Substitutes and solutions: transitioning to safer chemicals

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Introduction

Chemicals used in the workplace are estimated to cause more than 190,000 illnesses and 50,000 deaths of workers annually in the United States. While the demand for safer chemicals has increased, only a small number of the more than 80,000 chemicals used in commerce are tested and regulated in the workplace. The current shortcomings of the U.S. chemical regulatory system means businesses must move beyond compliance and target high-hazard chemicals that impact the health of workers. Elimination and substitution of hazardous chemicals are the most effective control measures in reducing hazards. Replacing known hazardous chemicals with safer alternatives is a significant step in reducing worker exposure.

SAIF has developed this guide to assist our policyholders in the process of transitioning to safer chemicals.

Understanding safer alternatives

A safer alternative means replacing a hazardous substance with one which poses less or no risk. This may mean changing a production process, substituting a chemical or material, redesigning a product, or making a system change. The goal of a safer alternative transition is to identify functionally equivalent alternatives that meet the performance needs of a product while eliminating the hazardous chemical. Transitioning to safer chemicals can be complex, but it is crucial that any change towards substitution is done so without regret. Regrettable substitution means the replacement of a toxic chemical with one that has unknown—if not greater—toxic effects.

*An example of **regrettable substitution** is replacement of diacetyl with 2, 3-pentanedione in food production. Responding to concerns over flavoring related lung disease caused by diacetyl (an artificial butter flavoring used in many products, most notably microwave popcorn), American food product manufacturers replaced the chemical with 2, 3-pentanedione. Unfortunately, 2, 3-pentanedione was found to be just as hazardous to the respiratory system as diacetyl. Identifying and making informed substitution choices reduces the risk of regrettable substitutions.*

Step-by-step approach

In this document, we cover:

- Building a safer alternative transition team
- Developing an action plan
- Assessing chemical inventory and use
- Selecting and evaluating safer alternatives
- Implementing and monitoring safer alternative choices

Building a safer alternative transition team

Building an internal team and engaging external stakeholders is the first in step in the reduction of chemical hazards in the workplace. The team is integral in the development of an action plan for safer chemical transition and should reflect all divisions within the organization. Stakeholders should be engaged throughout the transition process. The following section discusses how to build a team and create an action plan.

The team

The internal team should include a wide range of members from within the organization. Members holding different roles and responsibilities ensures diverse voices are included in the process. It is important to have both management and front-line staff on the team. Management can provide a high-level view of the operation and are key decision makers. Front-line staff are key internal stakeholders and can have detailed understandings of the operations and chemical exposures on site.

The roles

Roles and responsibilities for the team should be established early on. Have the group appoint a team leader. The leader will have to communicate clearly, make hard decisions or bold recommendations, and know how to resolve conflicts.

Goal setting

An early focus for the team should be establishing clear objectives. The overarching goals and priorities provide a clear vision of the changes the team would like to implement. The goals can be long-term, industry-specific, or chemical-specific. For example, what are the hazards that will be prioritized? Will the team address the non-debilitating hazards affecting significant numbers of workers or debilitating hazards faced by few? An initial run-through of priorities can help answer these questions and narrow the group's scope. In addition, the team should develop and communicate a policy statement (supported by management) committing to the elimination or reduction of targeted chemicals such as carcinogens and to substitute safer alternatives.

External stakeholders

The preliminary goals can be used to guide the team in identifying members for an external stakeholder group. Potential external stakeholders can include (but not limited to) researchers/technical experts, retailers, industrial hygienists, members of environmental groups, and end users. External stakeholders should be able to identify potential concerns, provide additional assessment, and bring important issues to the team. The development and makeup of the internal team and external stakeholder group is entirely contingent on the needs of the organization and can vary by industry.

Worksheet A, on page 10, is a template that can be used to define roles and responsibilities of the transition team. A list of the resources for this section can be found on page 13.

Developing an action plan

A plan of action is a written plan that indicates which tasks must be done and who is responsible for those tasks, with a timeline. There is no single method for developing a work plan for transitioning to safer chemicals. The plan should consider specific measurable goals set by the safer alternative transition team. Goals may include eliminating known carcinogens, reducing the use of hazardous chemicals by a certain percentage, or phasing out a specific class of compounds in a set number of years.

Key components of the plan should include:

- An inventory of all current chemicals that are used in processes and products within the facility

  - Chemicals can be ranked into categories of high, moderate, low, or unknown concern/use.
- A list of prioritized chemicals for elimination or reduction
  - Chemicals that present health concerns to workers should be prioritized.
  - Each chemical should have its own work plan with action steps, roles, and timelines.
- Elimination/reduction percentage goals and timelines for targeted chemicals
- Alternative assessment tools to be used for comparing hazards
- Approaches for prioritizing and managing chemical hazards
- Preapproval process for new chemicals (including determination of preapproval team)
- Engagement plan with suppliers/manufacturers of chemicals.
- Training and capacity-building of employees around hazardous chemical phase-out

A list of the resources for this section can be found on page 13.

Assessing chemical inventory and use

In order to prioritize chemicals of concern for elimination or substitution, assess the current chemical inventory at your facility. This means identifying products and chemicals that are used in all areas of the workplace. You have likely already done this within your hazard communication program. Building an inventory provides a comprehensive picture of all the chemicals in use in the workplace. It provides a realistic evaluation of potential hazards to the health of workers.

A comprehensive inventory is the starting point for assessing existing worker health hazards. In addition, new chemicals will be added to the inventory once approved. Knowing which materials, products, and processes contain a chemical of concern is a start towards creating a solution. Characterizing the function of a chemical of concern in a product is essential to identifying alternatives. The goal of a chemical alternatives assessment is to identify a functionally equivalent, effective, and safer alternative.

The inventory can be organized in whatever way best meets the needs of the team. Key components of the inventory should include:

- A list of all activities and processes in the workplace that use/or potentially may use chemicals (or formulated products)
- Locations within the facility of where all activities take place
- A process flow or supply chain to aid in the visualization of the workflow and use of chemicals in the workplace
- Data on Oregon OSHA permissible exposure limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs®), and National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits (RELs) of the chemicals

A safety data sheet includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. Often data on products can be insufficient and lack information on the health and environmental impacts of chemicals.

Directly contact manufacturers and suppliers of these chemicals and request comprehensive information to fill the data gaps.

- Pertinent hazard information found on safety data sheets

Worksheet B, on page 11, is a template that can be used to assess chemical inventory and use.

Some key areas to review on an SDS in relation to a health and safety hazard assessment include:

Section 2: Hazard(s) Identification
Hazard(s) identification includes the hazards of the chemical and the appropriate warning information associated with those hazards.
Section 3: Composition/Information on Ingredients
Composition/information on ingredients identifies the ingredient(s) contained in the product indicated on the SDS, including impurities and stabilizing additives. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed.
Section 4: First-Aid Measures
First-aid measures describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical.
Section 6: Accidental Release Measures
Accidental release measures provide recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard.
Section 8: Exposure Controls/Personal Protection
Exposure controls/personal protection indicates the exposure limits, engineering controls, and personal protective equipment (PPE) measures that can be used to minimize worker exposure.
Section 11: Toxicological Information
Toxicological information identifies toxicological and health effects information or indicates that such data are not available. This includes routes of exposure, related symptoms, acute and chronic effects, and numerical measures of toxicity.
Section 15: Regulatory Information
Regulatory information identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS.

Alongside the SDS, restricted substances lists—such as the European Union's REACH (Registration, Evaluation, and Authorization of Chemicals – click the consultations tab to access the content) Restricted Substances List (RSL)—are a great resource to cross-reference chemicals in the workplace. Other chemical databases, such as ChemHAT and RISCTOX, can be used to quickly identify the hazards associated with chemicals used in the workplace.

REACH is a regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances in order to reduce the number of tests on animals.

Prioritizing chemicals for assessment

The safer alternative transition team should identify priority chemicals from the inventory assessment. Chemicals should be prioritized based on criteria determined by the transition team and established goals in the work plan. Prioritization criteria can include (but is not limited to) substitution potential, serious health risks, employee exposure incidents, and hazard assessment.

Another way to prioritize chemicals can be to categorize them into the following three sections:

- Prohibited immediately
- Phase out by individually set periods
- Reduced use pending more research

Tools such as the restricted substances lists and ChemHAT can be used to prioritize chemicals for substitution/alternatives analysis.

A list of the resources for this section can be found on page 13.

Selecting and evaluating safer alternatives

An assessment should broadly consider the universe of possible alternatives available. A safer alternative may mean changing a production process, substituting a chemical or material, redesigning a product, or making a system change. Simple chemical substitutions may be the easiest to implement, but there may not be a direct substitution available. In some cases, the equivalent chemicals may all have problems with toxicity. Steps in identifying alternatives:

- Determine the function/purpose of the chemical.
- Reach out to manufacturers/suppliers about alternatives that have been assessed for hazards.
- Search publicly available resources that can be used to identify safer alternatives.

Types of alternatives: Chemical substitution—substituting a less-toxic chemical

Material/product reformulation—changing the makeup of the product so as not to require the chemical of concern

Product redesign—changing how the product is built, shaped, assembled, or used to reduce or eliminate the need for the chemical of concern

System/process change—changing how the product is manufactured to reduce or eliminate the need for the chemical of concern

The most promising alternatives should be prioritized, remembering to eliminate options with major-hazard red flags that may be regrettable substitutions.

- Engage external stakeholders with technical expertise in toxicology or green chemistry.

Alternatives that may be under development but not currently available should also be considered. Actively continue looking for one even if an alternative is not immediately available. If no alternative, best practices based on the hierarchy of controls should be implemented.

Implementing and monitoring safer alternative choices

The most promising alternatives should be prioritized remembering to eliminate options with major hazard red flags that may be regrettable substitutions.

Some questions to ask about alternatives:

- What are the known hazards of the alternative? For example, physical, human health, or environmental hazards
- What are the major gaps in knowledge of these alternatives?
- Is the alternative restricted in use by local, state, federal, or international legislation?
- What are the tradeoffs to implementing this alternative?
- Does this alternative meet the functional characteristics and performance standards that my product needs?
- Will the alternative be available from manufacturers and suppliers?
- What is the current and long-term cost associated with the alternative compared to that of the hazardous chemical?
- What are the life cycle impacts of adoption of the substitute?

The hierarchy of control is a system used in industry to minimize or eliminate exposure to hazards. The hazard controls in the hierarchy are, in order of decreasing effectiveness:

- *Elimination,*
- *Substitution,*
- *Engineering controls,*
- *Administrative controls,*
- *and Personal protective equipment*

Although definitive information on all hazard characteristics can be hard to attain, it is important to have sufficient information on the properties of the substance to be able to compare with properties of other potential alternatives. Develop a pro and con list for the alternatives addressing health, environmental, performance, and cost aspects.

Worksheet C, on page 12 is a template that can be used to compare the feasibility of alternatives.

Hazard profiles can be found on a number of websites, including GreenScreen and QCAT. Screen out alternatives that are on these restricted/chemicals of concern lists. External stakeholders and technical experts should be consulted to assist in narrowing down potential alternatives.

Pilot testing

Once an alternative is determined, a pilot test should be done before full implementation of the alternative.

Building a safer alternative transition team

Areas to address:

- Technological or organizational changes to be made
- Functional performance (e.g. the chemical works as well as the chemical of concern)

- Impact on workers, environment, or consumers
- Shifts of risks, and the necessary measures to address risks

Consult with employees during the pilot process to determine if there are any adverse health impacts, issues with performance, and other concerns relating to the new alternative. In addition, a company-specific preapproval process should occur at this stage. *If the findings from the pilot are negative, continue to pilot other alternative options.*

Full implementation and monitoring
After a successful pilot phase, the alternative can be fully integrated into the work process. However, this does not signal the end of the process. The transition requires continuous improvement, monitoring, and feedback to be successfully implemented as a permanent solution.

Areas to address:

- Measures needed to implement substitution at full capacity
- Supply chain updates
- Training and education of suppliers and employees
- Feedback from key stakeholders
- Continuous monitoring

Additional materials

This guide provides an overview of the safer alternative transition process. Worksheets for this guide can be found on pages 10-12, which can be copied and filled out during the process. In addition, a list of resources and case studies can be found on pages 13-15.

Case study: Paint B Gone (PBG) is a paint removal business that has committed to substituting the products they use for safer chemical alternatives.

Building a safer alternative transition team
PBG identified an internal team consisting of their site manager, a paint removal specialist, a facilities employee, and their off-site supervisor. The internal team designated the site manager to be the team leader as he/she had a direct line of communication to upper management and front-line staff. Using Worksheet A the team identified their respective roles and responsibilities. The group determined that their main objective was to target known and suspected carcinogens in their supply chain. Based upon their needs the group identified their external stakeholders. An industrial hygienist was selected to discuss the impacts of proposed changes on workers and a technical expert in the green chemistry field to aid them in avoiding regrettable substitutions.
Developing an action plan
With the teams in place PGB developed an action plan using the National Pollution Prevention Roundtable action plan template. A key component of their action plan was the elimination of toxic paint strippers in their work processes. The action plan laid out their timeline to switch to safer alternatives by the start of their next fiscal year.
Assessing chemical inventory and use
Using chemical information, they already had in their hazard communication program PBG was

able to assess their chemical inventory and use. They documented heir chemical inventory using Worksheet B. They collected additional hazard information on their inventory from ChemHAT and RISCTOX. From their inventory they were able to identify the priority chemicals they wanted to phase out. They prioritized their transition list based on serious health effects like cancer. They identified Methylene Chloride (a highly hazardous chemical used in paint stripping) as their first priority phase out chemical.
Selecting and evaluating safer alternatives
After establishing their priority chemical, the team researched chemicals that worked in a similar capacity to Methylene Chloride. The team determined that switching to a non-chemical stripping method was not feasible for their operation. Working with their external stakeholders (technical expert and industrial hygienist) the team identified alternatives for Methylene Chloride using GreenScreen and other available resources. Using Worksheet C they compared the feasibility and potential hazards of the possible alternatives. Based on their research the team identified a Benzyl Alcohol based paint stripper as their possible alternative.
Implementing and monitoring safer alternative choices
A pilot was done on the new alternative chemical at a few worksites. The team followed their internal pre-approval chemical process to integrate the pilot chemical into their work. Feedback from employees was taken to determine if there were issues with performance or any other concerns. In addition, the team worked with their external stakeholder industrial hygienist to monitor employee exposure to Benzyl Alcohol. Following a successful pilot phase, the safer alternative was fully integrated into the workplace. Moving forward the team will continuously monitor for employee exposure and train employees on the new chemical.

Worksheet A: Project roles and responsibilities

This template can be used to define roles and responsibilities. Below are a few typical examples of the different types of roles involved in delivering a project and their respective responsibilities.

Title	**Role**
Example positions: • Internal team – Leader • Functional specialist team member • Supply chain specialist	The person responsible for developing, in conjunction with the internal team, a definition of the project. The team leader then ensures that the project is completed on time and to the required quality standard (within agreed specifications). He/she ensures the project is effectively resourced and manages relationships with a wide range of groups (including all internal team members and external stakeholders).
Responsibilities	
• Managing and leading the project team • Developing and maintaining a detailed project plan • Resolving conflicts and delivering bold recommendations • Managing project deliverables in line with project plan • Liaising with, and updating progress to, upper-level management	

Worksheet B: Chemical inventory

This template can be used to assess chemical inventory and use.

Item#	Chemical Name	CAS#	Location	Chemical Function	Quantity	Activity/Process	Supplier/ Manufacturer	Main Hazards	SDS
Ex. 1	Methylene chloride	75-09-2	Facilities	Solvent	55-gallon drum	Used to strip paint	Fisher Scientific	Very hazardous in case of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact. CARCINOGENIC EFFECTS	Y

Worksheet C: Comparing alternatives

This template can be used to compare the feasibility of alternatives.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Health hazards	Ex. Dimethyl sulfoxide (DMSO) **Pro:** No data on carcinogenicity (IARC) **Con:** Slight skin and lung irritant	Ex. Benzyl alcohol **Pro:** No data on carcinogenicity (IARC) **Con:** Skin and eye irritant	**Pro:** **Con:**	**Pro:** **Con:**
Environmental hazards	**Pro:** Biodegradable **Con:** Moderate flammability	**Pro:** No bioaccumulation **Con:** Possible increase in VOC emissions	**Pro:** **Con:**	**Pro:** **Con:**
Performance /Functionality	**Pro:** Effective on many types of coatings **Con:** Stripping time longer than methylene chloride	**Pro:** Effective on many types of coatings **Con:** Stripping time longer than methylene chloride	**Pro:** **Con:**	**Pro:** **Con:**
Costs	**Pro:** Cheaper than abrasive methods (labor time) **Con:** Costs more than methylene chloride	**Pro:** Cheaper than abrasive methods (labor time) **Con:** Costs more than methylene chloride ($6.00/gal vs. $10.00 - $25.00/gal)	**Pro:** **Con:**	**Pro:** **Con:**

Resource list

Building a chemical transition team

OSHA has developed this step-by-step toolkit to provide employers and workers with information, methods, tools, and guidance on using informed substitution in the workplace.
https://www.osha.gov/dsg/safer_chemicals/

The Toxics Use Reduction Institute (TURI) at the University of Massachusetts-Lowell provides resources and tools to help make the Commonwealth a safer place to live and work.
http://www.turi.org/

The Green Chemistry & Commerce Council (GC3) is a cross-sectoral, business-to-business network of companies and other organizations working collaboratively to accelerate green chemistry across sectors and supply chains.
https://greenchemistryandcommerce.org/

Assessing chemical inventory and use

ChemView assists users in getting information on chemical health and safety data and on EPA's assessments and regulatory actions for specific chemicals under the Toxic Substances Control Act (TSCA). It also contains information EPA receives and develops about chemicals that end up on EPA's Safer Chemical Ingredients List.
ChemView | US EPA

A searchable database for obtaining many properties of chemicals: physiochemical properties, toxicity, ecotoxicity, and environmental fate/pathways. The first tier of results provides references to external data. The user must access these external sources for data.
https://www.echemportal.org/echemportal/

Haz-Map is an occupational health database designed for health and safety professionals and for consumers seeking information about the adverse effects of workplace exposures to chemical and biological agents.
https://haz-map.com/

The OSHA Occupational Chemical Database was developed by OSHA and EPA as a convenient reference for the occupational safety and health community. It compiles information from several government agencies and organizations.
OSHA Occupational Chemical Database | Occupational Safety and Health Administration

Selecting and evaluating safer alternatives

This is an online database of chemical products (a.k.a. "ingredients") used primarily to formulate residential, institutional, industrial, and janitorial cleaning products that have been preapproved to meet the U.S. EPA's Safer Choice Standard.
https://cleangredients.org/

GreenScreen® for Safer Chemicals is a method of comparative chemical hazard assessment (CHA) that can be used for identifying chemicals of high concern and safer alternatives. GreenScreen was developed by and is a project of Clean Production Action.
http://www.greenscreenchemicals.org/

Safer Choice helps consumers, businesses, and purchasers find products that perform well and are safer for human health and the environment. (EPA)
https://www.epa.gov/saferchoice

SUBSPORT is a free, multilingual platform for information exchange on alternative substances and technologies, as well as tools and guidance for substance evaluation and substitution management.
http://www.subsport.eu/

The goal of the interagency alternatives assessment webinar series is to educate federal, state, and local government agencies on the approaches, practices, and challenges of alternatives assessment for informed substitution.
http://www.chemicalspolicy.org/alternativesassessment.webinarseries.php

Pollution Prevention Options Assessment System (P2OASys) tool helps companies determine whether the TUR options they are considering may have unforeseen negative environmental, worker, or public health impacts
http://www.turi.org/Our_Work/Toxic_Chemicals/P2OASys_Tool_to_Compare_Materials

QCAT is a simplified hazard assessment tool that can be used to compare hazards of different chemicals when looking for safer alternatives. Washington Department of Ecology developed the QCAT to help small and medium businesses that are concerned about the alternative assessment process.
https://ecology.wa.gov/regulations-permits/guidance-technical-assistance/safer-alternatives

The IC2 has developed the Chemical Hazard Assessment Database to enable users to search for GreenScreen® and Quick Chemical Assessment Tool (QCAT) chemical hazard assessments.
http://theic2.org/hazard-assessment

OECD has pulled together a compilation of resources relevant to chemical substitution and alternatives assessments. This includes an Alternatives Assessment Tool Selector, a filterable summary of current Alternatives Assessment Frameworks, links to case studies and other resources, and a list of regulations and restrictions from OECD member countries.
http://www.oecdsaatoolbox.org/

This data source is for building material evaluations, and is divided into three parts: building materials library, chemical/materials library, and certification information.
Pharos Project

Using GreenScreen® as a blueprint, QCAT was developed by the Washington State Department of Ecology to function as a simpler tool for smaller businesses.
Green Chemistry: Quick Chemical Assessment Tool (QCAT)

RISCTOX was developed by the Spanish Trade Union Institute of Health, Work and Environment (ISTAS) and the European Trade Union Institute (ETUI) and is based on European environmental and health standards.
https://risctox.istas.net/en/

Implementing and monitoring safer alternative choices

BizNGO is a unique collaboration of business and environmental leaders who are advancing safer chemicals and sustainable materials, thereby creating market transitions to a healthy economy, healthy environment, and healthy people.
https://www.biznGO.org/resources

Case studies

Case studies of alternatives assessments that have been conducted by manufacturers, academic institutions, NGOs, or government bodies.
https://www.oecd.org/chemicalsafety/risk-management/substitution-of-hazardous-chemicals/