Committee on Chemical Safety

Proposed **White Paper**

Chemical Safety Information

This white paper is written for background and discussion by the chemical safety community. It describes the value of chemical safety information and the challenges of obtaining and using this information. ACS’ policy statement on Safety in the Chemical Enterprise advocates a core objective of, “ongoing collection and dissemination of safety information is standardized, harmonized, accessible, and understandable to all users.” This paper elaborates the policy statement by summarizing resources and considerations for researchers, manufacturers, policymakers, information curators, and chemical users to achieve this core objective.

Importantly, development of this white paper coincides with the publication of chapter 1.3 “Communicating Safety Information” in the 2020 edition of the *ACS Guide to Scholarly Communication.* That document encourages and guides scientists on communicating safety information as an integral part of their scientific communications—a message that this paper reinforces. The paper concludes with a proposed action plan.

# Sources, Uses and Value of Chemical Safety Information

Chemical safety information includes physical data that are useful for ensuring the safe manufacture, distribution, use and disposal of chemicals, materials and commercial products. This information informs chemists, policymakers, industry, consumers and the general public on the relative risks of chemicals in laboratories, commerce and the environment. Risk assessment and management requires quality chemical safety information.

In addition to physical data, chemical safety information includes the findings of engineering, toxicological, epidemiological and environmental testing, analysis and research. Experience in using chemicals often augments research findings by revealing relevant properties such as incompatibilities, behavior under specific physical conditions, reaction scale-up hazards, sensitivity of subpopulations, other low incidence toxicity, and environmental fate. Some of this information is probabilistic, which can make it difficult to understand. Examples include degradation, dose-response, environmental dispersion, and risk estimates. As explained below, to facilitate the understanding and use of this information, standard-setting organizations (e.g., International Agency for Research on Cancer, U.S. Environmental Protection Agency, etc.) often interpret physical data and research findings. Their characterizations and classifications are important chemical safety information as well.

Chemical safety information has grown exponentially due to chemical discoveries, expanding research on chemicals and materials, and the capabilities of information science. We’ve also grown our understanding of chemicals in biological and environmental systems through basic research in engineering, medicine, toxicology, epidemiology, and environmental science. In response to public and commercial interests, regulators and other standard-setting organizations also create a demand for chemical safety information.

Chemical safety information often includes information on hazard control and risk management, such as appropriate PPE, ventilation and other engineering controls, and spill/release response procedures. Regulatory information is often included.

# Role of Standard-Setting Organizations

Safety standards are created by voluntary and governmental organizations. These organizations provide guidance, standards and regulations to various audiences involved in research, industry, transportation, construction, public health, fire safety, commerce, hazardous waste management, emergency response, etc.

It is common for standard-setting organizations to define hazardous properties according to physical and other properties. They then group chemicals and chemical processes by risk, classification or category according to those properties. Control banding by risk group simplifies the application of safeguards. For example, organic solvents with flash points within a certain range may require a container having designated safety features.

Many regulators and standard-setting organizations are authoritative sources of safety information for the specific chemicals and materials within their purview. This information is published in regulations and databases.

To standardize and harmonize the classification and labeling of chemicals, the United Nations established the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). GHS provides nine categories that all chemicals fall into based on the type of hazards they characterize. The GHS was designed to contain the hazard endpoints and communication tools necessary for application to known regulatory schemes.

The International Codes Council (ICC) is another standard-setting body that defines certain chemical hazards. Under the ICC’s system, chemical hazard information is used when conducting a code review in order to establish limits on quantities of hazardous materials and storage requirements inside of buildings. Safety Data Sheets (SDSs) are often utilized as source information in order to know which chemicals fall into the specific categories and which do not.

# Challenges for Users of Chemical Safety Information

Users of chemical safety information face many challenges. While the number of sources is staggering, specific information is often hard to find. While not always expressed or apparent, each source has its own attributes, limitations, and most appropriate use.

Understanding and interpreting technical information requires knowledge of chemistry and science. However, many important safety terms are not taught in academic curricula, such as “flash point” or the use of “oxidizer” as a substance that causes or enhances the combustion of other materials.

While physical properties of a chemical are immutable, descriptors of a chemical’s behavior in biological and environmental systems can be subjective, as can the classification of a chemical’s hazard properties. This causes confusion. For example, the terms “flammable” and “ignitable” are synonymous in many contexts, but have different regulatory meanings. As a result, understanding chemical safety information also requires an understanding of specialized terminology, its context, its intended use, and the meaning of regulatory categories and classifications.

# Safety Data Sheets

Occupational health regulations require that manufactures and suppliers provide Safety Data Sheets (SDS), which are a primary source of chemical safety information for many end users and emergency responders. The quality of SDSs vary widely even though the law requires that “Competent Authorities” of the U.S. federal government ensure that manufacturers do their due diligence in completing the sections of SDS. Missing or incomplete information is common, even when it is otherwise readily available.

# Principles for Chemical Safety Information

The ACS’ “Safety in the Chemical Enterprise” policy statement describes the “application of the RAMP (Recognizing hazards, Assessing risks, Minimizing risks and Preparing for emergencies) model as an organizing principle for risk assessment and management.” To apply this model and address the needs of users, basic principles for chemical safety include:

* Chemical safety information should identify hazards accurately and with high scientific quality. Uncertainties should be explicit. Whenever possible, chemical safety information must be based on the best available peer reviewed scientific research.
* To facilitate understanding and appropriate use, chemical safety information should be readily interoperable between sources.
* Chemical safety information needs to be sufficiently complete to assess risks.
* The information must be useful for minimizing risks.
* Chemical safety information needs to be readily available to any individual who uses, may be exposed to, or may be harmed by the chemical.
* Chemical safety information should be helpful in preventing and responding to emergencies.

# Support for Science Research

ACS supports research and research funding for chemistry, chemical engineering and the chemical sciences, which generates chemical safety information. To further chemical safety knowledge, ACS supports research in toxicology, occupational health and environmental science. This basic research is critically needed to identify hazardous properties and conditions, and quantify the risks of chemicals used in laboratories, industry and commerce.

# Other Considerations

To address these challenges, below are some considerations for policymakers, regulators, standard-setting bodies, information providers, curators and users. Overall, it is highly desirable for the understanding and use of chemical information that hazard category boundaries be harmonized as much as possible (e.g., the definitions for flammability and toxicity by the ICC/National Fire Protection Association versus the U.S. Department of Transportation).

## Considerations for Policymakers, Regulators and Standard-Setters

Recommendations for regulators and other standard-setting organizations are addressed in ACS’ policy statement on Safety in the Chemical Enterprise, which recommends that, “agency-issued chemical safety information be:

* “Globally standardized across regulating agencies.
* “Comprehensive, clear, and concise.
* “Anchored in peer-reviewed scientific literature with transparent provenance.
* “Accessible.
* “Inclusive of best practices for purchase, storage, handling, use, and disposal of materials.”

Policy makers and regulatory agencies need to balance intellectual property rights and users who need complete chemical safety information. When promulgating regulations that impacts the use and dissemination of chemical safety information, agencies should strive to overcome barriers of proprietary and confidential business information.

## Considerations for Chemical Safety Information Providers

As noted above, chemical safety information is provided by a vast number of sources, including researchers, editors, SDS authors, publishers and standard-setting bodies. Chemical information providers should consider:

* Incorporating peer review and other quality assurance measures to ensure accuracy and completeness.
* Including the chemical’s environment impact.
* Including safety concerns in their indexing terms.
* Using common searchable terms that can be tagged.
* Performing due diligence in maintaining the accuracy of their indexing terms.
* Understanding multiple taxonomies that are mapped to each in an effort to decrease differences between them.
* Providing open access.

An important common goal is to ensure that SDS information is complete (as defined by the Globally Harmonized System) for all chemicals in commercial use.

For scientists, chapter 1.3 of the *ACS Guide to Scholarly Communication* notes that safety summaries in research articles and other scientific communications are an excellent opportunity to report observations of significant health and safety concerns that arise during the course of experimentation to help others prepare for unusual or special risks. The *Guide* details what safety information should be provided, how to present it in universally-understood terms, and example safety statements. Sharing this laboratory information is critical, as research scientists are often the first to observe a hazard or a hazardous condition, and their experimental reports are used by other scientists, pilot plant operators, and process safety engineers.

Similarly, editors should require authors to provide safety information. In recent years, scientific journals and publications have increasingly asked authors to include safety information in their submitted papers.

## Considerations for the Curation of Chemical Safety Information

Librarians, information scientists, regulatory agencies and safety organizations curate chemical safety information when they explain, categorize, excerpt, index, review and disseminate chemical safety information. Two excellent examples of curated safety information are:

* Laboratory Chemical Safety Summaries (LCSSs) are available via the National Library of Medicine’s PubChem. LCSSs provide chemical health and safety data, most pertinent for laboratory users of the given PubChem Compound record.
* The U.S. Department of Transportation publishes the *The Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Transportation Incident.* The ERG is used by emergency response personnel (such as firefighters, paramedics and police officers) in many nations when responding to a transportation emergency involving hazardous materials.

These two publications are created by obtaining chemical safety information from disparate sources and presenting it in a standard format to effectively communicate selected information to their intended audiences.

Curation of chemical safety information needs to mature and become standardized in itself. A system to manage information quality is necessary because errors and omissions are inevitably made by authors, editors, publishers, and database producers.

## Considerations for Chemical Safety Users

Some considerations for chemical safety users include:

* Due to the many information sources and the complexity of terminology, science, categorization and regulation, chemical users need to learn how to obtain, interpret and use chemical safety information.
* Scientific advancements may make information out of date so it is incumbent upon users to search the scientific literature and safety information.
* The review of chemical safety information must be integrated into the educational process so that scientists can understand informational capabilities and limitations when conducting risk assessments.

# Proposed Action Plan

This paper suggests several actions that may ameliorate the current challenges:

* Expand training and education for users of chemical safety information, so they understand sources and their best uses, terminology and safety concepts.
* Train scientists to obtain and use chemical safety information specifically for using the RAMP model for risk assessment and management.
* Train scientists to report, as part of their scientific communications, observations of significant health and safety concerns that arise during the course of their research.
* Advertise and communicate tools that help users understand, integrate and conceptualize chemical safety information from disparate sources.
* Facilitate communication and initiatives among librarians, information scientists, regulatory agencies and safety organization to address the challenges of curating chemical information, and to explore the use of artificial intelligence and other technologies.
* When opportunities arise, encourage standard-setting organizations to a) harmonize hazard category boundaries as much as possible, b) improve SDS quality and completeness, and c) minimize propriety or confidential business information, including among indexing terms. (The current policy statement on Safety in the Chemical Enterprise would support ACS comments in pursuit of these goals.)
* Identify and prioritize gaps in chemical safety information, and encourage research in these areas.

# Resources for Understanding Chemical Information

The following resources are useful when trying to interpret and compare chemical information provided by different sources:

[Hazard and Risk Evaluation Matrix](https://ehs.stonybrook.edu/Chemical%20Hazard%20and%20Risk%20Evaluation%20Matrix.pdf), Stony Brook University Environmental Health and Safety.

“Common Hazards and Descriptions American,” Table D-1, Appendix D, Chemical Society, [Identifying and Evaluating Hazards in the Research Lab](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjDxbTrl7ftAhWPElkFHQhdAbwQFjAJegQIBRAC&url=https%3A%2F%2Fwww.acs.org%2Fcontent%2Fdam%2Facsorg%2Fabout%2Fgovernance%2Fcommittees%2Fchemicalsafety%2Fpublications%2Fidentifying-and-evaluating-hazards-in-research-laboratories-page.pdf&usg=AOvVaw3fbtQcj1OBBwNuHOEnAYaK), 2015, pp. 101-5.

Table 3–1: Examples of Hazards Commonly Identified for Research Activities

Laboratory Chemical Safety Summaries (LCSSs).

Wikipedia’s Infobox provides basic chemical information for many substances, much of which is relevant for chemical safety.

[Consolidated List of Lists](https://www.epa.gov/sites/production/files/2015-03/documents/list_of_lists.pdf), U.S. Environmental Protection Agency. This is the consolidated list of chemicals subject to reporting requirements under the Emergency Planning and Community Right-to-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act.

An excellent compendium of safety information resources is provided in Table 1.3.3 of the *ACS Guide to Scholarly Communication.* These resources are sources of chemical safety information in themselves, but many also explain how to interpret chemical safety information.

# References

[Safety in the Chemical Enterprise](https://www.acs.org/content/acs/en/policy/publicpolicies/science-policy/safety-in-the-chemistry-enterprise.html), ACS Policy Statement, 2019-2022.

[Hazard Reviews/Risk Assessment](https://ehs.stonybrook.edu/hazard-reviewsrisk-assessment.php), Stony Brook University Environmental Health and Safety

[Globally Harmonized System of Classification and Labeling of Chemicals](https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf) (GHS).

International Code Council

Samuella Sigman and Leah McEwen, Chapter 1.3 “Communicating Safety Information,” in [ACS Guide to Scholarly Communication](https://pubs.acs.org/doi/book/10.1021/acsguide), Banik, Baysinger, Kamat, and Pienta, 2020

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