

The background of the entire page is a close-up, high-angle photograph of a blue printed circuit board (PCB). The board is densely packed with various electronic components, including integrated circuits, capacitors, and resistors. The components are interconnected by a complex network of white conductive traces. The lighting is dramatic, with strong highlights and deep shadows, creating a sense of depth and technical precision. A semi-transparent horizontal band is overlaid across the middle of the image, containing the title text. A solid yellow vertical bar is positioned on the left side of the page, partially overlapping the semi-transparent band.

IMOA Annual Review 2016/2017



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IMOA Annual Review

Overview from the Secretary-General



Tim Outteridge
Secretary-General

Welcome to IMOA's Annual Review, highlighting key elements of the work of our Committees, staff and consultants on behalf of our members and in support of the global molybdenum industry over the past year.

Health, Safety and Environment

The work of the Health, Safety and Environment (HSE) Committee plays a vital role in protecting members' access to markets. Closely monitoring developments in the international HSE arena, the Committee engages with regulators to challenge over-precautionary or unsound proposals concerning the effects of molybdenum on human health and the environment, and commissions world-class scientific research to provide further evidence where data gaps exist.

This year, the Committee has been active on a number of fronts. The International Agency for Research on Cancer (IARC) evaluated the carcinogenic risk of molybdenum trioxide. In response, the Committee took active measures to ensure all relevant data was available to IARC to assist their deliberations and to monitor proceedings. The Agency concluded that molybdenum trioxide is an IARC Category 2B substance, very similar to its existing classification under the 2007 EU Classification, Labelling and Packaging Regulation.

In the U.S., progress has been made in several regulatory matters. In Massachusetts, a limit value for molybdenum in biosolids was successfully raised following IMOA participation in a technical workshop. In Washington State, three years of engagement with regulators has resulted in molybdenum's inclusion in a delisting review under the Children's Safe Products Rule. IMOA has also submitted extensive technical information to the Agency for Toxic Substances and Disease Registry

(ATSDR) ahead of their toxicological assessment of molybdenum. In Canada, the Committee has presented evidence supporting the raising of the permitted level of molybdenum in water.

IMOA established the Molybdenum Consortium (MoCon) in 2007 to guide members through the requirements of EU REACH. Despite the last registration deadline being less than a year away, a number of potentially significant issues are under active management.

MoCon's Technical Working Group (TWG) and Steering Committee are addressing technical challenges to the status of sodium molybdate to minimize repercussions for members.

MoCon has generated comprehensive hazard and risk assessments for molybdenum and compounds, successfully REACH-registering 12 molybdenum-containing substances and publishing key studies and datasets in peer-reviewed scientific journals.

Since those original registrations in 2010 and 2012, MoCon has updated all 12 technical dossiers three times, with preparations underway for a fourth review.

In parallel, MoCon's TWG is working to update all 12 technical dossiers, addressing changes to the way data should be presented and other requirements recently announced by the European Chemicals Agency (ECHA), including the migration of all data to a new software version.

MoCon is also closely monitoring the regulatory environment for likely upcoming changes in focus from substance registration to evaluation, and is proactively undertaking key packages of technical work to anticipate the future evaluation of MoCon substances.

Market Development

By raising the profile of molybdenum amongst key audiences such as manufacturers, engineers, architects and specifiers, IMOA's Market Development Committee works to increase global demand, promoting its use in new and existing applications.

Our work continues in the carbon steel sector with workshops at steel producers and with end users, sharing technical advice on molybdenum-alloyed grades. The focus this year has been on new advanced grades for the automotive and structural steel sectors. The positive results of the gear steel project have been further disseminated via publications and discussions with end users around the world.



In the stainless steel sector, we continued our program of engagement with the architecture, building and construction community, working to promote a greater use of molybdenum-containing grades through one-to-one project meetings, workshops and webinars with some of the world's biggest architecture and design companies. Wider dissemination of information is achieved via technical articles published in leading international industry magazines.

China's economic growth and investment strategies provide further new potential markets for molybdenum-containing steel grades. IMO A proposed the China Molybdenum Application and Promotion Group (CMAPG), founded in April 2017, to fund selected development projects. In the stainless steel sector, we are working with major manufacturers and associations to promote stainless steel in sunscreens, curtain walls and building envelopes, offering assistance and technical advice to specific projects. We are also promoting molybdenum-containing ferritic stainless steels for use in large roofing projects.



The market development program commissions research to develop and demonstrate new or expanded uses for molybdenum. IMO A is sponsoring a collaborative project which is developing new guidance for the design of stainless steel slip-resistant connections, following successful trials. Another project underway in Japan is investigating the potential of molybdenum to improve toughness in super-strong grades of press hardening steel, with encouraging early results.

Communications

Our communications activities are specifically designed to support and complement the work programs, in particular market development activity. Our media program aims to raise awareness of molybdenum's properties and applications, targeting key industry audiences with articles and features, as well as news releases on molybdenum statistics, research findings and IMO A events. Supplementing this is an active contact program, building effective working relationships with trade media and journalists covering the mining, metals and sustainable development areas.

Our media program has produced a wide range of articles, including pieces on

the role of molybdenum in desalination, marine flue gas desulfurization, biogas generation, water distribution, automotive steel and the management of nuclear waste. These articles have been published in a wide range of industry titles and technical journals inside and outside of the mining and metals media. Two editions of MolyReview were published, with articles adapted for publication or reprinted in trade media.

Online communications are now arguably as important as traditional channels, with IMO A's website attracting more than 12,000 visitors per month. We regularly review the functionality of the website and have added a blog section this year to provide another, more contemporary outlet for IMO A news and features. Blog features also provide an ideal source of content for our social media pages, which continue to grow in popularity with follower numbers more than doubling on both Twitter and LinkedIn over the year.

Video content is increasingly important for online communications. A concise and informative video introducing molybdenum and its wide-ranging applications is nearing completion. It is designed to complement existing

online information and to drive further traffic to the website and social media pages.

Our program to highlight the essentiality of molybdenum, launched earlier last year, has been augmented with the publication of 'Molybdenum – Essential for Life', a 12-page electronic brochure exploring molybdenum's role in human, animal and plant life and underpinned by robust, fully referenced scientific data. We also continue to promote molybdenum's contribution to sustainable development as an integral part of our regular communications, including the content of our media and online programs and in relevant presentations and events.

Statistics

We collate and publish global molybdenum production and use statistics in the members' area of the website, as part of our service to members. We also condense this data into annual and quarterly summaries for release to the media, generating more 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 2016/2017

REACH Molybdenum Consortium (MoCon)

This year, we are nearer to the end of MoCon's life span than the beginning. This update reviews milestones and achievements to date, as well as our current challenges. We are already ten years into the EU REACH Regulation compliance journey that we embarked upon in 2007 with some natural trepidation about the uncharted road ahead. Now May 2018 is just around the corner and heralds the last REACH registration deadline for the <100 tonnes tonnage band.



Significant milestones to date include:

- MoCon-generated comprehensive hazard and risk assessment documentation for molybdenum and compounds to ensure their safe handling and use, thereby protecting human health and the environment. This required gathering and assessing existing literature for each substance against the extensive

REACH data requirement matrix; developing a read-across rationale and testing strategy based on the molybdate ion; identifying data gaps and conducting testing to fill those gaps; mapping EU uses for those substances; conducting the hazard and risk and classification assessments; and finally, documenting our findings in the REACH Chemical Safety Report (CSR), including developing 'Exposure Scenarios' to ensure safe use of those substances classified as hazardous (MoO₃ and RMC).

- MoCon also generated Lead Registrant technical dossiers, each including a CSR of more than 300 pages. All supporting scientific studies were entered into the IUCLID software required for reporting each hazard and risk assessment dossier to the European Chemicals Agency (ECHA).

- In 2010, MoCon successfully REACH-registered 11 molybdenum-containing substances.
- In 2012, registration was completed for chemically-produced molybdenum disulphide. Required by the petrochemical industry, much of the existing dataset on naturally-occurring molybdenum disulfide was used to generate the necessary technical dossier.
- Since those original registrations in 2010 and 2012, MoCon has updated all 12 technical dossiers three times to date: in 2013, 2015 and most recently in 2016, primarily to add a waiver for the 2nd species developmental toxicity endpoint, to ensure continued technical compliance. Updating is required by ECHA whenever significant new science becomes available, to ensure that each substance hazard and risk assessment remains a 'living document', and not just a snapshot in time.

Announcements				
The appeal announcements are published in English and in the language of the case.				
Page 1 of 2 50 Items per Page Showing 1 - 50 of 98 results -- First Previous Next Last --				
Case No.	Announcements	Date of Publication	Appellants	Keywords
A-006-2017	[EN]	28/07/2017	Climax Molybdenum B.V.	Compliance check Dossier evaluation Pre-natal developmental toxicity study

- Publication of key studies and datasets in peer-reviewed technical journals has been an ongoing task for several years, and is now complete. For environmental data, this completion milestone was achieved in 2016, whereas for human health data it occurred in 2017 after the publication of the genotoxicity studies conducted by MoCon. Peer-reviewed publications are important as they enhance data acceptance by the regulatory community.
- MoCon's phys-chem, human health and environmental effects dataset secured quality endorsement by the OECD's Mutual Acceptance of Data program in 2014. This forms the core of the scientifically robust data package that is finding increasing acceptance and application in the global regulatory community to secure appropriate regulation of molybdenum and compounds.
- The MoCon Secretariat has serviced all the numerous, diverse issues and individual enquiries made by the 61 MoCon member companies over the last decade.
- Likewise, the Secretariat has issued more than 75 Letters of Access (LoA) to non-MoCon member companies requiring REACH co-registrations of MoCon substances.
- LoA income, combined with rigorous budgetary and expenditure discipline, has meant that since the original 2007–2010 funding period, MoCon is one of very few consortia not to issue any additional funding requests, despite continuing significant annual work programs. Examples include dossier upgrades, additional studies, and multiple ECHA compliance checks.

Current challenges

Compliance checks are our most significant REACH concern to date. MoCon's Technical Working Group (TWG)



and Steering Committee are confronting a significant challenge on behalf of the MoCon membership and co-registrants of sodium molybdate, which can be summarized as follows:

- Last August, ECHA issued a 'draft decision' querying the dosing levels of the 1st species Prenatal Developmental Toxicity Study in the technical dossier, suggesting it was potentially too low. After reviewing MoCon's September response detailing the rationale for the dose concentrations, ECHA issued a Decision in March 2017, requiring the study to be re-done. MoCon has appealed against the ECHA decision.
- A key component of the Appellant's submission is to demonstrate that the tested dose concentrations already amply protect human health, and therefore further testing at increased concentrations is unnecessary science as it adds no greater degree of protection or risk prevention. To support this argument with scientific data, MoCon has used worker bio-monitoring data from a timely IMO A project (see the HSE Committee section of this review for more details).

Molybdenum trioxide (CAS No. 1313-27-5/EC No. 215-204-7) is another MoCon substance currently subject to some further scrutiny; this time currently

at the level of a single EU country, Denmark. In 2014, the substance was included on the ECHA Public Advisory Communication List (PACT). The purpose of the list is to publicly indicate that there may be further regulatory activity on the listed substances. In a June 2016 joint IMO A/MoCon initiative, interested companies took part in a Risk Management Options Analysis (RMOA) kick-off workshop which explained the process that Denmark would be undertaking. The key outcome was a series of data-gathering aspects that MoCon TWG is working on to assure preparedness if Denmark were to seek further regulatory action. As of May 2017, Denmark's RMOA remains listed as 'under development' for molybdenum trioxide.

MoCon TWG has similarly been active in another REACH aspect that concerns both the molybdenum trioxide cited above, and Roasted Molybdenite Concentrates (CAS No. 86089-09-0), also known as technical grade molybdenum oxide. The 2016 technical dossier update included changes to the 'Exposure Scenario' for each of those hazardous substances. Exposure Scenarios are used by all companies in the supply chain, and contain the key data and risk management measures to determine and achieve safe use.

Our future activity

Over the coming months, MoCon TWG will be working on a number of key projects:

- A fourth update of all 12 technical dossiers. The driver triggering this update is the recent availability of a 2-Generation reproductive toxicity study using sodium molybdate dihydrate. This endpoint is an Annex 10 formal REACH data requirement, and therefore MoCon will seek access to the study, to include relevant data in the IUCLID dataset and the REACH Chemical Safety Report for each MoCon substance.
- ECHA has issued a Guidance Document on the Read-Across Assessment Framework (RAAF) which REACH dossiers should follow.



RAAF is used by ECHA to help determine which dossiers should be compliance checked and scrutinized more closely in the future, so it is important to ensure that MoCon dossier content follows this approach.

- Boundary Compositions (BC) are now required by ECHA to be included

in all technical dossiers when they are updated. They are very similar to the 'Substance Sameness' data used to group pre-registrants into SIEFs back in 2007. MoCon will review those data and input BCs for each MoCon substance into the respective IUCLID 6 software.

- MoCon TWG is in the process of migrating all its data from IUCLID Version 5.6 to Version 6, as ECHA will now only accept IUCLID Version 6 (V6) dossier submissions via its updated REACH-IT3 portal (V6 Letter of Access co-registrant templates are already available).

The next chapter

There is some pressure on ECHA, from certain member state countries such as Denmark, to introduce mandatory periodic updating of technical dossiers, to counteract concerns that the datasets will become outdated without a legislative instrument to compel industry to submit updates.

The EU Commission is working on a strategy for a Non-Toxic Environment that will draw heavily on the technical data from REACH registrations.

For its part, ECHA is already working on 'mapping the chemical universe' between 2018–2020, screening all registered substances to determine which are high, medium or low priorities for more in-depth evaluation. Likewise, it is ramping up to switch focus after May 2018 from the 'R' in REACH to the 'E', transitioning from substance registration to evaluation. Pre-empting the evaluation of a MoCon substance remains a TWG core aim, and underpins the technical work that is still ongoing in the REACH Molybdenum Consortium. While we may all wish it were so, REACH will not be over, even after the last tonnage registration deadline in May 2018.

IMOA HSE Committee activities

Regulatory issues

On behalf of the Association's members, IMOA's HSE Committee tackles a steady stream of regulatory issues, seeking to ensure that appropriate regulation is achieved, based on the objective assessment of robust scientific data.

A full listing of the Committee's portfolio of circa 70 issues is available in the members' section of the IMOA website. Some of the more high-profile concerns that we have been working on since the last Annual Review are covered here:

IARC Monograph on Molybdenum Trioxide (CAS No. 1313-27-5):

The International Agency for Research on Cancer (IARC) met in March 2017 to evaluate the carcinogenic risk to humans of molybdenum trioxide and other substances. Announced in advance, it enabled us to submit a technical paper to IARC and observe the meeting in person, for close scrutiny of the scientific proceedings. Prior to the meeting, our re-review and assessment of data in existing literature led us into a fast-track project to author and publish a scientific paper entitled: 'New studies on the in vitro genotoxicity of sodium molybdate and their impact on the overall assessment of the genotoxicity of molybdenum substances'. Containing previously unpublished IMOA-commissioned genotoxicity studies, it conveyed, in addition to the data, an important core message about the absence of a genotoxic mechanism in tumor development.

IARC concluded that molybdenum trioxide is a Category 2B substance according to their evaluation scheme. This is a very similar hazard conclusion to the existing EU-wide harmonized hazard classification of GHS Category 2



Carcinogen under the 2007 EU Classification, Labelling and Packaging Regulation, so it is not expected to be a catalyst for significant change in classification and labeling practices.

Massachusetts Land Application of Sludge:

IMOA provided molybdate effects datasets about soil and water and secondary poisoning, and participated in a technical workshop to assist the state regulators in their task of deciding whether to increase the maximum permissible limit for molybdenum in biosolids. This topic reached a successful conclusion in November 2016 with a decision to uplift the value from 25 to 40 mg Mo/kg. The higher limit value was determined after the hazard and risk assessment that included IMOA's molybdate effects data.

Other proposed chemical changes

DEPARTMENT OF ECOLOGY
State of Washington

Proposed chemical addition

CAS	Acronym	Chemical
80-90-1	BPS	Bisphenol S
84-61-7	DCHP	Dicyclohexyl phthalate
84-69-5	DIBP	Diisobutyl phthalate
131-18-0	DPP	Dipentyl phthalate
335-67-1	PFOA	Perfluorooctanoic acid
620-92-8	BPF	Bisphenol F

Existing chemical expansion

CAS	Acronym	Chemical
140-40-5	4-NP	4 Nonyl phenol
25154-52-3	NP	Nonyl phenol
84852-15-3		4-Nonyl phenol branched

Proposed chemical delisting

CAS	Acronym	Chemical
85-44-9		Phthalic anhydride
556-67-2	D4	Octamethylcyclotetrasiloxane
7439-98-7	Mo	Molybdenum

delisted. To date, this has involved a technical submission, a workshop and a webinar, resulting in molybdenum being one of just three substances accepted into the delisting review process;

IMOA's OECD-endorsed molybdate effects dataset, and the higher reliability of specifically-cited IMOA studies compared to others. Likewise, a further document, 'Science Approach to Biomonitoring' by Health Canada (November 2016) concludes that, based on the studied data, molybdenum trioxide and molybdenum disulfide are of low concern to the health of the general public in Canada at current levels of exposure.

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

Washington State (WS) Children's Safe Products Rule:

This topic was first identified as an issue of significant concern in 2014, when several U.S. states in the process of enacting similar legislation adopted a 'cut and paste' approach using Washington's List of Chemicals of High Concern to Children (CHCC). Molybdenum and molybdenum compounds are on the WS CHCC List, based on their one-page risk assessment in 2009. Unwarranted negative perceptions, substance stigmatization and its 'domino effect' across other states are key undesirable impacts of the inadequate toxicological assessment. Within a formal Rule Review process announced last September, we engaged with the Washington State authorities to request that molybdenum and molybdenum compounds be

19 additions are proposed. The review continues until September 2017, includes three public consultations, and is an issue that we continue to monitor closely.

U.S.-Canada Regulatory Cooperation Council:

We became involved in this (recently concluded) project because molybdenum was selected as a case study. In phase one, we actively assisted the U.S. and Canadian authorities to develop a scoping document. Phase two focused on molybdenum biomonitoring equivalents with a view to their future use in substance risk assessment. Documented output once the project was completed included a technical paper entitled 'Biomonitoring Equivalents for Molybdenum' (Hays et al 2016), which we particularly welcomed as it refers to

Canada Chemicals Management Plan:

Both molybdenum trioxide (CAS No. 1313-27-5) and molybdenum disulfide are listed for hazard and risk assessment by the Canadian authorities (Health Canada and Environment Canada) between 2018 and 2020. Early in 2017, we submitted the technical dossier for MoO₃, and are preparing to do similarly for MoS₂. Undoubtedly, the Health Canada conclusions noted in the paragraph above will feed usefully into the upcoming assessment.

Review of Mo Water Quality Standard for the Protection of Aquatic Life:

This is also a Canadian-centred activity of interest to IMOA because Saskatchewan Province is proposing to significantly uplift its current standard of 0.07 mg Mo/L to 26 mg Mo/L. We contributed our OECD-endorsed

freshwater molybdate effects dataset towards the development of this proposal in our response to the recent public consultation. We await the final decision.

U.S. ATSDR Toxicological Profile of Molybdenum:

This U.S. federal agency is preparing a toxicological assessment of molybdenum that focuses on human health effects. In November 2015, we provided a significant number of IMO studies for their assessment, further supplemented by new studies in 2016 and 2017. The public commenting period was originally expected during 2016 but is now expected later in 2017. We are preparing to submit a response. It will be a high-profile and extensive document of more than 200 pages. It merits close scrutiny by IMO's HSE Committee because it will be a key reference publication for both medical practitioners and the general public.

Targeted testing

IMO has recently completed a trio of tests that generate information about human health endpoints, conducted according to OECD Technical Guidelines. Protection of human health is a primary objective, and this data facilitates continuous improvement in the necessary in-depth iterations of hazard and risk assessment of molybdenum substances.

Biological monitoring is another focus area where an IMO project is generating data to support health protection, in addition to regulatory use. Several IMO member companies involved in molybdenum processing voluntarily participated in the biological monitoring program to assess occupational exposure to molybdenum and compounds in the workplace. Project deliverables included a report on 'Biological Monitoring in the Molybdenum Industry', and a further study that uses the anonymized data in a (REACH) Derived No Effect Level (DNEL)

calculation methodology to ascertain a safe concentration value of molybdenum in blood serum. This information found immediate regulatory application in an IMO Risk Characterization Report demonstrating the absence of risk to humans, by comparing dosing concentration levels in a prenatal developmental toxicity study with the lower biomonitoring workplace exposure data.

Life Cycle Inventory activities

In January 2017, we launched a project to update the Life Cycle Inventories (LCI) for roasted molybdenite concentrates (technical grade molybdenum trioxide) in powder and briquette forms; and for ferromolybdenum. These products comprise the dataset for molybdenum in metallurgical applications. LCI has transitioned from a new concept to mainstream practice, with datasets becoming a standard component of sustainability assessments aiming to use substances with the least environmental impact.

An LCI is an inventory of flows from and to nature for a product system. Inventory flows include inputs of water, energy and raw materials, and releases to air, land and water. In our case, this relates to the inventory of flows in the production of the molybdenum products mentioned above.

Likewise, LCI data requirements are increasingly incorporated into industry standards mandating that the data be generated within the last five years, and global LCI platforms request a similar timeframe. Practical applications for our new datasets include:

- Stainless steel LCI datasets
- The EU Product Environmental Footprint initiative (scheduled to be rolled out across the EU in 2020)
- Inclusion in practitioner LCI assessment software such as USETox and GaBi
- Environmental Product Declarations
- IMO responses to individual direct enquiries

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, the HSE Executive staff member and our technical support service providers. We express our sincere gratitude for their dedication and professionalism. Likewise, to Mr. Ken Kloska (Climax Molybdenum Co.), who has very ably chaired the Committee from 2015–2017, with energy and dedication to the task. Stepping down from that position he hands the baton to Dr. Georg Thurner (Plansee SE), who we welcome as the incoming HSE Committee Chairman, starting September 2017.



Market Development



Dr. Nicole Kinsman
IMOA Technical Director



Market Development

Key activities and achievements in 2016/2017

Carbon steels

Our engagement program with the carbon steel sector included 40 visits and events over the year, providing technical consulting and in-house seminars for companies in the automotive, structural steel and seamless pipe sectors. Hot stamping (press hardening) steel, dual phase steel and advanced structural steel grades were the main areas of interest.

Recent market research in the European automotive industry indicates that the most popular product groups are press hardening steel (PHS) 1500–2000 MPa and upper level dual phase steel (DP780 and DP980). For the latter, a new DP980 galvanized steel grade with 0.2% Mo was launched in cooperation with a German steelmaker. Molybdenum alloying has a clear advantage – this grade has significantly better forming properties than competing materials, and the initial production volume of 25,000 tonnes per year looks set to increase. We worked with a Russian steelmaker to develop galvanized DP590 and DP780 grades containing 0.15% and 0.25% Mo respectively. This grade is now in production and being delivered to Russian car factories.

The potential of molybdenum has also been demonstrated in the 1800 and 2000 MPa grades of PHS, with improvements in relation to bendability and hydrogen

embrittlement. IMOAsponsored research carried out at Okayama University in Japan, together with a collaborative project with the National Taiwan University in Taipei are generating further evidence of these effects. Trials with molybdenum-alloyed PHS are currently running with a number of manufacturers. We are working with a European steelmaker to develop a variant of the 1500 MPa grade with molybdenum for heavy gage use in truck cabins, in cooperation with a Brazilian metal forming company. Alloy qualification trials of optimized PHS grades are also underway at a major automotive manufacturer in Detroit, U.S. Additionally, we are developing better tool steel for the hot forming of PHS. All the progress in these various activities has been published and presented at international conferences.

We continue to widely disseminate the results of IMOAs gear steel development project. A paper was published in the ‘Journal of Advances in Manufacturing’ (Springer), with a further paper due for publication in ‘Steels in Cars and Trucks’. Recently, the alloy concept and its advantages were presented to a major Chinese windmill and industrial gear manufacturer.

In the structural steel arena, we continue to focus on medium and heavy gage sheet and plate for trucks and heavy equipment. Development of S700MC for truck frame and trailer applications is in progress in China and South America. The alloy design is based on the proven Mo-Nb concept with additions of 0.2–0.3% Mo. New HB400 and HB500 wear plate grades have been successfully tested in Korea. A new development



project is also underway with an Asian steelmaker, focusing on EH51 extra heavy plate for ship decks, using a low-carbon MoNbCuNi alloy concept.

The IMOA project on ultra-high strength structural steel up to 1300 MPa in cooperation with SSAB Europe has concluded. The results are very encouraging and have identified multiple benefits associated with molybdenum, including high strength and toughness while counteracting excessive softening during welding. Both effects are highly relevant for the intended applications.

Due to continuing low oil prices, interest in line pipe projects remains depressed. Nevertheless, we have actively supported manufacturers with specific issues, including a seamless pipe producer in Russia which is qualifying an innovative alloy concept based on low carbon, high niobium and molybdenum to produce X70 seamless pipe without quench and temper treatment. We recommended some fine tuning concerning the molybdenum addition and temperature control. If successful, the new alloy will result in significant savings since heat treatment becomes obsolete, removing bottlenecks in the production of higher value-added products.

In the foundry sector, an Austempered Ductile Iron (ADI) alloy with 0.3% Mo has been qualified for wear-resisting applications. A Brazilian foundry has already shown interest for mining applications and we will shortly publish the results. We are also encouraging Mo-alloying for high-strength gray cast iron for cylinder heads.

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 in New York. Through their connections, Climax Molybdenum arranged a meeting with the Colorado Department of Transportation, including a workshop run by our consultant, in an effort to increase stainless steel usage. A webinar also gave Codelco information about the ABC sector for their market development efforts. In total, these events attracted more than 400 attendees from 19 companies.

IMO A has eight courses accredited by the American Institute of Architects (AIA) with all but one qualifying for sustainable design (Health, Safety and Welfare) continuing education credit.

In cooperation with the NI, IMOA's consultant gave a continuing education workshop on stainless steel's increased contribution to sustainable design in the new version of USGBC LEED to an audience of senior architectural specifiers at the Construction Specifications Institute's (CSI) annual Mid-Atlantic Region Conference (MARC).

U.S. architects and engineers play a major role in global design and construction. The ongoing interaction provided by these face-to-face workshops builds and strengthens relationships, influences global projects and has actively increased the use of molybdenum-containing stainless steel in building and construction.

Publications and website updates

IMO A has published the e-newsletter Stainless Solutions since August 2014. Each issue covers a technical topic or emerging application and currently reaches a distribution of about 1,300 architects, engineers and fabricators. Newsletter content this year included website updates addressing finishes, sustainability, structural applications,

grade selection and austenitic stainless steels.

The jointly-developed NI and IMOA ABC Stainless Steel Library contains over 360 PDFs and is a comprehensive resource for decision-makers. As of March 2017, more than 1,800 flash drives had been distributed and more than 2,000 copies downloaded.

Several articles written by our consultant and jointly sponsored by IMOA and the NI were revised and published in international journals. In August 2016, The Construction Specifier published a feature article as the cover story in the annual convention issue (the most widely read). That issue also announced that Ms. Catherine Houska's 2015 feature article 'Duplex Stainless Steel Revolutionizes Structural Design' had earned the CSI's National Society Technical Publication Award, the first issued in three years. The December 2016 issue of The Construction Specifier featured 'Maintaining Stainless Steel' as the cover feature article in an issue devoted to architectural metals.



With some modification, Stainless Steel World News reprinted the full-length feature articles on whole building Life Cycle Analysis (LCA) and stainless steel



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22K2

CAPACITY 26000 L
6869 US gal
MAX. GROSS 39000 kg
85980 lb
TARE 4030 kg
8885 lb

(November 2016) and environmentally friendly maintenance and cleaning of aesthetic applications (April 2017). In June 2017, Construct Canada reprinted a revised version of the LCA article with Canadian examples. NI China translated the article for publication in Architecture Technology. Based on publication statistics, about 140,000 people will have seen these articles.

Structural market development

Structural market development and education about the AISC Steel Design Guide 27: Structural Stainless Steel (DG 27) is an important aspect of our market development. IMO A's consultant has provided technical support on many structural projects during the past year including canopies and flood protection systems for New York Metropolitan Transit Authority subways.

In response to interest in stainless steel use for bridges and other highway applications adversely affected by increased deicing salt use, IMO A's consultant provided assistance in drafting a new ASTM International standard. She is also working to add large duplex stainless steel structural sections to ASTM A709, the standard for bridge steel.

Additionally, IMO A helped to sponsor the production of design tables for DG 27 by the Steel Construction Institute (SCI). Designers are accustomed to using tables to speed up design and select from the full range of options. The need for design tables for stainless steel structures is even greater because there are many shapes and sizes with no standardized library, complicating design and procurement. They will match the format of the carbon and alloy steel tables already available and are expected to facilitate increased use of structural stainless steel in everyday applications.

Market development in China

In 2013, a development strategy known as the Silk Road Economic Belt and the 21st century Maritime Silk Road was announced by Chinese President Xi Jinping. Also known as the 'Belt and Road' (B&R) initiative, it focuses on connectivity and infrastructure supported by a Chinese-backed lending program of more than \$100bn for new railways, roads, bridges, ports and other facilities in 60 countries to China's south and west (along the old Silk Road).

Almost half of China's central government-owned conglomerates have already participated in 1,700 B&R projects. In May 2017, Xi Jinping chaired China's first B&R forum. To align with the B&R initiative, IMO A intensified its focus on carbon steel over the last year.



Carbon steel

China is the largest molybdenum producing country and during the last year we worked with suppliers to introduce the concept of market development. IMO A proposed the China Molybdenum Application and Promotion Group (CMAPG – 中国钼应用推进小组) in Autumn 2016. The Group was officially founded in April 2017 by JDC, CMOC, Climax Molybdenum China and IMO A and admitted the CSSEA (China Special Steel Enterprises Association – 中国特钢企业协会) and the CSSC (China Stainless Steel Council – 中国特钢企业协会不锈钢分会) to its membership at the Group's first meeting.

The Group aims to fund selected molybdenum development projects. The first agreed project is a moly-steel forum to be held in 2018, focused on the strength and toughness advantages achieved with the addition of molybdenum in alloy steels.

Stainless steel

By 2030, China's cities are expected to be home to one billion people. Led by Shanghai and Beijing, seven Chinese cities ranked among the world's 30 most populated areas in 2010. Therefore, ABC remains our most important area of activity.



Facades and building envelopes

During 2016, contacts with the China Green Building Council (CGBC) were secured through the China Stainless Steel Cooperation and Promotion Group (CSCPG), with a joint IMOA-NI presentation delivered in Guangdong in December 2016. We will continue to concentrate our efforts in southern China as the area with the most potential for the development of stainless steel sunscreens and envelopes.

Supply chain education

We have established regular contact with the largest curtain wall manufacturers and are pooling resources with the NI to provide assistance for selected projects in the justification, design, specification, fabrication and installation stages.

We also continued to offer direct assistance in cases where problems have seriously affected the appearance of stainless steel. We have supported two major projects in Shenzhen and Shanghai, where mishandling of stainless steel components had caused issues.

A Stainless Steel Performance Atlas developed with the Central Iron and Steel Research Institute (CISRI) is expected to be published in early 2018. The atlas will be published in Chinese and will give architects performance data on existing installations in a variety of climates in eight Chinese cities, aiding appropriate specification in future projects.

Stainless steel roof systems

In a new market development project, IMOA is focusing on promoting molybdenum-containing ferritic stainless steels for large roofs in airports and stadia. Weight, maintenance, sustainability and resistance to fire, hail and wind must all be considered when selecting materials for these coverings. Ferritic grades proved to be an optimal solution, due to their lower rate of thermal expansion. The new Qingdao airport is an example of a 220,000 m² roof constructed with 1.8% molybdenum-containing ferritic stainless steel.

Energy-related segments

The energy sector increasingly relies on high-quality steels, so domestic supply is of strategic importance and molybdenum plays a key role. IMOA is now in contact with the Shanghai University of Electric Power (梁磊, 上海电力学院) to closely monitor trends in the development of molybdenum-containing ferritic grades for condenser tubes, and the development of high performance austenitic stainless steels for FGD (Flue Gas Desulfurization) scrubbers in coal-fired power plants.

Stainless steel service piping

This project is jointly conducted between the NI and IMOA. We now have project teams in the U.S. and Australia, where a small test order has been placed. Discussions regarding trials are ongoing with water authorities in both countries. IMOA attended the 8th Global Leakage Summit in London in September 2016 and gave a poster

presentation together with the NI at the American Water Works Association (AWWA) Infrastructure Conference in October 2016. We also demonstrated the system at the AWWA Annual Conference in June 2017. Through these conferences and exhibitions, we have made contact with several interested water authorities across the U.S.

IMOA has met with AWWA to discuss the inclusion of stainless steel service pipe in their pipe standards. In conjunction with the NI, we also met with water authorities and potential pipe suppliers in South Korea (together with ISSF) and South Africa (with SASSDA), where two water authorities have expressed an interest in trials to be organized by SASSDA.

Research

IMOA is sponsoring the role of the Steel Construction Institute (SCI) in SIROCO, a three-year European research project to develop guidance on the design of stainless steel slip-resistant connections. These are used for bridges, masts and other installations where slip needs to be restricted and/or the structure is subject to variable loading. Currently there are no rules for this type of connection.

The extensive program of tests on austenitic and duplex stainless steel bolted connections carried out under SIROCO concludes that austenitic and duplex stainless steel bolts can be satisfactorily preloaded, provided the correct bolt grade, tightening method and lubricant are used. The project also established that the preloaded losses in bolted assemblies and slip factors on grit blasted surfaces measured for stainless steel were very similar to those for carbon steel assemblies.

The final recommendations from SIROCO are under development and are expected to be introduced into the

next revision of the European design and execution standards. There has been considerable interest in this project from industry, including oil producers who use a large number of preloaded super duplex bolts in piping systems and offshore aluminum structures such as helidecks and living quarters.

The potential of molybdenum to improve bendability and reduce hydrogen embrittlement in super-strong grades of press hardening steel is being investigated in IMO A-sponsored research underway at Okayama University in Japan. Early indications are that increasing the molybdenum content in the steel increased resistance to fracturing by up to three times, an important property in automotive applications.



Workshops with the Nickel Institute

We regularly conduct workshops with the Nickel Institute in Southeast Asia. In October 2016, we gave a water and petrochemical industry workshop in Singapore, together with the Singapore Welding Society and Stalalube.

Team Stainless commissioned AgroParisTech in France and Manchester Metropolitan University in the UK to carry out a research study on how well stainless steel surfaces can be sterilized in a hospital environment. The results

machinery to metal goods. Stainless steel remains one of the most recycled metals with an end-of-life recycling rate of around 70%.

In conjunction with Team Stainless, the Specialty Steel Industry of North America, and the International Copper Association, we fund a consultant to represent our interests on the international standards being developed by ASTM International's E60 Sustainability and F40 Declarable Substances in Materials Committees. Through active involvement, our consultant is now chair of the E60.80 General Sustainability subcommittee and serves on the committee representing the U.S. on ISO TC59/SC17 Sustainability of Buildings and Civil Engineering Works. Standards are also under development on resilience, establishing guidance so that there is credit for recycled content during life cycle assessments and other topics that relate directly to molybdenum-containing product advantages.

We work with allied organizations to increase the effectiveness of our activities while sharing the cost of common projects.

Similarly, we ran workshops on food and hygienic applications, and on the welding of stainless steel in Malaysia, jointly organized with the Malaysian Iron and Steel Industry Federation in April 2017.

are about to be published in a short brochure which is aimed at the general public as well as health providers, confirming the excellent hygienic properties of stainless steel.

Team Stainless

IMO A is a member of Team Stainless, formed from the global trade associations of the stainless steel and alloying element industries to promote the benefits of stainless steel.

Team Stainless has also sponsored the Comprehensive Multilevel Cycle of Stainless Steels update by Yale University for 2015. The new study illustrates how China has cemented its dominant position and demonstrates a shift in the end use sectors away from industrial

Financial Report 2016

Income and expenditure account

For the year ended 31 December 2016

IMOA/Molybdenum Consortium

	2016 \$	2015 \$
Turnover	2,757,877	2,762,524
Operating and administrative expenses	3,066,686	3,509,878
Operating surplus/(deficit)	(308,810)	(747,354)
Other interest receivable and similar income	6,730	3,333
Surplus/(deficit) on ordinary activities before taxation	(302,080)	(744,022)
Tax on surplus/(deficit) on ordinary activities	5,616	15,204
Surplus/(deficit) on ordinary activities after taxation	(307,696)	(759,226)

Balance sheet

For the year ended 31 December 2016

IMO/Molybdenum Consortium

	2016		2015	
	\$	\$	\$	\$
Fixed assets				
Tangible assets		28,252		38,090
Current assets				
Debtors	100,469		96,969	
Cash at bank and in hand	3,385,431		3,658,493	
	3,485,900		3,755,462	
Creditors – amounts falling due within one year	(699,500)		(671,204)	
Net current assets		2,786,400		3,084,258
Total assets less current liabilities		2,814,652		3,122,348
Reserves				
Profit and loss account		2,814,652		3,122,348
Accumulated funds		2,814,652		3,122,348

Financial commentary

The 2016 audited accounts presented here are consolidated figures for IMO and the Molybdenum Consortium and are subject to approval at the 2017 AGM. Income from subscriptions and levies amounted to US\$2,757,877. After expenses of US\$3,066,686 a deficit (after taxation) of US\$307,696 was carried forward bringing the combined accumulated funds to US\$2,814,652. Of this US\$1,883,861 was attributable to IMO and US\$930,792 to the Consortium.

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



INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY



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