources in life cycle impact assessment – defining the path forward'* explores ways to improve how life cycle thinking is applied to the acquisition of mineral resources, and seeks to address some common misconceptions and overstated impacts.

Closer to home in terms of IMOA's Life Cycle Inventory datasets, we have had two papers accepted for publication in a special edition of the IJLCA during 2016:

- IMOA Life Cycle Assessment program and perspectives on the LCA harmonization effort
- Vehicle Lightweighting Through the Use of Molybdenum-bearing Advanced High-Strength Steels (AHSS)

These papers will complement 'Harmonization of LCA Methodologies for the Metals and Mining Industry', which was a multi-metal project in which IMOA actively participated.

### Looking ahead

And finally, to close this HSE summary with a very important recent development: a further hazard identification and risk assessment challenge has appeared on the horizon for molybdenum trioxide, pure and technical grades. In April 2016, the International Agency for Research on Cancer (IARC) announced that it will use an international consensus approach to prepare its March 2017 evaluation of the carcinogenic risk of this substance to humans.

The output from the evaluation, called an IARC Monograph, will be based on published scientific literature and performed by independent scientists who are active in research. This is a top priority issue for IMOA engagement, and preparatory work is already under way by the IMOA HSE Committee.

All MoCon and HSE technical activities are managed and driven forward by the corporate members of the respective HSE Committee and MoCon Technical Working Group (TWG), the HSE Executive staff member and our consultants. We express our sincere gratitude for their dedication and professionalism.



This year we also especially recognize and appreciate the outstanding contribution of our long-standing HSE and MoCon TWG Chairman, Dr. Guido Provoost, who stood down in September 2015, after eleven years at the helm, steadfastly navigating our way forward to meet every diverse challenge, particularly the 'REACH years' from 2007 onwards.

# Market Development



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Dr. Nicole Kinsman IMOA Technical Director

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# Market Development Key activities and achievements in 2015/2016

### **Carbon steels**

Our engagement with the carbon steel industry yielded more than 40 visits, meetings and events in 2015/16. Many of the visits and in-house seminars were related to the dissemination of the conclusions of the 'International symposium of Nb and Mo alloyed iron and steel materials for the mining and processing industry', held in Brazil in May 2015. Other visits were related to metallurgical consulting for steel and alloy developments.

In addition, IMOA participated in three metallurgical conferences in China and the U.S., giving papers and presentations highlighting the results of the IMOA gear steel project, which demonstrated that molybdenum-alloyed steel can outperform traditional gear steels without increasing alloy cost. A new paper based on the project has also been published in the Journal of Advances in Manufacturing. It outlines the benefits of the improved molybdenum alloy concepts along the gear-making manufacturing chain.

A large Korean manufacturer of excavators and forklift trucks is interested in optimizing castings, especially for higher wear resistance. IMOA was invited by a large Taiwanese steel maker to discuss alloy concepts and production routes for abrasion-resistant steel plate. IMOA was also invited by the heavy plate development team of a Korean steelmaker to give seminars and technical advice on the metallurgical concepts and production routes for abrasionresistant steel. The company targets the development of HB400–500 type premium grades and the first industrial trials are in progress, all with 0.3% molybdenum.

Their automotive team is developing 1500 MPa and higher press hardening steel grades. Laboratory trials have found that the Mo-Nb concepts using 0.2% molybdenum proposed by IMOA are clearly superior to the established titanium-boron concepts.

Molybdenum has two major advantages in the development of improved press hardening steels: Firstly, it helps to reduce the sensitivity of the steel to hydrogen embrittlement, and secondly, it increases



grain boundary cohesion, reinforcing the steel against crash impact. IMOA is closely cooperating with carmakers and steelmakers on a testing program for some of these concepts.

We also organized an in-house workshop at SSAB Europe in Finland, with speakers from applied industrial research experts Centro de Estudios e Investigaciones Técnicas of Spain, National University of Taiwan and Okayama University in Japan. This workshop showcased the next generation of high-strength steels, including ultra high-strength ferrites, direct quench and super-strong bainitic steels. Molybdenum alloying plays a key role in all of them, not least because of the very positive results from an IMOA-SSAB project on direct quench steels which finished earlier this year, revealing that appropriate strength-toughness combinations can only be achieved with the addition of molybdenum.

The 'HAZ-Simulation of Modern Line Pipe Steels' project, carried out by Voestalpine last year, demonstrated that molybdenum is crucial for high-strength pipe grades (X80 and higher), yet does not harm the weldability of such steels. It is planned to publish these positive results in the near future.

The development of niobium carbide as an alternative to established tungsten



carbide-based hardmetals is at the point of breakthrough. It was determined that the addition of molybdenum carbide to NbC powder is the best option for improving the hardness-toughness combination. A leading hard metal producer has fully confirmed these results. Industrial trials with an addition of 5–8% Mo<sub>2</sub>C are in progress.

### Architecture, Building and Construction (ABC)

### Workshops

In North America, IMOA and the Nickel Institute (NI) jointly sponsored building and construction workshops and project meetings at some of the world's most prestigious architecture and engineering firms and universities. In total, nearly 600 individuals from 31 companies attended. IMOA also has eight courses accredited by the American Institute of Architects (AIA).

U.S. architects and engineers play a dominant role in global design and construction. These face-to-face workshops build and strengthen relationships, influencing projects and material selection globally and encouraging molybdenum-containing stainless steel use.

#### Conferences and symposia

Jointly sponsored by the NI, IMOA's consultant gave presentations at events in the U.S. and China. In September 2015, a keynote presentation on sustainability and alloy selection was given at the annual convention of the Sheet Metal and Air Conditioning Contractors National Association in Colorado, U.S. In March 2016, a presentation on steel selection for longevity was given at 'Architectural Iron & Steel in the 21<sup>st</sup> Century' at the Massachusetts Institute of Technology in Boston. In total, these sessions

drew 250 attendees, including leading architectural metals fabricators, architectural designers and structural engineering firms.

In October 2015, a paper on sustainable sunscreens was given at the 4<sup>th</sup> International Conference on Civil Engineering and Urban Planning in Beijing. IMOA/NI stainless steel ABC library have been distributed to decision makers and fabricators. The fall 2015 version was significantly expanded to include over 360 publications.

Articles written by our North American consultant and jointly sponsored by IMOA and the NI were revised and published in international journals. In the fall of 2015, Stainless Steel World Magazine



### Publications and website updates

IMOA has been publishing monthly issues of the e-newsletter 'Stainless Solutions' since August 2014. Each issue covers a technical topic with a distribution of about 1,000 architects, engineers and fabricators. Content is developed simultaneously with website additions and updates, increasing website traffic and downloads substantially. Over 2,500 copies of the comprehensive and Corrosion & Materials (Oceania, circ. 7,000) published '50 Year Evaluation of St. Louis' Gateway Arch', which also discussed molybdenum-containing alloy use in restoration and new monument construction. Corrosion & Materials published a revision of 'Duplex Stainless Steel Revolutionizes Structural Design' in February 2016, which has been translated for publication in China to promote their new stainless steel structural design code.





### Structural stainless steel market development

Promoting the American Institute of Steel Construction (AISC) Design Guide No. 27 'Structural Stainless Steel' is an important market development activity. More than a quarter of global workshop and conference attendees were from leading structural engineering firms who are increasingly developing in-house stainless steel experts.

IMOA's consultant has provided technical support on many structural projects using DG 27, with two having particular significance: The construction of two 2205 duplex stainless steel bridges in Ft. York Park in Toronto; and system expansion and flood control work by the New York Metropolitan Transportation Authority (NY MTA). In Toronto, we provided assistance during the project's justification, design and specification, while in New York, our consultant has provided technical assistance for several innovative projects under development, including three new 2205 duplex stainless steel entrance canopies at South Ferry station.

Growing market interest has led an ASTM international task group to draft 'Standard Specification for Stainless Steels for Bridges and Transportation Structures'. New standard development is a multi-year process and our consultant is actively involved.

### Market development in China

The focus of China's 13<sup>th</sup> five-year plan (2016–2020) has shifted towards solving overcapacity problems, making higher value-added products and complying with stricter environmental standards. The main impact areas are energy efficiency, renewable energy generation, environmental protection and resource conservation. Many of these sectors rely on high quality molybdenumcontaining steel grades.

### **ABC** activities

### 12<sup>th</sup> International Conference on Green and Energy Efficient Buildings

The China Stainless Steel Cooperation Promotion Group (CSCPG), co-founded by IMOA, helped to organize a dedicated conference session, *Green Building Development and Stainless Steel Application*, in Beijing in March 2016. Co-organized by the Chinese Society for Urban Studies, China Green Building Council and Eco-City Research Committee of China, under the auspices of the Chinese Ministry of Housing and Urban Rural Development, it is the leading sustainable building event in China.

Gaetano Ronchi. IMOA Greater China Representative, delivered the keynote presentation highlighting the benefits of stainless steel in sustainable building construction projects. Leading engineering firms and industry experts spoke about other aspects, including the development of a standard for stainless steel in ABC applications. Ninety-three delegates representing 65 organizations attended, including architectural companies, design and research institutes, real estate developers and curtain wall fabricators. CSCPG also distributed its new brochure on sustainable stainless steel uses in ABC.



#### **Project support**

In mainland China, architects and curtain wall contractors still require assistance with the fabrication and installation of stainless steel façades. IMOA is continually refining its understanding of the drivers for façade specification currently almost always aluminum in China – to influence decision makers and to strengthen its relationships with the ABC supply chain. Since early 2014, IMOA has assisted key architects and contractors in the fabrication and erection of stainless steel curtain walls, including the Museum of Contemporary Art and Planning Exhibition (MOCAPE) in Shenzhen. More recently, IMOA supported a project in southern China, giving fabrication advice on a high profile mirror-finished stainless steel-clad soffit under completion in Hong Kong.

### Supply chain education

During 2015, we mapped the main Chinese curtain wall contractors, opening a fruitful dialogue with important industry players. We are developing further workshops and training sessions for companies, employees and subcontractors, in association with the NI.

#### Other efforts

Our work on the Stainless Steel Performance Atlas, which we are developing with China's Central Iron and Steel Research Institute, is ongoing. It will be published in 2017 in Chinese and will give architects performance data on existing stainless steel installations in a variety of climates and environments in eight Chinese cities.

### **Energy-related segments**

### FGD – Flue gas desulfurization

China is expected to add the equivalent of a new 600 MW power station every ten days for the next ten years. The current five-year plan requires both old and new coal stations to be cleaner and more efficient. This is expected to provide



significant opportunities and our activities in 2016–2017 will leverage the superior longevity of high-performance stainless steels and nickel alloys.

#### Solar water heaters

An increasing number of administrative authorities are mandating the installation of solar thermal systems for new buildings in the residential and public sectors. Several corrosion cases have been reported, especially in the water tanks which are usually Type 304 austenitic stainless steel. We began investigating the potential to substitute molybdenum-containing ferritic stainless steel in 2015 and plan to conclude by the end of 2016.

### **Duplex stainless steel**

'Practical Guidelines for the Fabrication of Duplex Stainless Steels', now in its third edition, remains as popular as ever. The brochure is available in eight languages – English, Chinese, German, Japanese, French, Italian, Portuguese and Spanish – with more than 70,000 copies downloaded within the last year, bringing the total to more than 280,000 copies since the end of 2009.

### Stainless steel service piping

Replacing ageing water service pipes with molybdenum-containing corrugated stainless steel piping can dramatically reduce water leakage. These new pipes are simply bent to fit, virtually eliminating connection joints, which are the main source of service pipe leakage. The pipes are strong but have sufficient flexibility to cope with vibration, accidental damage and seismic tremors, while their inherent corrosion resistance protects against the effects of soil chlorides in marine and urban environments. A program to replace lead piping with Type 316L stainless steel began in Tokyo in the 1980s and reduced water leakage by 13 percentage points to 2 to 3%, while an ongoing program in Taipei has achieved reductions of some ten percentage points to date.

We are aiming to disseminate this technology in the U.S., Europe, China and the Pacific Rim, focusing our efforts on areas with regular seismic activity and/or high rates of water leakage. In association with the NI, we have presented papers at conferences, begun negotiations with water authorities, and are assessing a pilot-scale replacement project in Australia. The subject has also been covered in MolyReview.

### Research

We sponsor research to develop new or expanded uses for molybdenum, with projects at various stages:

IMOA co-sponsored the role of the Steel Construction Institute (SCI) in the HILONG project, probably the largest test program investigating structural highstrength steel (HSS) hollow sections. The project studied the structural performance of HSS members, connections and pre-stressed systems with the aim of developing cost-effective design rules to overcome some of the





barriers to the wider use of HSS. Eurocode 3 rules for hot-formed HSS hollow sections were confirmed, with the potential to relax some of them, making HSS sections more cost-effective. New design rules were developed for some HSS joints and existing rules confirmed for others. Over 20 scientific reports were published and a seminar was held in London to promote the use of HSS in construction. The third project with SCI is BIOGASS, now complete, which studied the corrosion and structural performance of several stainless steels for biodigesters and storage tanks, concluding that molybdenum-containing grades are needed to withstand the more corrosive environments. The recommendations for the structural design of stainless steel tanks are under discussion within the steel tank Eurocode technical committee.

The Market Development Committee works to raise the profile of molybdenum and increase demand by promoting new and existing applications.

IMOA is also sponsoring the role of SCI in SIROCO, a three-year European collaborative research project which seeks to develop guidance on the design of stainless steel slip-resistant connections. Stress relaxation tests have been carried out on a range of molybdenum-containing austenitic and duplex stainless steel plate and bar bolt assemblies to investigate the relationship between stress relaxation and stainless steel grade, applied load, product form and material strength. Design rules are being developed which will be submitted for inclusion in the next revision of the stainless steel Eurocode.



It is expected that new design rules will be included in the next revision of the standard, due in 2020.

The atmospheric corrosion project that we began in 2014 in association with the Kuwait Institute for Scientific Research has been extended for another year. The atmospheric corrosion conditions in Kuwait are milder than in other parts of the Middle East. After analyzing the samples that were exposed for up to two years, it was determined that more time was needed to obtain meaningful results. The samples were therefore returned to the test site for another year.

### **Team Stainless**

IMOA is a member of Team Stainless, formed from the trade associations of the stainless and alloying element industries to promote the benefits of stainless steel. IMOA is chairing Team Stainless in 2016.

Following the publication of the AISC Design Guide No. 27 'Structural Stainless Steel' in 2013, work is underway preparing a series of design tables for several commonly available structural stainless steel sections in accordance with DG 27. The tables will allow designers to rapidly choose from a range of structural sections. This project is co-sponsored by Team Stainless members as well as some stainless steel companies.

Team Stainless commissioned the Swedish Royal Institute of Technology, KTH, to test stainless steel grades for leaching using a new EU procedure simulating food contact. The study showed metal releases from all tested grades well below the EU limits, demonstrating the continuing safety of stainless steel for food use. A summary was published by Team Stainless in November 2015, as part of a communications campaign targeting manufacturers, distributors and retailers. It is available to download from the IMOA website.



Team Stainless will sponsor the 'Comprehensive Multi-level Cycle of Stainless Steels' update by Yale University for 2015. This study, which characterizes all life cycles of stainless steel and provides useful information on supply, demand and recycling, was performed in 2000, 2005 and 2010. The update will provide the current primary and secondary stainless steel supply; magnitude and location of production; stainless steel making; use; in-use stocks; and end-of-life flows.

# **Financial Report 2015**

Income and expenditure account

For the year ended 31 December 2015

### IMOA/Molybdenum Consortium

	\$	\$
Turnover	2,762,524	2,789,485
Operating and administrative expenses	3,509,878	3,480,009
Operating surplus/(deficit)	(747,354)	(690,524)
Other interest receivable and similar income	3,333	1,954
Surplus/(deficit) on ordinary activities before taxation	(744,022)	(688,570)
Tax on surplus/(deficit) on ordinary activities	15,204	488
Surplus/(deficit) on ordinary activities after taxation	(759,226)	(689,058)

2015

2014



### **Balance sheet**

For the year ended 31 December 2015

### IMOA/Molybdenum Consortium

	2015 ¢	¢	2014 د	¢
	Ψ	Ψ	φ	φ
Fixed assets				
Tangible assets		38,090		51,416
Current assets				
Debtors	96,969		68,209	
Cash at bank and in hand	3,658,493		4,502,889	
	3,755,462		4,571,098	
Creditors – amounts falling due within one year	(671,204)		(740,939)	
Net current assets		3,084,258		3,830,159
Total assets less current liabilities		3,122,348		3,881,575
Reserves				
Profit and loss account		3,122,348		3,881,575
Accumulated funds		3,122,348		3,881,575

### **Financial commentary**

The 2015 audited accounts presented here are consolidated figures for IMOA and the Molybdenum Consortium and are subject to approval at the 2016 AGM. Income from subscriptions and levies amounted to US\$2,762,524. After expenses of US\$3,509,878 a deficit (after taxation) of US\$759,226 was carried forward bringing the combined accumulated funds to US\$3,122,348. Of this US\$2,008,284 was attributable to IMOA and US\$1,114,064 to the Consortium.

In the case of IMOA, budgeted expenditure was again higher than subscription income due to essential work in the HSE program. Reserves were used to finance the difference, bringing the year-end balance below the Executive Committee's longer term objective. It was resolved to balance the budget in future years. The Molybdenum Consortium reserves will contribute to the funding of the Consortium until at least 2018.



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