HEALTH, SAFETY AND ENVIRONMENT

Key Activities and Achievements in 2024/2025

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IMOA HSE Committee activities

For almost 20 years, IMOA has steadfastly invested in generating sound science about the toxicology of molybdate with respect to human health and the environment. Now in 2024–2025, that investment is particularly paying dividends in terms of forming the basis for appropriate regulation.

Our datasets have long been effective in terms of achieving compliance with chemicals management regulations, but bringing about change at regulatory authority level in relation to water quality standards is always a longer-term ambition.

IMOA has engaged both at state and federal level in the US, where the regulatory authorities are choosing to use IMOA's OECD/GLP-compliant studies instead of other outdated poorer-quality data:

Colorado 2024: Many years of dialogue and sharing IMOA toxicology data for regulatory consideration were settled when the molybdenum surface water quality standard, after years of intense dialogue, debate and scrutiny, was uplifted from 210 to 530 micrograms Mo/liter, applicable to specified water bodies.

Illinois 2025: The final outcome of a four-year long rule-making process to introduce groundwater quality standards for several substances including molybdenum, resulted in setting a value of 308 µg Mo/L. The original proposal was 23 µg Mo/L, which dropped down to 10, moved to 19 until finally rising to 308 µg Mo/L as the Illinois Pollution Control Board opted to use a US government agency assessment that included IMOA's toxicology dataset. IMOA also contributed four written submissions and one in-person testimony session in Springfield, Illinois.

Wisconsin 2024: After two years of dialogue, the state authorities confirmed that the correct calculation for their proposed molybdenum groundwater standard resulted in a value of 600 micrograms Mo/L, instead of a ten-fold lower value announced earlier.

US Safe Drinking Water Act (SDWA)

At federal level, IMOA first engaged with the US EPA Office of Water in 2008 when molybdenum was initially listed as a potential contaminant for regulation, i.e. setting a SDWA limit value for its occurrence in drinking water.

"Building our scientific knowledge, sharing it and achieving regulatory traction has been our 20-year task"

2006 – 2025 → Next:

Data Generation	Data to Regulators	Regulatory Traction	Next:
MoCon & IMOA progressively generating robust molybdate effects dataset (HH + ENV) **2006 – to date:** process still ongoing as new endpoint data becomes mandatory	Molybdate effects datasets shared with regulatory authorities **2010 – to date:** e.g. ECHA (REACH), US EPA, US ATSDR, Korea-REACH	ECHA REACH Assessment of Regulatory Needs outcome = just one requirement **(2023):** US ATSDR now preferred choice instead of US IRIS Mo database, i.e. Mo WQS in Wisconsin (2022), Colorado (2024), Illinois (2025), US Office of Water (2025)	US TSCA UK REACH India REACH Denmark Mo QWS

Progress on regulatory uplifts in molybdenum water quality standards

Date/Location	Previous Mo WQS	Revised Current Mo WQS
2024 – Colorado, US [1)]	210 µg Mo/L	530 µg Mo/L
2024 – Wisconsin, US	40 µg Mo/L	600 µg Mo/L [2)]
2025 – Illinois, US	23 µg Mo/L [3)]	308 µg Mo/L [4)]
2025 (January) – Federal US Safe Drinking Water Act	**No set limit, but Mo on candidate contaminant list since 2008**	**Preliminary determination of *no requirement* to regulate Mo as a contaminant in drinking water [5)]**

Notes: Mo WQS = Molybdenum Water Quality Standard 1) Applicable to specified waterbodies 2) Proposed. Rule-making not finalized 3) Initial proposal 4) In process of finalization 5) Finalization expected 2026

Over 17 years, IMOA worked to put into place new toxicology datasets according to internationally agreed test protocols on critical aspects such as repeated-dose, 2-generation reproductive toxicity and the prenatal developmental endpoint. Likewise, we worked to firstly achieve peer-reviewed publication of the studies in scientific journals which is a precondition for data acceptance as serious weight-of-evidence, and secondly to proactively share the new datasets and publications with the Office of Water.

The EPA conducted a Mo-occurrence in drinking water survey at federal level to assess the level of exposure risk as well as a rigorous assessment of data that included IMOA toxicology datasets. In January 2025, an entry in the US Federal Register announced a preliminary regulatory determination that, based on its toxicology and occurrence, molybdenum should *not* be regulated as a contaminant under the US federal level SDWA.

During the March public commenting period, IMOA submitted a technical paper in support of that preliminary outcome, and key water authorities including the American Water Works Association, the Association of State Drinking Water Administrators, and the Association of Metropolitan Water Agencies are on record supporting what is termed a "negative regulatory determination" for molybdenum. The final outcome will be known in 2026.

Reproductive Toxicity Assessment

Potential reproductive toxicity from exposure to molybdenum compounds in the workplace has been the focus of considerable deep scrutiny by the Dutch Expert Committee on Occupational Safety (DECOS) during the year. After announcing in February 2024 that it would produce a report with recommendations to the Netherlands Ministry of Social Affairs and Employment, in September 2024 DECOS published its draft proposal that the soluble inorganic molybdate ion was suspected to be a reproductive toxicant to humans.

Based on the toxicology data set provided to DECOS by IMOA, and the highly questionable quality of some other published data, IMOA did not concur, and so commissioned an Expert Report prepared by an internationally highly-respected toxicologic pathologist to independently assess all the available evidence for a reprotoxicity hazard classification. That submitted documentation was the turning point for the May 2025 final published announcement on the DECOS website, stating their re-assessment is now to recommend no hazard classification of the molybdate ion for reproductive toxicity because "the available data does not justify classification".

HSE infographic

Regulatory defense challenges with positive outcomes such as the ones highlighted above are the result of IMOA constantly investing in generating sound scientific data, whilst also pooling knowledge from its members and technical support team within our HSE Committee. A new HSE infographic, summarizing what we do and why we do it, and the implications of not doing it, aims to raise awareness across the IMOA membership and prospective IMOA members. This HSE on-a-page document was very well received at the 2024 AGM, and is currently available in several languages: English, Chinese, Hindu, Japanese, Korean, Spanish and Thai.

Genotoxicity publication

A long-standing IMOA HSE policy is publication in peer-reviewed scientific journals about the test work carried out by the Association for legal compliance with chemicals management legislation. Multiple geographic jurisdictions around the globe enact this type of legislation and data is always required to secure compliance and thus access to markets. Our most recent HSE publication, published in Regulatory Toxicology and Pharmacology (December 2024), publicly shares the conclusion that molybdate is not genotoxic, providing and explaining the data underpinning why that is the valid assessment conclusion.

Metals Data Centre (MDC)

Metals trade associations are excellent sources of high-quality scientific data and rigorous data assessments about hazard, risk and exposure aspects. Several associations successfully exhibited together as the Metals Data Centre (MDC) at the Society of Environmental Toxicology & Chemistry (SETAC) North America Conference in November 2024 and subsequently at SETAC Europe, May 2025 in Vienna. The SETAC event attracts throngs of scientists, regulatory authorities and academia to learn about emerging science and novel solutions to environmental issues. This first MDC initiative was enthusiastically supported by the zinc, molybdenum, copper, nickel, lead and cobalt associations.

Life Cycle Inventory Update

During the second half of 2024, IMOA finalized its latest Life Cycle Inventory Update Study. We began this type of study, which is the data-backbone of life cycle assessment (LCA), in 1999 and since then have generated updates around every five years. For this most recent edition, we are deeply grateful to the IMOA member companies who invested in taking up the challenge of this IMOA HSE project. That enabled IMOA to source vital background data from 24 facilities in 10 countries across Asia, Europe, North and South America.

When generating the new datasets, IMOA was mindful to align with the recent project of the International Council of Minerals and Metals (ICMM) to harmonize the allocation and carbon footprint calculation methodologies for metals.

Particularly noteworthy and new to the study is the Product Carbon Footprint (PCF) section. The significant reductions in PCF, as shown in the table below, are a very positive reflection of ongoing de-carbonization initiatives by IMOA member companies. These encouraging results will be much welcomed by downstream users, such as the steel industry, for whom Roasted Molybdenum Concentrate (Tech Oxide) and Ferromolybdenum products equate to Scope 3 greenhouse gas (GHG) emissions.

A further new aspect is the inclusion of Molybdenite Concentrate production as a separate unit process. Interested parties can download the Executive Summary and the more extensive Summary Report about the IMOA 2024 LCI Update Study from the IMOA website. Embedding the LCI datasets into commercial software packages used by LCI practitioners is a further way we are disseminating the data and results, as well as articles in pertinent journals such as Stainless Steel World. We also share the high-level outcomes with peer organizations such as ResponsibleSteel.

Looking ahead

Linked to LCA projects, we are participating in a multi-metal project to enhance the quality of data in the United Nations-endorsed USEtox modeling software that calculates impacts of metals and other chemicals on human health and the environment. This is yet another application for IMOA's molybdate toxicology datasets, and a relevant one insofar as the USEtox model is starting to be cited in sustainability-related legislation, for example in the EU Eco-design for Sustainable Products Regulation.

We have made two submissions to the US American Conference of Governmental Industrial Hygienists, before and after their draft proposal to reduce the workplace threshold limit value for soluble molybdenum compounds from its current level of 0.5 mg Mo/m^3 to 0.2 mg Mo/m^3. We await the outcome.

Also planned is an IMOA HSE webpage tool to search through worldwide molybdenum water quality standards, their current reference values and assessment factors, with links to supporting documentation.

The HSE and MoCon activities featured in this Annual Review are both managed and driven forward by the corporate members of the HSE Committee and the MoCon Technical Working Group, the HSE Executive, and our invaluable team of specialist technical service providers. We are immensely grateful for their continuing dedication and professionalism.

Comparisons of the carbon footprint of 1 kg of each product

Year	Unit	Molybdenite Conc. (~50% Mo)	Tech Oxide (~60% Mo)	Briquette (~59% Mo)	FeMo (~67% Mo)
2024	kg CO2-eq	2.84	3.79	4.03	7.41
2018	kg CO2-eq	not calculated	4.96	5.04	8.04
% change from 2018		**n/a**	**24% lower**	**20% lower**	**8% lower**

EU REACH Molybdenum Consortium (MoCon)

Achieving regulatory compliance with EU REACH Regulation 1907/2006 was why the IMOA EU REACH Molybdenum Consortium (MoCon) was originally established back in 2007.

Continuing to maintain that legal compliance as the Regulation has evolved over the intervening years is why MoCon remains in existence today.

MoCon works to maintain and update the technical dossiers, known as Chemical Safety Reports (CSRs), for 12 key commercial molybdenum products. Recent challenges include:

2nd species prenatal developmental toxicity (PNDT)

An ECHA Decision in 2023, with which compliance is mandatory, requires test data on the PNDT endpoint to be generated and reported to the European Chemicals Agency (ECHA) in MoCon CSRs by early 2027. As such, progressing the necessary scientific work on a timely basis is currently a core focus of MoCon's Technical Working Group.

Endocrine Disruption (ED)

The endocrine system is a network of glands that produce, release and regulate hormones essential for bodily functions such as growth, development, metabolism, and reproduction. Serious health issues can be triggered if its normal functioning is disrupted by endocrine-disrupting chemicals that can mimic, block or alter the action of natural hormones in the body.

For this reason, in 2023 the EU regulatory authorities introduced the endocrine disruption hazard endpoint into the EU Classification, Labelling and Packaging Regulation (EU CLP). It stipulates that by 2025 available existing literature must be scrutinized against a set of scientific criteria to assess whether individual chemical substances are EDs.

Similarly in 2023, the European Chemicals Agency announced that the upcoming revision of the REACH Regulation will introduce the ED endpoint as a mandatory standard information requirement. A MoCon project

Conceptual model delineating the three main types of mechanisms of action whereby metals can interact with the endocrine system

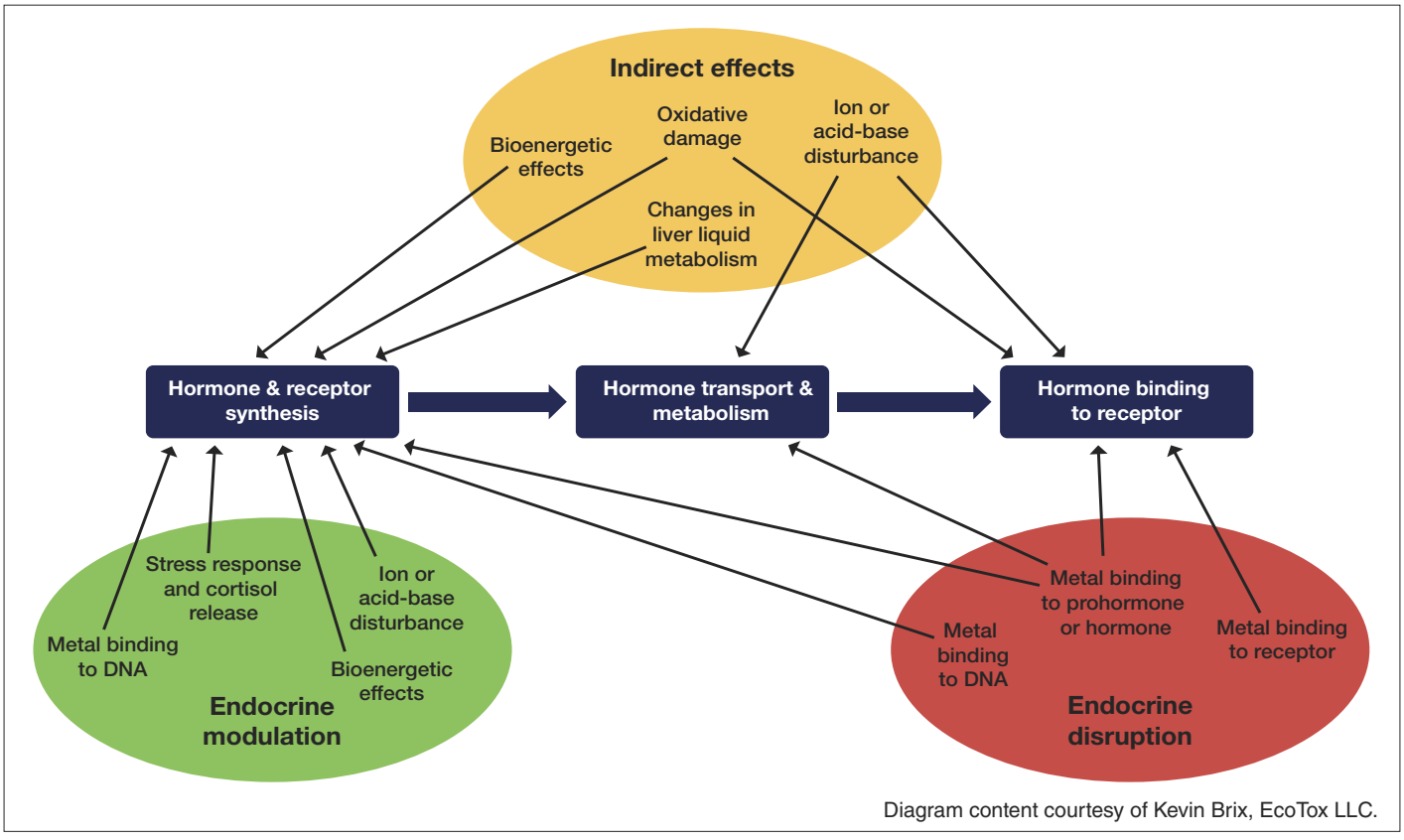
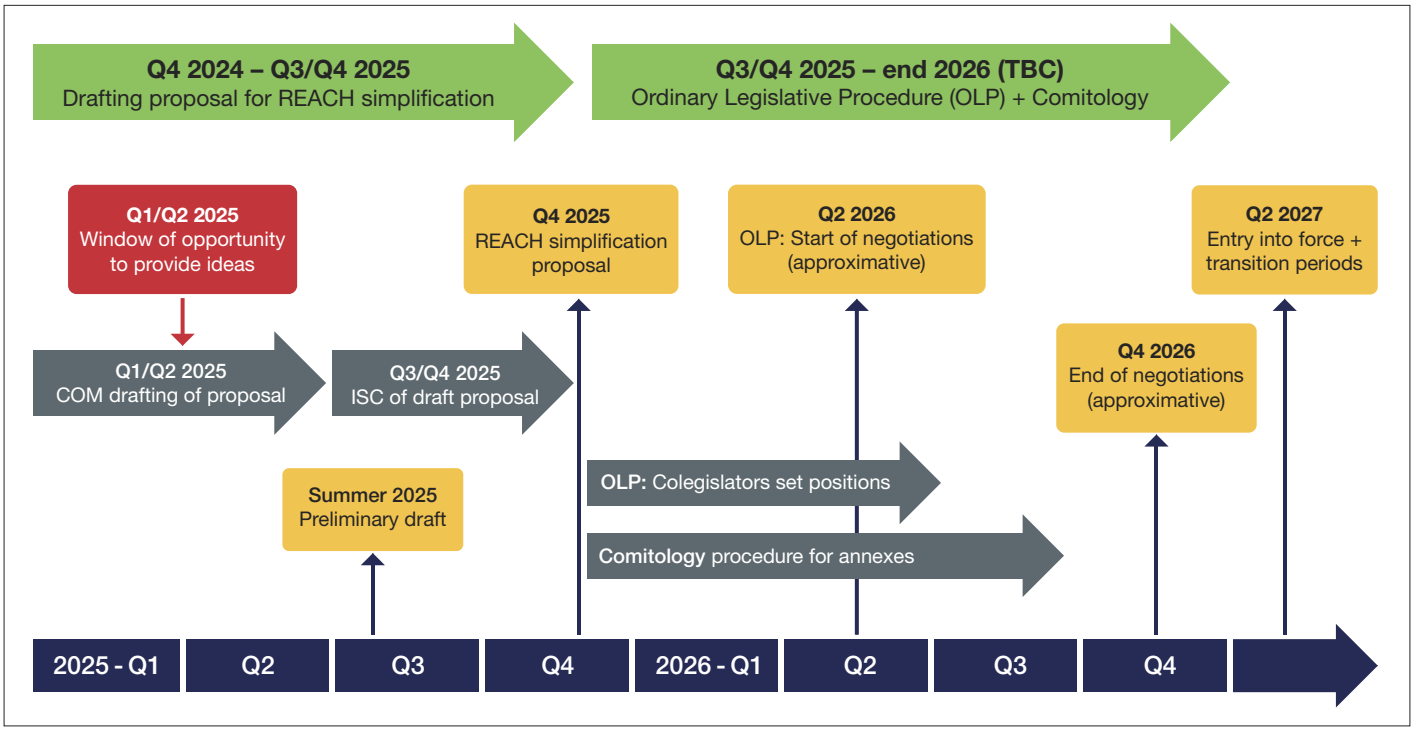


Diagram content courtesy of Kevin Brix, EcoTox LLC.

REACH “simplification” indicative timeline



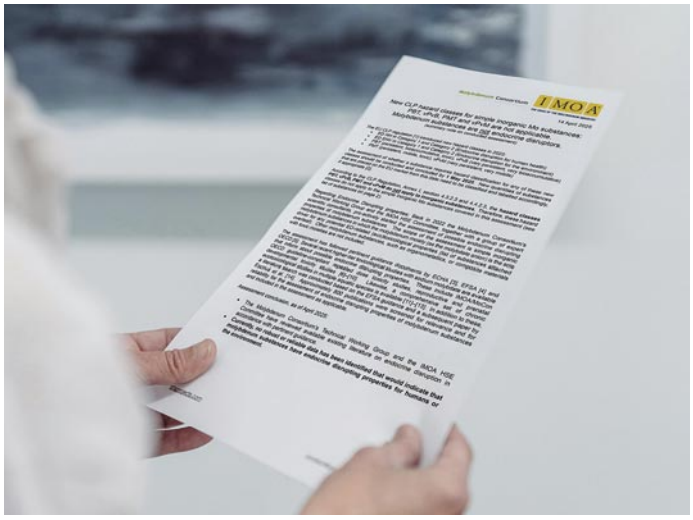
to extensively scrutinize all identified scientific literature, against a set of ECHA-prescribed criteria, has therefore been underway in MoCon TWG to fulfil both the REACH and the CLP obligations. Most of the work took place in 2024, with the assessment reaching the conclusion that: “Currently no robust or reliable data has been identified that would indicate that (MoCon) molybdenum substances have endocrine disrupting properties for humans or the environment.”

Safety Data Sheets (SDS)

Updating SDSs by May 2025 with respect to endocrine disruption is another stipulation of the EU CLP Regulation. Accordingly, in April 2025 MoCon shared its above-indicated literature assessment conclusion with all REACH registrants for MoCon substances, and likewise with the IMOA membership. As a further service to facilitate this SDS updating task, MoCon provided translations of the English language MoCon ED assessment phrase into Danish, Dutch, Finnish, French, German, Italian, Polish, Spanish and Swedish.

REACH Regulation revision

The original timeline for publishing the proposal to revise the REACH Regulation, known colloquially as REACH 2.0, was postponed by the EU Commission from 2023 until



the latter part of 2025, with entry into force envisaged for 2027. The ongoing revision work is being framed as a REACH Simplification Proposal; the EU Commission-stated goal is to simplify the rules for the chemicals industry without compromising on safety and environmental protection. By 2026, it will be clear whether that is the outcome. Meanwhile, MoCon continues with its current legal compliance-maintaining scientific activities for the benefit of its 60 MoCon members and 240 Letter of Access holders.