19 Government Regulations Affecting Metalworking Fluids

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19.1 INTRODUCTION: REGULATING METALWORKING FLUIDS

The U.S. chemical industry is one of the most highly regulated of all national business categories, primarily through the auspices of the Environmental Protection Agency (EPA) Toxic Substances Control Act (TSCA). Chemical regulations on the federal, state, and local levels are usually very specific for well-characterized and rigorously defined chemical compounds and raw materials that can be analyzed by validated standard methods and established laboratory protocols. The Chemical Abstract Service (CAS)—a division of the American Chemical Society—maintains a registry of nearly 130 million records for unique organic and inorganic chemicals, and each registered chemical is assigned a unique identification number. However, there is no assigned CAS number for metalworking fluids (MWFs), with the exception of some purified mineral oils.

MWF products are complex chemical mixtures with proprietary formulations produced by many companies, and no given fluid is truly representative of the thousands of unique products in commercial channels. The regulation of MWFs can be especially challenging because, during normal usage, they undergo physical, chemical, and microbiological changes. Therefore, it is not always clear whether regulations address the intrinsic chemical properties of constituents in unused (neat) fluids, the extrinsic chemical properties of additives used to prolong the life and optimization of fluid performance, or the chemicals that result from the process of fluid degradation. On the other hand, regulations dealing with the handling, storage, and ultimate disposal of MWF wastes are well established.

Chemical raw materials and products manufactured and utilized in U.S. industries are subject to federal, state, and local regulatory oversight. In general, chemical regulations are based on (1) human health and safety concerns and (2) impacts that chemicals may have on the environment.

- *Human health and safety concerns*: Workers in chemical or related industries and the general public
- *Environmental impacts*: Pollution control (impacts on surface and ground waters, air emissions, waste effluents, solid wastes) and conservation management (including the protection of endangered animal species)

This chapter presents a general overview of selected regulations that are applicable to MWF products and chemicals and is not intended to present a comprehensive and all-inclusive discussion of existing or emerging regulations. Readers with questions or concerns about regulatory details, legal opinions, litigation matters, or similar issues should seek the advice of legal counsel.

19.2 GENERAL DUTY CLAUSE

The foundation for OSHA regulations is broadly stated in Section 5(a)(1) of the Occupational Safety and Health Act, commonly referred to as the General Duty Clause (GDC):

1. Each employer:
   a. Shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;
   b. Shall comply with occupational safety and health standard promulgated under this Act.
2. Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

The enforcement powers of OSHA under GDC are profound and sweeping, due to the fact that GDC grants authority to OSHA inspectors to levy citations in situations where there are no specific or applicable occupational health and safety standards. Violations of GDC occur when a *recognized hazard* is not abated. In situations where applicable standards exist but are inadequate to protect workers, enforcement is sanctioned under GDC.

The OSHA administrator (the Assistant Secretary of Labor for Occupational Safety and Health) can use GDC, federal regulations, and various health and safety standards such as the OSHA permissible exposure limits (PELs) for substances as criteria to determine the necessity for and extent of enforcement action.

19.3 SOME AREAS AFFECTED BY INDUSTRIAL CHEMICAL REGULATIONS

- Air emissions
- Application of biocides
- Chemical storage
- Effluent discharges
- Employee health and safety
- Environmental impacts
- Hazard communication and training
- Industrial zone permitting
- Manufacturing
- Materials transportation
- On-site storage of chemicals
- Product labeling
- Prevention of fires and explosions
- Product packaging requirements
- Publicly owned treatment works (POTW)
- Right-to-know (RTK) requirements
- Spill control, clean-up measures
- Truck placarding
- Usage applications
- Waste disposal and recycling
- Recycling and disposal of chemicals
- Waste disposal procedures
- Waste hauler licensing
- Waste site selection and management
- Waste transport

19.4 OVERVIEW OF REGULATIONS AFFECTING MWFS

Industries and businesses that manufacture, distribute, transport, utilize, or dispose of MWFs may be impacted by various federal regulations, as shown in the following examples:

1. EPA Toxic Substances Control Act (EPA/TSCA)
2. OSHA Hazard Communication Standard (OSHA/HCS)
3. EPA Federal Insecticide, Fungicide, and Rodenticide Act (EPA/FIFRA)
4. EPA Emergency Planning and Community Right-to-Know Act (EPA/EPCRA)
5. EPA Resource Conservation and Recovery Act (EPA/RCRA)
6. EPA Toxic Release Inventory (EPA/TRI)
7. EPA Spill Prevention, Control, and Countermeasures (EPA/SPCC)
8. EPA High Production Volume (HPV) Program (EPA/HPV)
9. DOT Transportation/Hazardous Materials Transportation Act (HMTA)

We will discuss each of these in more detail in the following sections:

19.4.1 EPA/TSCA

https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act

The EPA monitors over 80,000 industrial chemicals (domestically produced or imported) by authority of the TSCA. These chemicals are a mix of *grandfathered* and *new*. TSCA gives EPA

authorization to (1) review new chemicals prior to their manufacture, (2) gather data on existing chemicals in commercial channels, and (3) regulate chemicals. These chemicals are subject to mandatory testing and reporting requirements, especially when reliable scientific data indicate that they are hazardous to the environment or to the health of humans. If a chemical is deemed to be hazardous, its manufacturer can be required to submit information and/or test results. TSCA also monitors the properties of new chemicals that enter the industrial stream. A new chemical that is not on the TSCA list is subject to premanufacture notification (PMN), and the manufacturer must notify EPA 90 days prior to the manufacture of the chemical.

Under TSCA, a *chemical substance* is defined as "any organic or inorganic substance of a particular molecular identity … occurring in whole or part as a result of a chemical reaction or occurring in nature and … any element or uncombined radical." Examples of exceptions not covered by TSCA are mixtures, FIFRA pesticides, tobacco and its products, nuclear compounds, and foods and drugs.

The facility-reporting aspects of TSCA are as follows:

- Reporting threshold of 25,000 lb.
- Data reported on inorganic chemicals
- Information about the use(s) of chemicals
- Concentrations of chemicals leaving a facility
- Physical form(s) of the chemical leaving a facility
- Production volumes of chemicals

In 2016, a major revision of TSCA (the Frank R. Lautenberg Chemical Safety for the 21st Century Act) received unanimous support in Congress, after having been basically unchanged for 40 years. The 2016 TSCA revision affects all industries that manufacture and utilize chemicals, and major changes are characterized by EPA as follows:

- Mandatory requirement for EPA to evaluate existing chemicals with clear and enforceable deadlines
- New risk-based safety standards
- Increased public transparency for chemical information
- Consistent source of funding for EPA to carry out the responsibilities under the new law

19.4.2 OSHA/HCS

https://www.epa.gov/epcra/fact-sheet-revisions-occupational-safety-and-health-administration-hazard-communication

OSHA administers regulations that protect workers from hazardous chemicals in the workplace, and the regulatory authority for the federal oversight of occupational safety and health activities in the United States lies with OSHA's Hazard Communication Standard (HCS) (29 CFR 1910.1200). The revised 2012 HCS was updated from OSHA's previous 1994 HCS, in order to align with the United Nation's Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The GHS initiative had its inception in 1992 (UN Rio de Janeiro meeting), with the purpose of harmonizing disparate chemical classification and labeling systems that existed in various countries with the utilization of consistent criteria, in order to facilitate global trade, communicate information about hazardous chemicals, and promote regulatory efficiency. Both the European Union (EU) Classification, Labelling, and Packaging (CLP) regulation and the U.S. OSHA HCS are in accordance with GHS and written into respective health and safety laws. The global implementation of GHS remains incomplete at this time, although its gradual adoption across manufacturing countries is expected.

The U.S.-aligned OSHA HCS gave workers not only the right to know about workplace hazards but also the right to understand them. According to OSHA, the 2012 HazCom standard provides the following major changes:

- *Hazard classification*: Provides specific criteria for the classification of health and physical hazards, as well as the classification of mixtures.
- *Labels*: Chemical manufacturers and importers will be required to provide a label that includes a harmonized signal word, pictogram, and hazard statement for each hazard class and category. Figure 19.1 in Appendix A shows the nine new pictograms used to indicate product hazards.[1]
- *Safety data sheets* (SDSs) (formerly *material safety data sheets*) will now have a specified 16-section format (see Appendix A).
- *Information and training*: Employers were required to train workers by December 1, 2013 on the 2012 HazCom label elements and the revised SDS format to facilitate recognition and understanding of documents.

19.4.3 EPA/FIFRA

https://www.epa.gov/laws-regulations/summary-federal-insecticide-fungicide-and-rodenticide-act

EPA/FIFRA regulates commercial pesticides, including their registration and label language. According to EPA,

> An antimicrobial pesticide is intended to disinfect, sanitize, reduce, or mitigate growth or development of microbiological organisms or protect inanimate objects, industrial processes or systems, surfaces, water, or other chemical substances from contamination, fouling, or deterioration caused by bacteria, viruses, fungi, protozoa, algae, or slime.

During the mass production of metal parts, the microbial spoilage of water-mixed MWF is a major concern, since worker health and the quality assurance of machined materials are at risk.

Biocides cannot be manufactured or distributed unless the manufacturer has registered the product and label with the EPA. The application process for the registration of a new pesticide is rigorous, lengthy, and expensive, and is analogous to the FDA approval process for prescription pharmaceuticals.

- Comprehensive and costly application process
- Submission of the proposed label
- Statement of claims about the product
- Submission of test data

FIFRA registration requirements involve extensive toxicological testing of a pesticide for a single use. A cost–benefit analysis of data is performed amid considerations of environmental, societal, and economic variables and the efficacy of the product. Pending the acquisition of new data that warrant a reexamination of a pesticide, the EPA may review a product's registration prior to its expiration date. Pesticides are used in water-soluble MWF products to control the growth of bacteria and fungi in recirculating fluids. Only biocides that are EPA registered and approved for use in MWFs can be used in fluid distribution systems (central systems and sumps). As an example, antimicrobial pesticides approved for paints or wood preservation cannot be used in MWFs unless the manufacturer decides to register it with the EPA for MWF use.

Due to the expense and time involved in applying for biocide registrations and receiving approvals, new antimicrobial products suitable for MWF applications have been slow to appear in commercial markets.

19.4.4 EPA/EPCRA

https://www.epa.gov/epcra

Chemical manufacturers/end-users file annual EPCRA reports with local firefighting headquarters and emergency response offices. Responsibility for monitoring the effluents from various industrial sites is usually placed on local sewer districts. Companies must report the contents, condition, and amounts of their waste discharges and any unusual conditions that might affect waste treatment plants downstream. Companies within a given locality may be required to secure permits that stipulate limits on air emissions, wastewater effluents, and the generation of solid wastes.

Regional occupational safety and health functions are managed by local health departments and/or state OSHA offices. Local Emergency Planning Committees (LEPCs) are appointed by State Emergency Response Commissions (SERCs). LEPCs are responsible for contingency planning for responses to emergency situations involving hazardous materials. MWF manufacturers, and other businesses that use chemicals, must file annual reports according to LEPC requirements.

19.4.5 EPA/RCRA

https://www.epa.gov/rcra

EPA/RCRA regulates hazardous wastes from "cradle to grave."

- Waste generation
- Waste transportation
- Waste treatment
- Waste storage
- Waste disposal

The functions of RCRA deal with facilities that are operationally active. Remedial activities regarding abandoned waste sites are under the management of the EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).

19.4.6 EPA/TRI

https://www.epa.gov/toxics-release-inventory-tri-program

EPA/TRI came into existence in 1987, after the catastrophic incident in Bhopal, India, in 1984, when thousands of people were killed by the release of methyl isocyanate from a manufacturing facility into the air of a contiguous community. Subsequently, U.S. citizens began to demand information about chemicals in their own communities. Under TRI, the following information is collected.

- Identification of chemicals in inventories of companies in localities
- Locations and quantities of chemicals at industrial facilities
- Air emissions and effluents from industrial facilities
- Quantity of chemicals taken away from industrial sites for disposal and recycling
- On-site waste treatment

Perennially, TRI reports are submitted (usually by electronic filing) on or before July 1 of the calendar year on Form R or Form A (a shortened version for companies exempt from Form R).

19.4.7 EPA/SPCC

https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations

According to EPA, SPCC is intended to "prevent, prepare for, and respond to oil spills that occur in and around inland waters of the United States." (Authority for coastal waters and deepwater ports

is given to the U.S. Coast Guard.) SPCC plans are site specific to prevent the accidental discharge of oil into navigable waters or adjoining shorelines and are classified in three tiers:

Tier I (Small facilities): Containing 10,000 gal. or less aggregate above-ground petroleum storage capacity (add all containers holding at least 55 gal.)
Tier II (Mid-sized facilities): Storing 10,000 gal. above-ground petroleum capacity; no individual container greater than 5,000 gal.
Tier III (Large facilities): Storing more than 10,000 gal. aggregate above-ground petroleum storage capacity (TRI plan must be prepared by a licensed professional engineer)

19.4.8 EPA/HPV

https://www.epa.gov/chemical-research/prioritization-high-production-volume-chemicals-under-chemical-assessment-and

The EPA HPV Chemical Testing Program has the authority to collect information on potential health and environmental impacts of chemicals produced in large volumes in the United States. Various data sets of selected chemicals consist of physicochemical properties, toxicity, environmental fate, environmental releases, production volumes, and usage application. Subsequently, the EPA may use this information to limit or prohibit the production of certain chemicals deemed to be inimical to the environment and/or human health. Toxicological testing involves the following criteria:

- Acute toxicity
- Chronic toxicity
- Developmental/reproductive toxicity
- Mutagenicity
- Ecotoxicity
- Environmental fate

Chemicals used in various MWF formulations, including additives, may be subject to HPV testing and reporting requirements.

19.4.9 DOT/Transportation

The DOT HMTA regulates numerous functions involving the transit of hazardous materials by air, ground, and rail.

- Labeling
- Packaging
- Placarding
- Manifesting
- Spill reporting

Under HMTA, workers involved in the handling, transporting, shipping, and storing of hazardous waste must undergo *hazmat* training. The packaging of hazardous materials involves performance-oriented packaging standards: shipping name, material identification number, hazard class, package requirements, and vehicle placard.

HMTA CLASSES OF HAZARDOUS MATERIALS

Class 1: Explosives
Class 2: Gases

Class 3: Flammable liquids
Class 4: Flammable solids, spontaneously combustible materials, materials that are dangerous when wet
Class 5: Oxidizers and organic peroxides
Class 6: Poisons and infectious materials
Class 7: Radioactive materials
Class 8: Corrosives
Class 9: Miscellaneous hazardous materials (not included in other categories)

19.5 STATE AND LOCAL REGULATIONS

19.5.1 State

Individual state regulations for chemicals closely resemble their federal counterparts. A state law may be more stringent but not less than a corresponding federal law. Some states are delegated authority by federal agencies to run programs dealing with air emissions (Clean Air Act), water pollution (Clean Water Act), and hazardous wastes (RCRA). All states have environmental protection agencies with functions similar to EPA that deal with a variety of environmental issues. Contiguous states that share waterways (e.g., rivers and lakes) and are affected by common air pollution problems may enjoin in interstate cooperative agreements to protect their respective environments. States also have occupational safety and health agencies similar to OSHA that protect workers.

Each state maintains a State Emergency Response Commission (SERC) subject to EPA/EPCRA requirements. SERCs facilitate the gathering of information about facilities that store, produce, use, and release hazardous chemicals as a means to aid emergency responders. Companies that manufacture MWFs are required to file annual EPCRA and SERC reports. States also engage in activities related to Superfund (CERCLA) and cooperate with federal agencies during site remediation operations.

19.5.2 Local

Regional municipalities (e.g., cities and counties) are granted authority from state legislatures and agencies to manage regional air emissions, water quality, wastewater management, sewer systems, publicly owned treatment works (POTWs), and land use zoning issues. Industries that operate within a municipality must adhere to local and regional laws/ordinances, industry reporting requirements, and inspections of industrial facilities.

MWF manufacturers file annual EPCRA reports with local firefighting headquarters and emergency response offices. Responsibility for monitoring effluents (qualitative and quantitative) from various industrial sites is usually placed on local sewer districts. Companies must report the contents, condition, and amounts of their waste discharges and any unusual conditions that might affect waste treatment plants downstream. Companies within a given locality may be required to secure permits that stipulate limits on air emissions, wastewater effluents, and the generation of solid wastes.

Regional occupational safety and health functions are managed by local health departments and/or state OSHA offices. LEPCs are appointed by SERCs. LEPCs are responsible for contingency planning for responses to emergency situations involving hazardous materials. MWF manufacturers and other industries that utilize chemicals must file annual reports according to LEPC requirements.

19.6 MWF STANDARDS (REGULATORY, NONREGULATORY)

A federal regulatory standard carries the full force of law—for example, sanctions, fines, operational restrictions, and so on. There are MWF nonregulatory (consensus) standards that are promulgated by private organizations that have no legislative mandate or enforcement authority. Many of these standards are very useful to industrial professionals, because they have been vetted by scientists, engineers, industrial hygienists, epidemiologists, chemists, and so on, and provide useful information in decision-making activities. These standards guidelines are commonly written in the following forms:

- PELs (OSHA)
- Occupational exposure limits (OELs)
- Full and provisional (temporary status) standard methods
  - Sampling
  - Analytical
  - Advisory
  - Policy
  - Management systems

Proposed standards are extensively discussed, researched, drafted, and undergo numerous iterations before they are eventually voted on by committee members and then may be approved for provisional or full standard status. Some examples of standards organizations that are important for MWF industries are as follows:

- American Society for Testing and Materials (ASTM International)
- American National Standards Institute (ANSI)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- International Organization for Standardization (ISO)

19.6.1 Some Current MWF OELs

- OSHA PEL for oil mist, mineral (regulatory) = 5 mg/m^3, time-weighted average (TWA) (CAS No. 8012-95-1)
- National Institute for Occupational Safety and Health (NIOSH) REL for oil mist, mineral (nonregulatory) = 5 mg/m^3, TWA (CAS No. 8012-95-1)
- ACGIH Threshold Limit Value (TLV®) for mineral oil (excluding MWF) (nonregulatory) = 0.2 mg/m^3, TWA
- MWF volatile organic compounds (VOCs) rule:
  - MWF VOC rulemaking is currently limited to the California South Coast Air Quality Management District (AQMD).
    - AQMD Rule 1144 (“Metalworking Fluids and Direct-Contact Lubricants”)
      - Purpose: “To reduce volatile organic compound (VOC) emissions from the use of metalworking fluids and direct-contact lubricants at industrial facilities.”
      - The VOC limits in this rule as follows are for as-used dilutions.
        - Metalforming, 75 g/L
        - Metal removal (general), 75 g/L
        - Metal treating, 75 g/L
        - Metal protecting (general), 50 g/L
        - Direct-contact lubricant, 50 g/L
      - California’s VOC rule resulted from cooperative analytical methods development and extensive round-robin tests by state government and MWF manufacturers.

19.7 CONCLUSION

The regulatory aspects of MWFs are numerous, due primarily to the chemical complexity of MWF products and governmental efforts to (1) protect human health and safety, and (2) reduce environmental impacts. Unlike many commodity chemicals, modern industrial lubricant products are subject to efficacy reviews and contingent R&D activities that facilitate the rapidly changing demands of machining industry technologies, new materials, and product safety issues. Machining operations are faced daily with considerations involving factors such as tribological effects, machine tool life, machine speeds, parts quality, and the effective management of fluid distribution systems. Although the latter factors are not within the realm of regulatory oversight, they may nevertheless have a profound influence on mist production, additive usage, microbial contamination, and the waste treatment/ultimate disposal of MWFs.

Historically, regulations closely track technological advances. Formulations of many industrial lubricant products have been modified over the years in response to compelling scientific data about certain MWF constituents, which resulted in either voluntary responses from manufacturers or the emergence of regulatory activity. Federal and consensus standards organizations have recommended protective limits of MWF mists based on epidemiologic data and animal studies. However, there still remains a deficit of understanding about the health effects of mixed exposures in machining environments that may influence regulations in the future. In this regard, degree programs and courses are now being offered in some university engineering departments to formally train students about tribology and MWF lubrication science technology.

REFERENCES

1. Van Rensselar, J., Industry report: The ongoing challenges of GHS compliance, *Trib. Lubr. Tech.*, 72(5), 2016.

APPENDIX A: ELEMENTS OF OSHA/HCS SDS

FIGURE 19.1 Pictograms of new GHS warning labels. Used with permission from STLE.

SDS SECTIONS:

1. Identification of the material and its supplier
2. Hazard(s) identification
3. Composition/information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure control/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

APPENDIX B: SELECTED MWF STANDARDS

OSHA, PEL for mineral oil: 5.0 mg/m^3 (regulatory standard).

ACGIH, TLVs for chemical substances and Biological Exposure Indices. TLV for "Mineral Oil Used in Metalworking" is 0.2 mg/m^3, TWA. For "pure" mineral oil, TLV is 5 mg/m^3 TLV-TWA (consensus standard, nonregulatory).

DHHS/CDC/NIOSH REL for oil mist (mineral, CAS No. 8012-95-1): 5 mg/m^3, TWA, 10 mg/m^3 STEL.

California South Coast AQMD proposed Rule 1144 for the reduction of emissions of MWF VOCs, 75 g/L (general level) for the as-used dilution.

APPENDIX C: 29 CFR RELEVANCE FOR MWF INDUSTRIES

- MWF raw materials suppliers, manufacturers, and end users are subject to all applicable OSHA/HCS requirements.
- Currently, OSHA has no nominal PEL for water-solute MWFs. However, mineral oil—a constituent of many MWF formulations—has a PEL of 5.0 mg/m^3:29 CFR 1910.1000 (Table Z-1, Limits for Air Contaminants).
  - Oil mist, mineral, 5 mg/m^3
  - Particulates not otherwise classified (PNOC), 15 mg/m3 (total) (PNOC refers to particulates with no known toxic effects but which may be toxic at certain airborne concentrations.)
  - PNOC, 5 mg/m^3 (respirable)
- 29 CFR 1915.1000 (Table Z, Air Contaminants, Shipyards)
  - Oil mist, mineral, 5 mg/m^3
  - PNOC, 15 mg/m^3 (total)
- 29 CFR 1926.55 App A (Gases, Vapors, Fumes, Dusts, and Mists)
  - Oil mist, mineral, 5 mg/m^3
  - PNOC, 15 mg/m^3

APPENDIX D: 40 CFR RELEVANCE FOR MWF INDUSTRIES

- Chemicals on the TSCA inventory that are utilized in MWF formulations are subject to TSCA reporting requirements. Exempted from reporting requirements are polymers, inorganics, naturally occurring chemical substances, and microorganisms (40 CFR 710.30).
- Biocides that are used in MWFs must be registered under FIFRA specifically for that application, and those that are registered for other applications only may not be used for MWFs.
- Spent MWFs may be classified as hazardous waste and are subject to applicable treatment/disposal methods as required by federal, state, and local regulations in accordance with RCRA.

APPENDIX E: 49 CFR RELEVANCE FOR MWF INDUSTRIES

- Part 172.101 lists materials that are hazardous for transportation and requirements for labeling, packaging, and quantity limits.
- Alkaline properties (pH >8.5) of many MWF formulations may cause these products to be classified as corrosive; however, they may be nonhazardous, depending on an evaluation of analytical testing data and other criteria.
- MWFs may be included into HMTA Hazard Class 8.
  - The shipping name for some MWFs is "Corrosive Liquid, n.o.s." The n.o.s. designation (*not otherwise specified*) is a catch-all term that is used when substances are not specifically named in a regulation.

APPENDIX F: INTERNET RESOURCES

- American Chemistry Council (ACC), http://www.americanchemistry.com/cmawebsite.nsf
- ACGIH, http://acgih.org
- ANSI, http://www.ansi.org
- ASTM, http://www.astm.org
- Antimicrobial Pesticide Registration, https://www.epa.gov/pesticide-registration/antimicrobial-pesticide-registration
- Auburn University Tribology and Lubrication Science Minor, http://eng.auburn.edu/programs/tribology
- California VOC/MWF rulemaking, http://www.aqmd.gov/home/regulations/compliance/vocs/rules
- EPA/TSCA, https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/frank-r-lautenberg-chemical-safety-21st-century-act
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- EPA/SPCC, https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations
- EPA/HPV,https://www.epa.gov/chemical-research/prioritization-high-production-volume-chemicals-under-chemical-assessment-and

- ISO, http://www.iso.org
- NIOSH Criteria Document, MWF, http://www.cdc.gov/niosh/docs/98-102
- OSHA General Duty Clause, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=OSHACT&p_id=3359
- OSHA HCS Pictograms, https://www.osha.gov/Publications/HazComm_QuickCard_Pictogram.html
- OSHA MWF Standards Advisory Committee, https://www.osha.gov/dhs/reports/metalworking/MWFSAC-finalReportSummary.html
- OSHA Revised HCS, https://www.osha.gov/dsg/hazcom/index.html