



INTERNATIONAL MOLYBDENUM ASSOCIATION  
THE VOICE OF THE MOLYBDENUM INDUSTRY

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# 2020/2021 ANNUAL REVIEW





# IMOA Annual Review

Overview from the Secretary-General

Tim Outteridge  
Secretary-General



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## Market dynamics in the face of a pandemic

Once again, we reflect on a year of Covid-19 and its far-reaching impact. International travel restrictions, home working and intermittent lockdowns continued to be the norm.

The pandemic caused an unprecedented fall in the demand for molybdenum in 2020 in all regions except for China, as the lack of economic activity led to reduced investment and massive destocking along supply chains. Overall, there was a 5% decline in global molybdenum use, with growth in China offset by large falls elsewhere.

The first half of 2021 experienced a 'boom' in commodities not seen for over a decade, driven by restocking and strong demand from reopening economies. This led to higher use of molybdenum across all market segments, except oil & gas and aerospace, resulting in tightness across almost all special steel products, exacerbated by a shortage of skilled labor which had been downsized during the pandemic.

**“Throughout the pandemic, the Association has continued to deliver results for members.”**



## The molybdenum horizon

Looking forward, strong demand is expected from the mechanical engineering sector in the short-term. In the longer-term, molybdenum will make a contribution to power generation and infrastructure projects as society attempts to build back with adaptation to climate change at the top of the agenda. Molybdenum will play a key role in ensuring infrastructure is more resilient to the increasing number of extreme weather events.



The global effort to decarbonize society will require massive investments to modernize industries and will likely trigger molybdenum demand in the form of high-quality molybdenum-containing alloys and downstream products to meet the new technological necessities. However, the net effect of the transition from carbon-based to 'green' energy sources remains challenging to evaluate.

Suppliers of all metal and mineral products are increasingly expected to respond to the expectations around responsible sourcing and supply chain due diligence. The rise of voluntary sustainability standards and regulatory compliance requirements reinforces this growing trend. The molybdenum industry will play its part by responding to the requirements of ResponsibleSteel, the steel industry's multi-stakeholder standard and certification initiative. IMOA is leading the engagement with ResponsibleSteel on behalf of our members.



## Reflecting on a year of progress

Our programs and communications work promote the many sustainability credentials of molybdenum-containing products, from durable, corrosion-resistant stainless steels and alloys for architectural applications to high strength alloy steels for light-weighting and resource conservation in the construction and automotive sectors. The recent development of standards for structural stainless steel in North America will open up new opportunities for growth in building and construction, including large infrastructure projects such as bridges.

The work of the HSE Committee is contributing strongly to maintain appropriate regulation based on sound science in the ever more stringent and proliferating environment of chemicals management.

## The value of industry partners

Our collaboration with industry peers continues to bear fruit. A notable example is our cooperation with Team Stainless to raise awareness of the benefits of stainless steel service lines in municipal water distribution systems. Over the coming years, this market offers significant opportunity for increased molybdenum usage. In HSE, cost and efficiency benefits accrue for our members via multi-metal projects such as USETox, the MECLAS hazard classification calculator, LCI harmonized methodologies, and pooling of chemicals management global regulatory know-how.

## Laying the foundations for a bright future

A new era is about to begin for IMOA with a new Secretary-General at the helm. Eva Model is well known to many of you and I'm sure you have confidence, as I do, that she will not only maintain the important work of our Association but develop and improve upon it.

I consider it a privilege to have served as Secretary-General for the last thirteen years. You will be the judge, but I hope to be leaving IMOA in a better place than when I arrived. I have been fortunate to enjoy the support of our Presidents, an enlightened and thoughtful Executive Committee and the membership, for which I am most grateful.

I think I can say without fear of contradiction that my team has achieved many notable successes over the years. In the area of environment and human health, we have built up a vast and unrivaled repository of knowledge about the effects of molybdenum. It has been successfully deployed by our IMOA Molybdenum Consortium for the registration of the 12 EU REACH substances and the continual, diligent updating of the substance dossiers as required by ECHA. We achieved the recognition and endorsement of our molybdate soluble salts database by the OECD and ensured that regulators around the world have access to the data through both direct engagement and the publication of peer-reviewed, scientific papers. This effort has and will continue to facilitate fair and appropriate regulation of molybdenum and to maintain access to markets.

Our work in Market Development has contributed to the growth of molybdenum use across stainless and alloy steels, in architecture, building and construction, infrastructure, automotive, mechanical engineering, energy generation, processing industries and other sectors. The new structural stainless steel standards will add to an already impressive track record.

We created our 'More for Less' program, highlighting the contribution of molybdenum to sustainable development, which was summarized in the brochure *A Sustainable World with Molybdenum*. This was followed by the creation of IMOA webpages to highlight molybdenum's role as a bio-essential trace element for humans, plants and animals.

Throughout, the dissemination of our work has been professionally supported by our strategic communications consultant, Stratia, an integral part of the IMOA team. The IMOA staff, committee members and all the consultants that we work with are to be congratulated on the generous enthusiasm, diligence and determination that they have invested to deliver the Association's success to date. I have no doubt that it will continue.



## Forward-looking message from the new Secretary-General

I am delighted to pick up the reins from Tim as IMOA's next Secretary-General. Working within the molybdenum industry has been a significant and enjoyable part of my career to-date and I am excited to have the opportunity to support the wider industry by continuing IMOA's important work.

The last two years have definitely reaffirmed a long-standing belief of mine; we live in a world where the only constant is change. Against this backdrop, the focus of the IMOA team is on delivering value for our members through times of change and we will remain steadfast in our role as the authoritative voice of the global molybdenum industry.



A key priority will be the successful delivery of the Association's five-year strategic plan through a market development program that adapts to changing market needs, and an HSE program that maintains an effective radar, drawing on experts to proactively respond to emerging regulatory issues and embedding IMOA as the go-to body for robust scientific data. It is imperative that we continuously ensure information is easy-to-access and delivered through an effective global communications program.

I very much look forward to working with the experienced and well recognized IMOA team, our members and Committees, and our many industry stakeholders to ensure the Association goes from strength to strength.

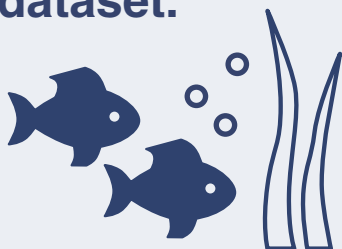
**Eva Model**  
New Secretary-General



# This Year's Highlights

## HSE

**Increased** Mo water quality standard in British Columbia is based on **IMO A dataset**.



Canadian authorities conclude **MoO<sub>3</sub>** and **MoS<sub>2</sub>** are **low risk substances** to human health and the environment.

IMO A team authors new **Molybdenum Chapter** for **Patty's Toxicology**.

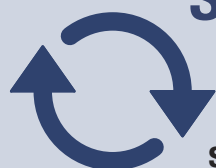


**MoO<sub>3</sub>** **Korea REACH** data-sharing agreement signed.

**Securing access to markets, with rigorous scientific evidence to support appropriate regulation and chemical management.**

## MoCon

**EU PACT** List concludes no **MoO<sub>3</sub>** regulatory action required.



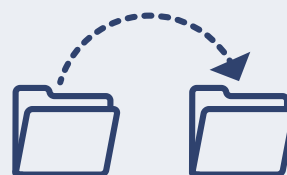
**Sixth** update of the **REACH technical dossier** for **sodium molybdate** submitted in June 2021.

**MoCon 2020** funding call achieved its

**US\$500K** target.



Two-year project completed to submit supplementary **1st species Prenatal Developmental Toxicity data** to ECHA.



## Membership

**95%**

**Existing membership** represents of production outside China, CIS and Mongolia.



## Market Development

**Promoting the advantages of molybdenum-containing alloys in a range of applications.**

Our **40+** virtual **workshops** and **presentations** reached more than **15,000** people.



Joint-project research team received the prestigious **Gilbert Speich Award**.



**Austenitic Fabrication brochure** updated in **Chinese** and **English**.

**5** **Peer-reviewed papers** on molybdenum-alloyed steels published.

Completion of **1,000+** pages **AISC structural stainless steel standards & design guide**.

**3**



**Stainless Flexible Service Line** videos created.

## Communications

**Raising awareness of molybdenum's unique properties and sustainability credentials.**



IMOA **videos** viewed over **12,000** times.

**13**

IMOA authored articles in **trade media publications** reached an audience of over **284,000**.

**52%**

increase in **LinkedIn** followers



and **36%**

increase in **WeChat** followers.

New **Chinese website** launched.







# Health, Safety and Environment

Key Activities and Achievements in 2020/2021



**Sandra Carey**  
IMO HSE Executive





## IMOA HSE Committee activities

Our HSE Secretariat, with the support of our expert Committee, works tirelessly to secure continued access to markets for members, using rigorous scientific evidence to support appropriate regulation setting and chemical management.

### Water quality standards

Our evaluations of molybdenum water quality standards present an evergreen challenge. This year was no different, with ongoing reviews in Canada and the USA:

**“Facilitating proportionate regulation underpinned by sound science is an ever-present IMOA goal.”**



#### British Columbia

This Canadian state is proposing a chronic long-term Mo water quality guideline for the protection of freshwater aquatic life of 5.1 mg Mo/L, which is a 70-fold increase from the 0.073 mg Mo/L value in force since 1986. It is very encouraging that this higher safe value is based almost exclusively on the IMOA molybdate effects dataset. Generated since 2007, this dataset is publicly available online<sup>1</sup> via the OECD website, and via peer-reviewed publications in scientific journals. Also proposed is an acute short-term value of 46 mg Mo/L. During the public-commenting period, we submitted technical commentary on aspects of the overall review, which includes values for livestock and wildlife.

#### Wisconsin

The 10th Cycle of Groundwater Standard Recommendations indicates a value of 40 µg Mo/L to be retained unchanged as an Enforcement Standard, but with a Preventive Action Limit also proposed at 4 µg Mo/L. 40 µg Mo/L, in place since 2006, is based on the US EPA's 1993 lifetime health

<sup>1</sup> [https://hpvchemicals.oecd.org/UI/SIDS\\_Details.aspx?id=5c88d62f-4401-4cad-b521-521a4bd710f3](https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=5c88d62f-4401-4cad-b521-521a4bd710f3)



advisory level. We interacted with the Wisconsin Dept. of Health on three separate occasions in 2020 to facilitate their review of the proposal and ensure awareness about IMOAs datasets. Similarly, we also pointed towards recent information from the US ATSDR<sup>2</sup> government agency. In May 2020, it published an extensive Toxicological Profile for Molybdenum, that also contains IMOAs studies data.



## Illinois

A state bordering Wisconsin, Illinois is in the process of establishing a water quality standard for molybdenum in groundwater. Their 2021 proposal cites an exceedingly low value of 0.019 µg Mo/L based on a calculation methodology that uses the daily water intake of children up to six years old as a starting point instead of an

### Illinois Class I Groundwater Quality Standard Updates

CASRN	Constituent	Current Class I GQS mg/l	Current Class I GQS Source	Proposed Updated Class I mg/l
7439-98-7	Molybdenum	–	–	0.019
1317-33-5	Nickel	0.1	Livestock	0.077

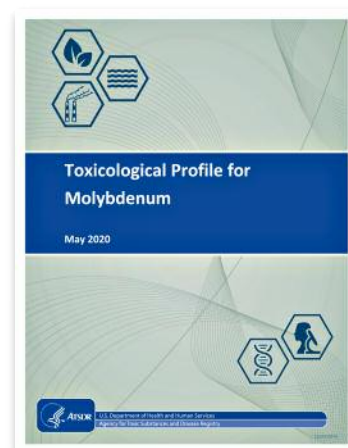
adult intake. Our submission in June 2021 referred to this and other observations to facilitate further consideration of the proposed value.

## Denmark

IMOAs data is integral to the ongoing Danish Mo water quality review initiated in 2021. Danish chronic duration values under review include 67 µg Mo/L for freshwaters, and 6.7 µg Mo/L for marine waters. By contrast, the IMOAs Predicted No Effect Level (PNEC) for each of those environmental compartments is significantly higher at 11,900 µg Mo/L and 2,280 µg Mo/L respectively.

## Hazard and risk determination methodology

We are engaged in dialogue with US ATSDR about an uncertainty factor that makes a material difference to risk calculations, but for which there was no public consultation prior to its publication.



## Canada screening assessments

Canada continues to progress its Chemicals Management Plan 3, and in November 2020 the country published the outcome of its screening assessments<sup>3</sup> for both molybdenum trioxide (CAS No. 1313-27-5) and molybdenum disulfide (CAS No. 1317-33-5). IMOAs had submitted data for consideration by their competent authorities, Health Canada and Environment Canada. For both substances, a low likelihood of causing harm to human health or the

<sup>2</sup> US Agency for Toxic Substances and Disease Registry

<sup>3</sup> <https://www.canada.ca/content/dam/eccc/documents/pdf/pded/low-concern/Screening-assessment-substances-identified-as-being-of-low-concern.pdf>



## ERC-I classifications for the molybdenum substances addressed in the Canadian screening assessment

CAS RN	DSL name	ERC-I Predictive Modelling Ranking	ERC-I Water Quality Monitoring Ranking	Overall ERC-I Classification
1313-27-5 <sup>a</sup>	Molybdenum oxide (MoO <sub>3</sub> )	Low	Low	Low
1317-33-5	Molybdenum sulfide (MoS <sub>2</sub> )	Low	Low	Low

environment was concluded, as assessed by Canada's Ecological Risk Classification of Inorganic Substances, and their Three Human Health Science Approaches.

## California Prop 65 List

On 19 March 2021, California's Office of Environmental Health Hazard Assessment (OEHHA) added Mo Trioxide (CAS No. 1313-27-5) to the Proposition 65 List of substances known to the State of California to cause cancer. This is an automatic consequence of the March 2018 IARC Monograph 118 that assigned molybdenum trioxide an IARC 2B ranking, meaning the substance is 'possibly carcinogenic to humans'. It is comparable to the long-standing classification of MoO<sub>3</sub> as a Carcinogen Category 2 according to UN GHS and EU CLP criteria. In November 2020, we made a submission seeking a qualified Prop 65 listing to limit the scope to 'airborne particles of respirable size', as tested in the 1997 US NTP Studies TR 462. The OEHHA decision<sup>4</sup> was to include both respirable and inhalable particle sizes.

The ruling means it is essential that companies both within and outside the USA whose products may potentially be sold in California are aware of Proposition 65, as they will be bound by its provisions and must ensure they comply with this legislation.



The California Prop 65 Warning requirement comes into effect a year from the date of the 19 March 2021 listing. Under Proposition 65, a warning must be given in California for chemicals listed as carcinogens (unless the exposure is low enough to pose no significant risk of cancer). Therefore, by 19 March 2022, any business with 10 or more employees that causes an employee or consumer in California to be exposed to molybdenum trioxide must place a clear and reasonable warning on the product or post a warning

sign in the workplace, such as: 'WARNING. This product contains chemicals including molybdenum trioxide, which is known to the State of California to cause cancer. For more information, go to [www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov).'

Prop 65's formal name is the Safe Drinking Water and Toxics Enforcement Act of 1986, and as such it also prohibits California businesses from knowingly discharging significant amounts of a listed chemical into sources of drinking water.

## Genotoxicity

The micronucleus test requirement under Korea REACH was the legislative driver to recently investigate this toxicological endpoint. The outcome of the study, conducted with sodium molybdate dihydrate as a readily soluble source of the molybdate ion, was negative for the induction of bone marrow micronuclei. This negative test result is important weight-of-evidence data in regulatory fora, and is supportive of our working hypothesis that the carcinogenicity (preceded by inflammation) of MoO<sub>3</sub> in the NTP study is not caused by a genotoxic action of the molybdate ion.

## KOREA REACH

In August 2020, we submitted data-sharing proposals and a value proposition document in the Korean language, to the substance groups for RMC, Mo and molybdenum trioxide. A data-sharing License to Use agreement has been successfully concluded with the MoO<sub>3</sub> substance group.



<sup>4</sup> <https://oehha.ca.gov/proposition-65/crrn/chemicals-listed-effective-march-19-2021-known-state-california-cause-cancer>

## UK-REACH registration deadlines

Deadlines post 28 October 2021	Tonnage	Hazardous property
2 years from 28 October 2021	1000 tonnes or more per year	Carcinogenic, mutagenic or toxic for reproduction (CMRs) – 1 tonne or more per year Very toxic to aquatic organisms (acute or chronic) – 100 tonnes or more per year Candidate list substances (as at 31 December 2020)
4 years from 28 October 2021	100 tonnes or more per year	Candidate list substances (as at 27 October 2023)
6 years from 28 October 2021	1 tonnes or more per year	

## UK REACH

Since coming into force on 1 January 2021, we have alerted and assisted companies with the initial Grandfathering stage of the Regulation. Grandfathering enables EU REACH substance registrations of Great Britain-based companies to be recognized under UK REACH. Our involvement is foreseen to continue through the future process phases to ensure the timely submission of UK REACH Lead Registrant technical dossiers for both molybdenum and compounds.

## ETAP

We participated in a multi-metal project of the (metals) Ecotoxicology Advisory Panel about influent molybdenum into public sewage treatment plants (STPs). The project aimed to determine Mo-release volumes, their sources and apportionment between domestic, industrial and service use plus run-off rainwater from roads and buildings. The report, necessary for regulatory dialogue about the environmental impact of diffuse emissions, documented that molybdenum influent into STPs is negligible in quantity and does not present a concern.

## Patty's Toxicology

The opportunity arose in 2020 for IMOA to author a new Molybdenum Chapter for Patty's Toxicology, a well-known, prestigious reference handbook for industrial hygienists and toxicologists. The emphasis is on commercial inorganic molybdenum substances and those where the molybdate ion  $[\text{MoO}_4]^{2-}$  is the driver for a biological effect. The content includes chemistry, toxicokinetics, carcinogenicity, repeated dose toxicity, reproductive and genotoxicity, biomonitoring and occupational exposure limits. The peer-reviewed chapter was submitted to the publisher Wiley in June 2021, and will be available to buy online in PDF format.

The HSE and MoCon activities featured in the next section are managed and driven forward by the corporate members of the HSE Committee and MoCon Technical Working Group, the HSE Executive staff member and our invaluable technical service providers. We are immensely grateful for their continued dedication and professionalism.

## REACH Molybdenum Consortium (MoCon)

The EU REACH Regulation came into force in 2006. This led to the creation of IMOA's EU REACH Molybdenum Consortium to generate the extensive data required to achieve technical and legal regulatory compliance and thereby retain access to EU markets via REACH registration of substances. Fifteen years later, the European Chemicals Agency (ECHA) continues to stringently evaluate the REACH-registered substance dossiers that form the basis of scientific hazard and risk assessment for all registrations.

## ECHA Integrated Regulatory Strategy Annual Report

The April 2021 ECHA report declares its ambition to accelerate data generation, the identification of groups of substances of concern, and regulatory action. To achieve higher throughput, ECHA will work with groups of substances instead of individual ones. This approach enabled a tenfold increase in the number of substances assessed in 2020. The report highlights the need for industry to be proactive with dossier updating, rather than waiting until the authorities take regulatory action.





## Implementing regulation on dossier updating

To compel greater numbers and higher frequency of dossier updating, ECHA introduced the *Implementing Regulation on the Duties placed on Registrants to update their REACH Registrations* in December 2020. The regulation stipulates timeframes, typically between three and six months, for different types of updates. It does, however, very usefully highlight that it is the obligation of all registrants to address this additional regulatory burden. This collective obligation is very important, not least from the financial perspective of all registrants contributing to the updating endeavors, proportionate to their tonnage band data requirements.

## MoCon funding

For the first time since 2010, MoCon issued funding invoices in 2020, with an accompanying explanatory letter, to all MoCon member REACH registrants and Letter of Access registrants. The funding round will enable MoCon to continue the necessary work to maintain regulatory compliance of the technical dossiers. Despite the difficult Covid-19 climate, which drastically altered many working practices and made corporate outreach processes more arduous, by August 2021 an invoice payment rate of over 92% was achieved, raising US\$668K. Work continues to receive the remaining 8%. The Secretariat recognizes and applauds the timely payments made by most registrants of MoCon substances.

## CoRAP list

Thankfully, no MoCon substances were listed on either the 2020 or 2021 Community Rolling Action Plan (CoRAP) for formal REACH Substance Evaluation by an EU Member State authority. However, there is still much work to be done because data endpoint and dossier compliance checks abound, and ECHA has already indicated it will shortly have

## Overview of timing for updating the registration dossiers

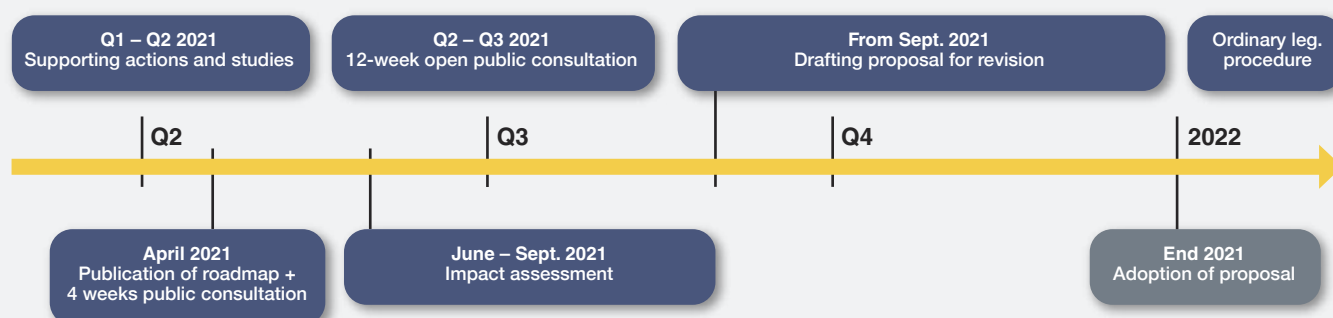
Type of update	Implementing Regulation published in the EU Official Journal on 12 October 2020
Registrant's status (Art. 1)	3 months
Substance composition (Art. 2)	3 months
Tonnage band (Art. 3)	3 months
New identified uses (Art. 4)	3 months
New knowledge of risks ENV/HH risk (Art. 5)	6 months
Classification and labelling (Art. 6)	6 months (immediate in case CLH)
CSR (Art. 7)	12 months
Testing proposals (Art. 8)	6 months/12 months (in case of group of substances)
Confidential information (Art. 9)	3 months

a focused campaign on UVCBs<sup>5</sup>. Roasted molybdenum concentrates (RMC) and Ferromolybdenum slags are both UVCBs in the MoCon substance portfolio.

## REACH and CLP reviews

The EU Commission and ECHA are working in 2021 to extend the scope of the EU CLP<sup>6</sup> and EU REACH Regulations to include new hazard endpoints such as Endocrine Disruption (ED) in a first phase, and immune, neurological and respiratory system endpoints in a second review phase.

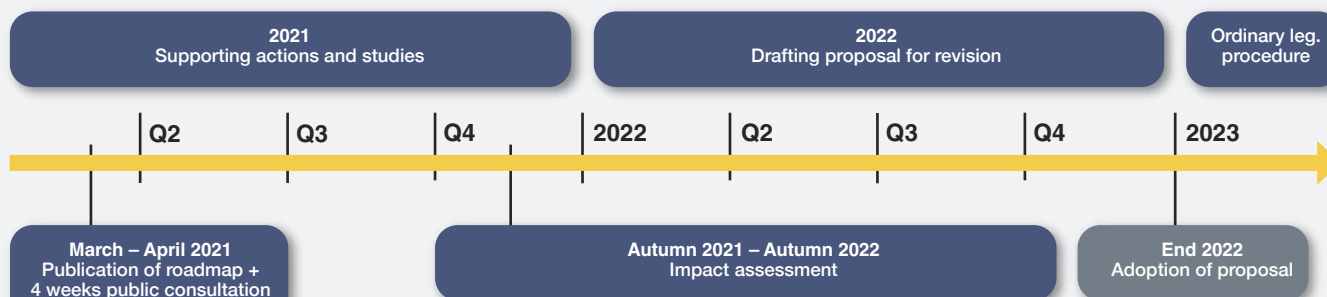
## CLP amendment timeline



<sup>5</sup> Unknown or variable composition, complex reaction products or biological materials

<sup>6</sup> EU Classification, Labelling & Packaging Regulation No. 1272/2008

## REACH revision timeline



For MoCon this will translate into more toxicological endpoint investigations, either in existing literature or new studies. The EU regulatory authorities are looking to strengthen full compliance of registrations dossiers, enforcement and market surveillance, and the possibility for the Commission (via ECHA) to initiate harmonized hazard classifications.

Demonstrating its proactive approach to hazard classification, the EU is taking the unusual step of introducing the new ED endpoint into CLP (Classification, Labelling and Packaging) even before it is introduced into the GHS (Globally Harmonized Classification system). A first set of OECD guideline-compliant ED data about molybdate is available for the thyroid gland, from a recent study. The thyroid data, comprising hormone levels and organ evaluation, did not identify any adverse effects from molybdate exposure. While this is an encouraging first dataset, we keep in mind that the endocrine system also includes multiple glands such as adrenals, pituitary, testes and ovaries.

### 1st species prenatal development toxicity (PNDT)

Throughout 2020 and the first half of 2021, our technical work had a sustained focus on evaluating recent 1st species PNDT studies. The aim was to augment the data available in an existing study (Tyl 2013) in response to a mandatory ECHA Decision. Progressing knowledge about this higher tier human health endpoint requires significant financial resources – around US\$500K – and is a time-intensive complex undertaking. Results from a set of three preliminary and definitive studies were evaluated, entered into the technical dossier for sodium molybdate<sup>7</sup> in the prescribed IUCLID software summary format, and submitted to ECHA in June 2021. The study demonstrated no effect on the incidence of fetal malformations or variations.

### MoO<sub>3</sub> on the EU PACT list

Between 2016 and December 2020, molybdenum trioxide<sup>8</sup> featured on ECHA's Public Activities Coordination Tool (PACT) List in the 'risk management under consideration' category whilst EU Member State Denmark was conducting a Risk Management Option Analysis (RMOA) to determine whether it would propose further regulatory measures in relation to the safe handling, exposure and uses of this substance. MoCon submitted the 2019 peer-reviewed published paper to the Danish competent authority about the two-generation reproduction toxicity study<sup>9</sup> using sodium molybdate that addressed this critically important human health endpoint. Encouragingly, the RMOA concluded that no further regulatory action is required at this time as the identified risks are already appropriately managed. Identified risks refer to the existing EU-wide harmonized hazard classification of the substance as a Category 2 Carcinogen, eye irritation 2, STOT SE 3<sup>10</sup>.

Despite the completion of the RMOA process, the substance will remain on the PACT List as a marker that it was assessed by an EU Member State, and that no further regulatory action was proposed. This is important because the PACT List is a tool to alert existing and potential users that there may be further regulatory restrictions afoot in relation to a substance, which could discourage new and existing uses. Public visibility of an RMOA outcome is important because it confirms that risks associated with a substance are either appropriately managed by existing regulatory measures, or that further regulatory measures are proposed.

<sup>7</sup> EC No. 231-551-7/CAS No. 7631-95-0

<sup>8</sup> <https://doi.org/10.1016/j.reprotox.2018.11.004>

<sup>9</sup> <https://doi.org/10.1016/j.reprotox.2018.11.004>

<sup>10</sup> <https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/details/68763>



## EU Chemicals Strategy for Sustainability and Zero Pollution Action Plan

The EU's recent Chemicals Strategy for Sustainability (CSS) and its Zero Pollution Action Plan (ZPAP) are both introducing multiple legislative measures to reduce pollution, with the aim of achieving a toxic-free environment as part of the EU Green Deal. EU policy on the environment is based on the precautionary principle and that preventative action should be taken, environmental damage should be rectified as a priority at source, and that the polluter should pay. ZPAP spans water, air and soil legislation and is expected to be adopted during 2021. Each of these legislative areas are within the scope of EU REACH and will bring further regulatory challenges for REACH-registered substances.

### Mixture Assessment Factor (MAF)

The EU will introduce a Mixture Assessment Factor for both the environment and human health, to account for the uncertainty surrounding exposure toxicity of unintended combinations of chemicals. The likely default MAF is 10. Applying this factor within the REACH context will reduce PNECs and DNELs, which in turn will constrain the operational envelope, for example for environmental permitting purposes, unless it can be demonstrated that there is no contribution to risk in local and regional exposure scenarios. Such scenarios are an integral part of the REACH registration dossiers for hazard classified substances to describe the conditions under which the substances can be used without adverse environmental or human health effects.

### MISA initiative

The Metals and Inorganics Sectoral Approach (MISA) is an industry/ECHA cooperative program, coordinated by

Eurometaux as the ECHA-accredited stakeholder for the EU non-ferrous metals industry. The program addresses remaining technical and scientific challenges to EU REACH technical dossier updating, and it fosters continuous improvement in dossier quality (in tandem with the Implementing Regulation on Dossier Updating). Although MoCon successfully completed its MISA task list of updating activities by the end of 2019, the initiative remains in place as a useful framework for projects that can be done collectively and more cost-effectively by multiple metals, such as updating regional environmental exposure datasets which is a likely 2021/2022 project.

### Looking ahead

The sodium molybdate dossier was updated in June 2021, in line with the ECHA Decision mandating our provision of supplementary 1st species PNDT data. With sodium molybdate being our read-across substance, there is a due diligence requirement to update sections of our other 11 MoCon substance REACH dossiers with toxicological information generated with sodium molybdate data. The update of these dossiers is an ongoing priority during 2021.

The upcoming EU CLP and EU REACH introduction of the endocrine disruptor hazard category will require the screening of scientific literature to identify any molybdenum-related data about EATS endocrine disruption modalities (Estrogen, Androgen, Thyroid, Steroidogenesis).

We shall continue to work to minimize the need and cost of interacting with the European Chemicals Agency, by updating the REACH dossiers with new and relevant scientific information as required, to ensure that they are maintained as 'living documents' in accordance with ECHA's requirements and related legislation.

## Zero Pollution Action Plan - scope



Prevent and reduce  
pollution to waters  
and oceans and  
facilitate remediation



Prevent and reduce  
air and noise pollution



Prevent and reduce  
soil pollution and  
facilitate remediation



# Market Development

Key Activities and Achievements in 2020/2021



Dr Nicole Kinsman  
IMO Technical Director





Despite the pandemic, market development activities continued successfully. Our ability to adapt and operate effectively online expanded our audience significantly. Thousands of attendees accessed our webinars in China, hosted in partnership with domestic organizations such as the China Stainless Steel Council, AT or New Steel. Elsewhere, the reach of our joint South East Asian workshops with the Nickel Institute increased substantially during the last year through online delivery in conjunction with local industry associations. Over 20 webinars were attended by thousands of engineers, architects and fabricators in Singapore, Malaysia, India and Vietnam. Presentation topics included corrosion resistance, material selection, welding and fabrication, finishes, sustainable and resilient design and water.

## Carbon Steel

The complications of the past year necessitated all virtual market development activities for carbon steel, which proved to be as effective as the in-person activities of previous years. IMO A consultant, Professor Hardy Mohrbacher, hosted webinars and online meetings on the outcomes of IMO A research projects. He also expanded on how newly discovered metallurgical functionalities of molybdenum could be exploited in automotive, structural, line pipe and special steel applications.

**“A key focus of our market development work is promoting the sustainability benefits of molybdenum.”**



## Flat steel development

An earlier IMO A project demonstrated the beneficial effect of molybdenum alloying on reducing hydrogen embrittlement sensitivity in ultra-high strength press hardening steels (PHS). We are pleased to report that these findings were corroborated by several other research groups in the meantime.

Further PHS development activity focused on heavy gage variants of the 1500 MPa grade for truck applications. In cooperation with a Brazilian component supply company, the entire production process was validated using a steel containing 0.15% molybdenum. Laser welding was identified as the best assembly process, providing both high strength and good ductility in the heat-affected zone of the optimized steel. A paper published in the widely influential journal *Materials Science & Engineering: A* describes both the steel concept and the welding results.

The development of 'Super-HSLA' steel for thin cold-rolled and galvanized steel sheet in automotive body applications also began this year. A leading European steelmaker successfully cast a 160t-trial heat, containing 0.2% molybdenum and is now testing different rolling and annealing scenarios to optimize the final properties.

This steel grade is intended to become a cost-effective alternative to traditional dual phase steels, offering both superior weldability and bendability. A prominent North American steelmaker is exploring the same idea using a mini-mill production concept.

In relation to hot-strip products, a large European steelmaker requested support for developing >15 mm gage S700MC for use in heavy vehicle frame structures and >20 mm gage X70 for line pipe steel. This activity draws on IMO A's significant database and existing knowledge gained from comparable past projects. Similarly, we supported a US steelmaker in the development of medium-gaged grade S760MC for use in light truck manufacturing. Pilot production of 0.25% molybdenum-containing alloys resulted in a market-ready steel in the 4 to 6 mm gage range.

## Special steel developments

In many countries around the world, government policies on decarbonization are promoting further growth of wind turbine installations. These policies coincide with the development of state-of-the-art 10–12 MW power-output-rated offshore turbines, with the potential to achieve 20 MW on the horizon.



© Audi 2021



A German special steelmaker has further improved the superior gear steels developed in a past IMO A project for 5–6 MW output turbines. The improved gear steel is expected to match the requirements of turbines with twice the power output. Increasing the molybdenum content from 0.45% to 0.8%, should enable the upgraded alloy to sustain the high torque density expected in the drivetrains of such large turbines. The new gear steel currently is undergoing qualification tests at both a German gearbox manufacturer and at a major European wind turbine OEM (original equipment manufacturer).

## Cast iron development

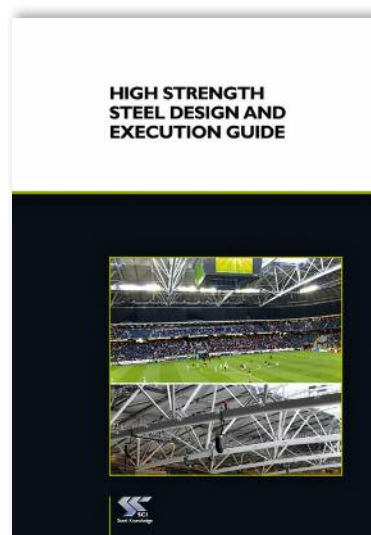
Separately from the Shanghai University cast iron research project (see Research section on page 25 for details), pilot trials have been conducted on a SiMo iron. The trials indicated that the newly developed niobium microalloyed SiMo iron, containing approximately 1% molybdenum, could have a significantly increased peak operating temperature with sufficiently high creep strength to compete with more expensive incumbent materials. This upgraded alloy will be tested both by a leading turbocharger manufacturer and a European carmaker to evaluate possible applications and cost savings.



## SCI design guide

High strength steel (HSS) plate with a yield strength of around 700 MPa typically contains between 0.1% and 0.4% molybdenum. Although these steels are not yet common in construction, their use can lead to both significant weight and carbon emission savings. Therefore, the use of HSS is likely to increase significantly in the coming years, given the growing focus on climate change.

A recent example is the Cross Bay Link in Hong Kong, where 6,600 tonnes of steel with a yield strength of 690 MPa were used to form the two 200 m long curved arches. Each arch is made of a box section of 3 x 3 m to 3.5 x 3.5 m with 50 to 60 mm thick plates (see picture on pages 16/17).



With support from IMO A, the Steel Construction Institute (SCI) published the *High Strength Steel Design and Execution Guide* in November 2020, which explains the specification, design and fabrication of HSS in structures. The free [Design Guide](#) is available on the SCI website. The Swedish Steel Construction Institute is currently preparing a Swedish translation.

## Webinars and presentations

Over the year, the webinars and online conference presentations given by Hardy Mohrbacher reached an audience of over 1000. He discussed the results of the IMO A Okayama University project on the benefits of molybdenum in 2000 MPa PHS at the European Materials in Car Bodies Conference. The same talk was repeated at an event on the Chinese New Steel online platform. At the Chinese CSM special steel forum another successful presentation addressed the role of molybdenum in carburizing steels.

The development of heavy-gaged PHS was presented at the combined Europe and North America *Joining in Car Body Engineering* 2021 conference. Finally, Professor Mohrbacher gave a presentation entitled *Alloy design opportunities for molybdenum and niobium in martensitic stainless steels* at the International Forum on Technology and Application of Houseware Martensitic Stainless Steels, held in Yangjiang, China.

To build awareness of the latest information, Nancy Baddoo of the SCI organized a series of four lunchtime webinars in January and February 2021 on HSS, where both the STROBE project's findings (see Research section on page 25 for details) and the contents of the SCI Design Guide were presented. Each week, the webinars attracted an audience of 250 to 350 designers and steelwork contractors, more than any previous SCI webinar series. Further dissemination activities are planned.

# Architecture, Building and Construction (ABC)

We continue to build on the success of our long running multi-pronged program to promote the benefits of molybdenum-containing stainless steel in ABC. Much of our work to-date has targeted North American and European architectural and engineering firms, which strongly influence global design. However, we have also delivered workshops in Asia and republished articles globally.

## Delivering stainless steel workshops

IMOA has developed eleven ABC courses that have been accredited by the American Institute of Architects (AIA), which provides architects and engineers with continuing education credit. Two new finish specification workshops were developed in 2021. All but three workshops qualify for sustainable design (Health, Safety and Welfare) continuing education credit. During the past year, IMOA and the Nickel Institute (NI) jointly sponsored online workshops presented by IMOA consultant Catherine Houska in India, Singapore and New York, which attracted over 330 attendees.

Whilst there have been no face-to-face workshops due to Covid-19, additional live organization-specific webinars are being discussed with several firms. Such ongoing interaction builds and strengthens relationships, influences global projects and actively increases the use of molybdenum-containing stainless steel in building and construction in North America and elsewhere.

Also, a series of live global webinars is being planned. The webinar attendees will receive AIA credits, if they are members, and all attendees will receive certificates of attendance. The AIA has an automatic cooperative professional certification program with both the Royal Institute of British Architects (RIBA) and US-based professional engineering associations. These certificates are required for professional and state licensing in the US. Being able to issue them will enable IMOA and the NI to dramatically increase the number of firms accessing educational materials. Other global architecture associations typically accept AIA certificates of completion.

## Stainless steel library

The 2018 edition of the jointly-developed IMOA and NI *ABC Stainless Steel Library*, containing over 550 PDFs, has been distributed to more than 8,800 industry decision-makers globally. Feedback from architectural and engineering firms confirmed that this comprehensive library is highly valued. Content additions and updates are planned so that a 2021 version of the library can be released.

# Structural Market Development

Catherine Houska provided technical support for many structural projects during the past year. These included both potential and approved US vehicular and pedestrian bridge projects, Indian pedestrian and vehicular bridges, sculptures, monuments and building applications.

## Market development in China

China's crude steel output exceeded one billion tons in 2020, increasing its global market share from 53% to 56%. Europe, India and Japan, second, third and fourth in crude steel volumes, reduced their respective shares from 8.4 to 7.4% (Europe), from 5.9 to 5.3% (India), and from 5.3 to 4.5% (Japan).

With molybdenum use per tonne of crude steel comparatively lower in China than other parts of the world, our focus on increasing engagement within the country has intensified. This work is led by IMOA consultant Dr. Gaetano Ronchi. The Chinese steel industry is currently streamlining its production infrastructure and upgrading its technological capabilities to tackle pressing issues, such as overcapacity, high energy intensity (EI) and carbon emissions. The guidelines by the Ministry of Industry and Information Technology (MIIT) increased the steel capacity swap ratio from 1.25:1 to 1.5:1. This means that a steelmaker would need to cut 1.5 million tonnes per year (tpy) of old, inefficient capacity for every 1 million tpy of new capacity it installs. The focus of our webinars and presentations on supporting the development of higher quality, stronger steel grades, resulting in lighter and thinner designs, as well as superior welding properties and corrosion resistance, is well aligned with the technological ambitions of the Chinese steel industry.

## Molybdenum and steel symposiums

Four summary papers from the 2018 Molybdenum and Steel Symposium, organized by IMOA in cooperation with Shanghai University in November 2018, have been translated into Chinese and will be published on the IMOA website. All four papers had already been published in the *Journal of Advances in Manufacturing*.

Following the successes of the inaugural 2018 event and the second Molybdenum and Steel Symposium in Xian in December 2019, IMOA will co-organize, with our member Jinduicheng (JDC), a third event in Jilin in early November 2021.









## Stainless steel in China

In 2019, China's stainless steel crude output exceeded 30 million tons, and the global market share of Chinese stainless steel rose from 56% to 59%.

Our stainless steel ABC activities supported Chinese architects, designers and curtain wall contractors in several building development projects, mainly focused on coastal cities in China's greater bay area (Shenzhen, Hong Kong, Zhuhai, Macau) as well as on Shanghai. Additionally, a MolyReview article on the Qingdao new Jiaodong Airport promoted molybdenum-containing stainless steel solutions for large, low slope metal roofing. This article, explaining the benefits of continuously seam welded stainless steel roofing technology, is now available in both English and Chinese and is scheduled to appear in trade media publications in the coming months.

## High-performance stainless steels

The IMO A presentation *Processing and manufacturing of high-performance austenitic stainless steel*, had over 200 in-person attendees at the 3rd International Conference on Super Austenitic Stainless Steels and Nickel-Based Alloys, held in Beijing and hosted by the China Stainless Steel Council (CSSC).

The Chinese edition of the recently updated brochure *Practical Guidelines for the Fabrication of Austenitic Stainless Steels* was available and promoted at the conference.

The IMO A presentation *Considerations on the fabrication of high-performance stainless steels* was well received by a 180-strong in-person audience at the *Super SS and Nickel-Based Alloy Supply Chain Service* conference, held in Wuxi in March 2021. The Survey of wet Flue Gas Desulfurization (FGD) and corrosion of coal-fired power plants in China study, which aimed to better understand the potential for using high-performance stainless steel in this important application, concluded successfully. The study, commissioned with CSSC in 2018, is based on the results surveying 31 coal-fired power plants, 15 electric power design and research institutes and desulfurization equipment manufacturers located in seven different regions of China.

## Stainless steel in water distribution systems

In March 2020, the Chinese national standard recommended stainless steel as the first choice for secondary water systems in new residential and public building projects. In autumn 2020, we started cooperating with a new consultant based in Beijing to promote the adoption of Type 316 stainless steel for this application. During the Secondary



Water Supply Equipment and Technology Conference and Product Exhibition in Shenzhen in April 2021, it was announced that Type 316 stainless steel has been mandated as standard material for tubes, joints and tanks used in all secondary water systems in the city of Shenzhen, be it external, underground or in-wall. Nationwide, this application is expected to require at least five to six million tonnes of stainless steel over the next three to five years, with some 10 to 15% estimated to be Type 316 stainless steel.

## Chinese webinars and our WeChat channel

IMOA partnered with an influential branch of the Chinese Society of Metals, the New Steel platform, to successfully launch a series of in-depth webinars on special steels (see the carbon steel webinars section on page 19). The online delivery of these seminars will make our high-quality content available to a much wider audience.

Audience reach across our whole range of Chinese webinars increased by an order of magnitude, with over one thousand attendees joining several of them. For example, Catherine Houska delivered a successful live webinar, including Q&A session, to over 1900 people. The webinar entitled *Bioclimatic (Sunscreen) Design with Stainless Steel* was organized together with AT (Architectural Technology Magazine) in September, 2020.

China's 14,500 km long eastern coastline, stretching from its southernmost Guangdong province up to its northernmost Liaoning province, is subject to corrosive conditions. Steel rebar is essential to the development of coastal concrete structures such as bridges and coastal safety systems. A 100-year service life requirement is increasingly mandated. IMOA partnered with CSSC to deliver a virtual conference presentation in November 2020 and three webinars in January and March 2021, collectively attended by thousands, highlighting the longevity benefits of using molybdenum-containing stainless steel rebar instead of plain carbon steel rebar in these environments.

Further dissemination of information about the benefits of alloying with molybdenum is also continuing on our popular WeChat channel, which has seen a 36% increase over the last year to over 3,100 followers. To join IMOA's WeChat community, scan the following QR code.



## Team Stainless

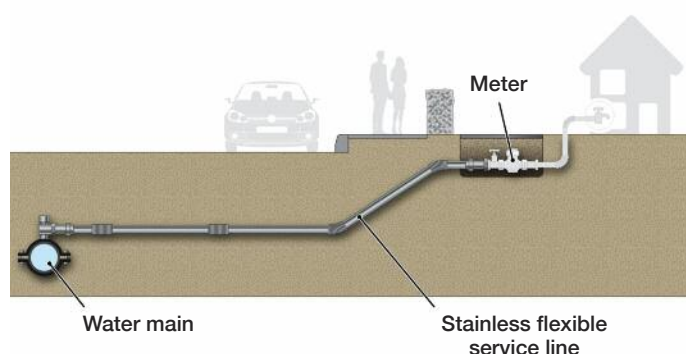
IMOA continues to be a member of Team Stainless, formed from the global trade associations of the stainless steel and alloying element industries to promote the benefits of

stainless steel. In the past year, a new Team Stainless brand identity was developed and a new website launched. A strategic Team Stainless communication plan is in development to coordinate and maximize opportunities to promote the sustainability benefits of stainless steel.

## Stainless steel service lines

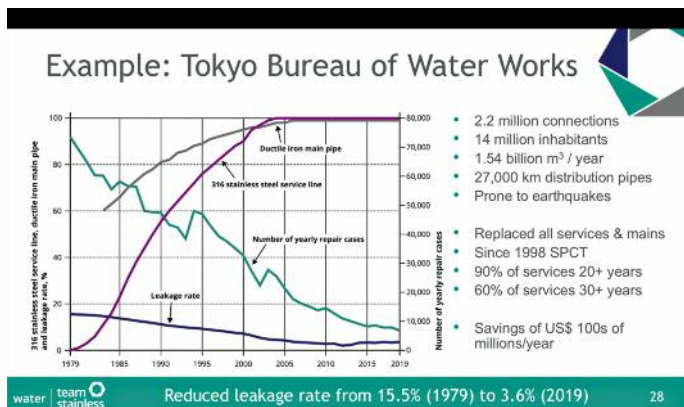
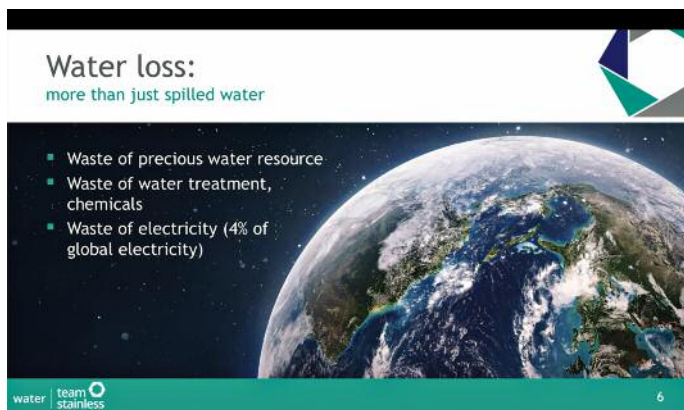
Water utilities worldwide lose an estimated 30% of freshly treated drinking water through leaks in their distribution networks. Most of the loss occurs in the service line that connects the water main under the road to the water meter on each property. This loss is costly for water authorities, not only due to the direct cost of water that cannot be sold but also due to the financial and environmental costs of finding and fixing leaks and finding, treating and storing more water to compensate for those losses. The adverse impact on the environment is particularly problematic considering dwindling freshwater resources and the consequences of climate change.

The impact of water loss cannot be overstated. It threatens the resilience of water distribution systems and can lead to potential water shortages during extreme weather events.



Partially corrugated Type 316 stainless steel service lines, developed and implemented with great success in Japan, are a proven solution to this problem. Together with the Nickel Institute and Team Stainless as of 2021, we are promoting this solution to water utilities in several world regions. Field testing programs are planned or underway in utilities in the UK, Malta, Australia, China, the US and Canada. To facilitate these trials, our group has established a small stock of stainless partially corrugated tube (SPCT) as well as tapping saddles with valves and fittings in a warehouse in Singapore. A step-by-step installation video and short promotional video are now available to watch on the [Team Stainless YouTube channel](#).

Additionally, a promotional Team Stainless brochure *Stainless Flexible Service Line – Simply fit and forget!* was created and distributed to the 3000-member strong Water Loss Specialist Group (WLSG) of the International Water Association (IWA). A webinar outlining the issue of water loss given as part of an IWA WLSG webinar series in May 2021, discussed case studies where Type 316 stainless steel service line installations have dramatically reduced both leakage and maintenance repairs. The webinar, watched by almost 300 people, is available on demand on the [IWA Water Loss Specialist Group YouTube channel](#).



ASTM standard A1119-20 for the stainless steel partially corrugated tube was issued in the US in late 2020, while a fittings standard is currently under development in China.

## Structural stainless steel specifications development

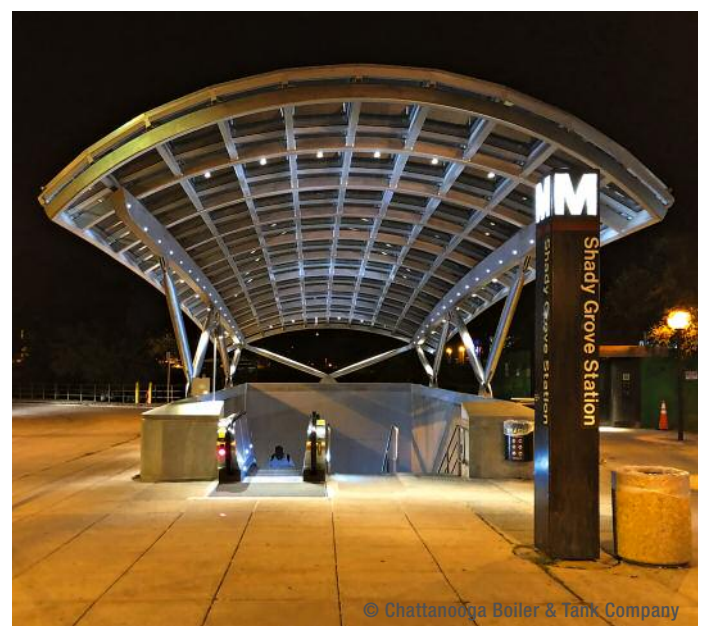
Structural stainless steel has significant market growth potential. However, structural engineers require codes and standards to build with stainless steel. Until now, no such standard was available in North America for heavier structural sections, which hindered the growth of stainless steel in bridges and other higher load applications.

This problem is finally solved. The American Institute of Steel Construction's (AISC) first stainless steel design specification AISC 370 and Code of Standard Practice 313 are ready to be issued.

The culmination of three years' work by Nancy Baddoo of the SCI with support from Catherine Houska and many others, the specification gives both cost-effective and easy-to-use design rules, based on cutting edge research from universities in both Europe and Asia. Once published at the end of the year, it will be available for designers both in the US and in other parts of the world that have AISC design standards implemented.

The standard will also be adopted in the 2024 International Building Code. This design standard will effectively remove the longstanding obstacle to growing the US market for stainless steel in construction. SCI has also prepared a revision to the AISC Design Guide 27 Structural Stainless Steel, which acts as a handbook to AISC 370. The revision gives a selection of design examples and contains member and connection design tables. This will be published at the end of the year, alongside AISC 370.

In parallel with this, Nancy Baddoo and Catherine Houska have contributed to a major revision of the American Society of Civil Engineers (ASCE) design specification for lightweight, cold-formed structural stainless steel (SEI/ASCE 8-02), which is also due for publication later in 2021. The significant revision adds duplex stainless steels and modernizes this outdated design specification, making design more cost-effective and potentially expanding its use for structural industrial roofing, platforms and decks, blast and fire barriers, and curtain wall and support systems. These efforts will remove barriers to stainless steel use for everyday larger structural sections.





In April 2021, SCI's Nancy Baddoo presented an online workshop at AISC's annual conference to 200 structural engineers on both the new AISC 370 and AISC 313 standards. All stainless steel standardization and planned dissemination work has been financially supported by a consortium of several organizations, including IMOA.

## Brochures

One of the most popular brochures on the IMOA website, *Practical Guidelines for the Fabrication of Austenitic Stainless Steels*, was revised and made available in both English and Chinese in March 2021. A German version of the brochure is being produced in cooperation with the German Stainless Steel Development Association (ISER).



## Research projects

Our project on direct quenchable heavy plate in the 1000 MPa strength class in cooperation with the Spanish research center CEIT and the German heavy plate producer Dillinger Hüttenwerke, has been finalized. A technical paper about the results received the prestigious Gilbert Speich Award from the Association for Iron and Steel Technology (AIST), which will be celebrated in an official ceremony during the MS&T 2021 conference in Columbus, Ohio. Three additional peer-reviewed papers describing the results of this project and the metallurgical functionality of molybdenum were published in *Metals* and the Journal of *The Minerals, Metals & Materials Society*.

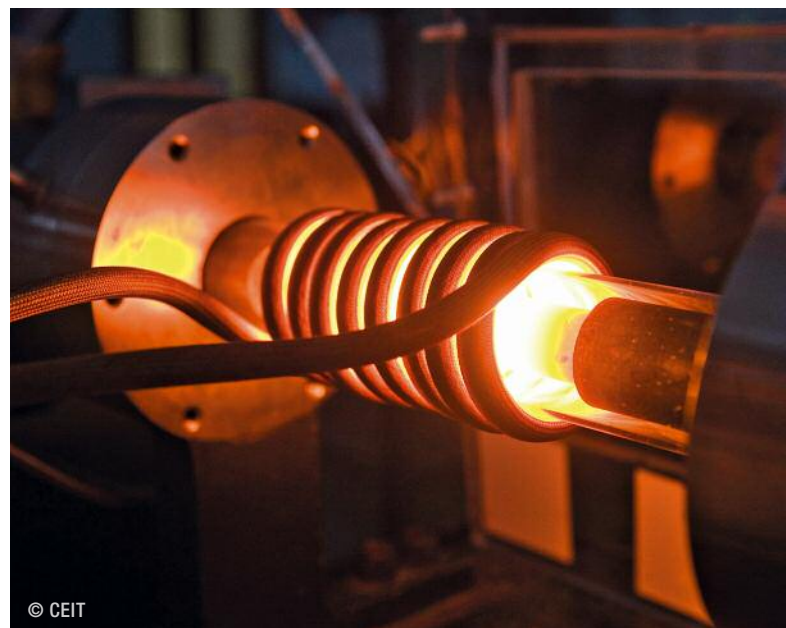
Dillinger has since performed industrial trials based on the project results. The first plates of 30 mm gage fulfilled the strength requirements for grade S965T and achieved a toughness at -40 °C that was more than four-times better than the minimum required by the applicable standard. The steel producer is therefore using this new alloy concept commercially and plates are now being shipped to selected customers for verification of processing properties.

The steel grade is used for welded steel structures within mechanical constructions, plant constructions and structural steel works, such as machines for structural engineering, conveying plants, hoists, cranes, flood gates and frameworks.

The research project in collaboration with Shanghai University (SHU) to develop a better, more cost-effective cast iron for automotive parts is in its final stages. The project generated a huge amount of data that must be analyzed in depth over the coming months. However, it is already clear that the intended optimal property combination of high strength (>350 MPa) with good heat conduction (>40 W/mK) could be achieved with a molybdenum addition of 0.5%. Even this small addition of molybdenum adds more than 70 MPa to the overall strength.

This newly developed grey cast iron is an attractive material for components in the hot area of combustion engines and potentially also for lightweight brake discs, fly wheels and cylinder heads. SHU's Centre for Advanced Solidification Technology (CAST) has a network of Chinese foundries connections that will help us to disseminate the results of the project and promote the advantages of molybdenum-alloying in cast irons.

Finally, IMOA has also sponsored the SCI role in leading a 3.5 year collaborative European research project called 'STROBE' (Stronger Steels in the Built Environment). Through laboratory tests and numerical analysis, the project studied the ductility, stability and dynamic response of HSS. More economic design rules were formulated and simple tools developed to help designers maximize the advantage of HSS structural members. Partners include three European universities, the steel producer Dillinger and the global construction company Hochtief.





# Financial Report 2020

## Income and expenditure account

For the year ended 31 December 2020

IMOA/Molybdenum Consortium

	2020 \$	2019 \$
Turnover	3,662,154	2,946,472
Operating and administrative expenses	2,822,530	2,818,195
Operating surplus/(deficit)	839,624	128,277
Other interest receivable and similar income	14,669	24,477
Surplus/(deficit) on ordinary activities before taxation	854,293	152,754
Tax on surplus/(deficit) on ordinary activities	6,589	6,682
Surplus/(deficit) on ordinary activities after taxation	847,704	146,072



# Balance sheet

For the year ended 31 December 2020

IMOA/Molybdenum Consortium

	2020 \$	\$	2019 \$	\$
<b>Fixed assets</b>				
Tangible assets		525		788
<b>Current assets</b>				
Debtors	110,168		72,887	
Cash at bank and in hand	4,531,259		3,765,583	
	4,641,427		3,838,470	
<b>Creditors – amounts falling due within one year</b>	(535,425)		(580,435)	
<b>Net current assets</b>		4,106,002		3,258,035
<b>Total assets less current liabilities</b>		4,106,527		3,258,823
<b>Reserves</b>				
Profit and loss account		4,106,527		3,258,823
<b>Accumulated funds</b>		4,106,527		3,258,823

## Financial commentary

The 2020 audited accounts presented here are consolidated figures for IMOA and the Molybdenum Consortium and were approved by members in June 2021. Income from subscriptions and other revenue amounted to US\$3,662,154. After expenses of US\$2,822,530, an after-tax surplus of US\$847,704 was carried forward, bringing the combined accumulated funds to US\$4,106,527. Of this total, US\$3,550,006 was attributable to IMOA and US\$556,522 to the Consortium. In the case of IMOA, below-budget expenditure largely due to the Covid-19 pandemic resulted in a surplus accruing to the reserves.

This surplus maintained the accumulated funds in line with the Executive Committee's objective of holding one year's expenditure in reserves.

The funding call to Consortium members and Letter of Access holders mandated by the Molybdenum Consortium Steering Committee in 2020 raised approximately US\$635,000. The Molybdenum Consortium reserves will contribute to funding the Consortium's essential activities around standard information requirements and maintaining dossier compliance in 2021.





INTERNATIONAL MOLYBDENUM ASSOCIATION  
THE VOICE OF THE MOLYBDENUM INDUSTRY

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