

HazCom Employer's Guide

Step 5: Substitution Plan

What You NEED To Do

Eliminating chemical hazards in the workplace removes the risks they pose. The next best is substituting the hazardous chemical for something non-hazardous or less hazardous. These activities can reduce the costs and work associated with storing and disposing of chemicals and training and equipping employees. It can also reduce liabilities and costs from downtime due to accidents and occupational injuries and illnesses. It is important when substituting chemicals to select safer alternatives and not just swap one harmful agent for another, which could do even more harm to employees and downstream users of products. [Download a worksheet for how to select chemical substitutes.](#)

[BACK TO START](#) | [NEXT STEP OF 12](#)

Chemicals in the workplace lead to over 190,000 illnesses and 50,000 deaths annually in the United States. These shocking statistics, referenced by OSHA on its chemical substitution web page, stem from a 2006 California Policy Research Center report entitled "Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation."

Statistics aside, there is a global growing awareness that more can and should be done to safeguard employees, our communities, and the environment from the effects of hazardous chemicals. Chemical substitution has been identified as one of the primary tools for achieving those ends, and on that front, OH&S professionals are uniquely positioned to take the lead.

Understand the Push Toward Chemical Substitution and the Potential Benefits.

There are myriad reasons for transitioning away from hazardous chemicals to safer alternatives. On a basic level, it conforms to the hierarchy of controls, which posits that there is an order in

which hazards should be dealt with, with the most effective controls considered first and the least effective controls used when necessary. The controls in order of effectiveness are:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal protective equipment (PPE)

Looking at these controls through the lens of chemical safety, the order makes sense. Eliminating chemical hazards in the workplace removes the risks they pose. Next best is substituting the hazardous chemical for something non-hazardous or less hazardous. These activities can reduce the costs and work associated with storing and disposing of chemicals and training and equipping employees. It can also reduce liabilities and costs from downtime due to accidents and occupational injuries and illnesses.

It is important when substituting chemicals to select safer alternatives and not just swap one harmful agent for another, which could do even more harm to employees and downstream users of products.

If a company is unable to remove the hazard entirely or minimize it, then it should look next at engineering controls, which physically change the workplace to remove the hazard or place a barrier between the hazard and the worker. Next, it should look at administrative controls that require employer/employee actions to align with new processes that seek to mitigate risks. If a hazard cannot be controlled by the methods described above, then an employer may have to resort to PPE, which is generally considered the least effective method of control.

The benefits of chemical substitution go beyond safety, and a strong business case can be made that chemical substitution benefits include improvements to productivity through gained efficiencies, as demonstrated by the American Industrial Hygiene Association (AIHA) in a 2008 study, "Demonstrating the Business Value of Industrial Hygiene." These efforts, the study concluded,

positively contribute to a company's bottom line.

Proof of the business case can be seen in the marketplace today: Local, state, federal, and international regulations are mandating the move toward safety alternatives; consumers are demanding safer products and services and are rewarding companies that provide it, and communities are holding business more accountable for their actions; larger downstream companies are mandating safer chemicals and tighter hazard communication protocols from upstream suppliers. In today's marketplace, sustainability is good business.

Carry Out the Transition to Safer Chemical Alternatives.

OSHA has outlined seven steps it recommends for making the transition successful. Those steps are:

1. Form a team and develop a plan.
2. Examine current chemical use.
3. Identify alternatives.
4. Assess and compare alternatives.
5. Select safer alternatives.
6. Pilot (test) the alternative.
7. Implement and evaluate the alternative.

More specifically, OSHA recommends:

- Getting the right mix of stakeholders together to ensure a comprehensive and successful implementation. With this team, set goals, tasks, and timelines.
- Performing a chemical inventory, making sure to include all chemicals to which employees are exposed and that a safety data sheet is on hand for each.
- Prioritizing chemicals for substitution based upon their intrinsic hazards and potential for exposure. A good electronic SDS management tool can make it easier to search safety data sheets for chemicals of concern, even at the ingredient level. Extremely hazardous chemicals as identified by the EPA, OSHA, and other agencies should be at

or near the top of the list.

- Locating alternatives that could replace the chemical in question, including using steps outlined in the hierarchy of controls to abate the chemical hazard.
- Making an informed decision by analyzing the comparable hazard footprints of the alternatives under consideration, including data about hazards, performance, costs, and other factors, and then selecting the best option. The best option will likely include a number of trade-offs, some of which may require new protections to safeguard employees, even though safety as a whole improves.
- Testing and evaluating to ensure that the piloted improvement achieves desired results without complicating matters. This final step is never really finished because chemical hazard abatement is an ongoing process, and new technologies and chemical alternatives are being developed at an accelerated pace.

Why is Substitution Important?

Why is Substitution Important?

Substitution of currently-used materials with less hazardous materials is one of the most effective ways of eliminating or reducing exposure to materials that are toxic or pose other hazards. A hazard is the source of danger or injury. A hazard includes any chemical or material that has the ability or a property that can cause an adverse health effect or harm to a person under certain conditions. Risk, on the other hand, is the probability or chance that exposure to a chemical hazard will actually cause harm to a person or cause an adverse effect.

Other occupational hygiene methods for controlling employee exposure to chemicals include elimination, isolation, enclosure, local exhaust ventilation, process or equipment modification, good housekeeping, administrative controls and personal protective equipment. All these methods reduce or eliminate the risk of

injury or harm by interrupting the path of exposure between the hazardous material and the worker. Substitution removes the hazard at the source.

Why Should the Substitute Product be Chosen Very Carefully?

Why Should the Substitute Product be Chosen Very Carefully?

Extreme care must be taken to ensure that one hazard is not being exchanged for another, especially one that could even be a more serious hazard. Before deciding to replace a chemical, one must know what risks the chemical poses to the employees, the environment, the equipment and facilities. If the risks are serious, then alternatives should be considered. A thorough understanding of the potential risks associated to the alternative solution is necessary.

The selection of a substitute can be a very complex process. In large organizations the selection process may involve a committee with representatives from engineering, purchasing, industrial hygiene, safety, maintenance, research and development, environmental control, waste management, shipping, and the supervisors and workers who directly work with the product. In smaller organizations, one person may carry out many of these functions.

What are Some Major Considerations to Look at When Considering the Suitability of Potential Substitutes?

What are Some Major Considerations to Look

at When Considering the Suitability of Potential Substitutes?

1. **Effectiveness.** Will the product meet the technical requirements (e.g., solubility, drying time) for the job or process?
2. **Compatibility.** The substitute must not interfere or react with the process, the other products, or the equipment.
3. **Existing Control Measures.** Existing control methods may not adequately control the substitute (e.g., a less toxic substitute may evaporate more rapidly and the existing ventilation system may not adequately capture the vapors).
4. **Waste Disposal.** Will the current waste disposal system meet technical and regulatory requirements when dealing with any new waste created by using the substitute?
5. **Hazard Assessment.** A hazard assessment should be done to decide whether to substitute a chemical or product with a different one.

What are Some Points to Consider When Doing a Hazard Assessment?

What are Some Points to Consider When Doing a Hazard Assessment?

Use safety data sheets (SDSs) and other sources of chemical information to compare the hazards of various products. For easier comparison, set up a table with the following categories for each potential substitute. The important properties to compare are:

1. **Vapor Pressure.** Vapor pressure is an indicator of how easily a chemical evaporates into the air. Exposure by inhalation is the primary route of exposure for many products; therefore, the vapor concentration in the air largely influences the potential degree of exposure. If a solvent is not very volatile (does not evaporate easily), the potential

for exposure by inhalation may be very low.

2. **Short Term Health Effects.** Biological effects or adverse health effects caused by short-term exposures to high concentrations of a chemical may not be the same as those resulting from low level, long-term exposures. For example, two closely related aromatic hydrocarbons, benzene and toluene, have similar acute toxic properties but only benzene causes cancer following long-term or chronic exposure. Recommended occupational exposure limits such as the American Conference of Government Industrial Hygienist's (ACGIH) Threshold Limit Values (TLVs) must **not** be used in the comparison of materials since the basis for establishing these values varies from substance to substance (e.g., protection from irritation, becoming unconscious, or impairment of health). The TLV booklet clearly states that the TLVs are **not** a relative index of toxicity.
3. **Long-Term Health Effects.** Long term health effects such as chronic lung disease may be more significant than short term health effects.
4. **Skin Toxicity.** Both the potential for direct irritation and allergic sensitization must be examined. One also must consider that, besides breathing in chemicals, some solvents (and even some solvent vapors) can also be absorbed through intact skin. This route of exposure can contribute significantly to the overall uptake of chemicals in the body.
5. **Sensitization of the Respiratory System:** If repeated exposure to the chemical by inhalation can cause hypersensitive reactions, like an asthma attack, then special exposure control methods and workplace practices should be set up and maintained.
6. **Cancer-Causing Potential and Reproductive Effects.** If there is sufficient evidence that a compound could cause cancer or reproductive effects in humans, special handling precautions need to be considered.
7. **Physical Hazards.** Fire and explosion are sometimes the greatest hazards from a product. Properties that must be examined include vapor pressure, autoignition temperature,

flash point, flammability limits, and reactivity.

Although substitution is the most direct method of reducing hazards, it is not always practical. A very careful evaluation must be done before any substitution plan to ensure that the new, alternative chemical does not pose a greater hazard than the currently used product. For example, a less environmentally harmful substance may actually pose a more significant risk for the health of the workers.

What is an Example of the Steps to Take When Investigating a New Product?

What is an Example of the Steps to Take When Investigating a New Product?

The Health and Safety Executive (HSE) in the United Kingdom recommends a seven step process when considering substitution*. These steps include:

1. **Identifying hazards and assessing risks.** This step involves deciding whether the current substance or process is a hazard. Is there a significant risk involved in storing, using or disposing of a substance? A hazard is defined as "the potential a substance or process has to harm someone or damage the environment." Risk is "how likely this is to happen."
2. **Identifying alternatives.** Investigate a wide range of options. Compare all of the hazard assessment information as previously mentioned in this document. Compare the different states of a chemical (e.g., will a granular form create less dust than a powder form?) Also consider whether the job is necessary or not (e.g., can the part be replaced rather than cleaned). If you are a supplier, you may need to select options according to your customers' needs as well as those of your own employees.
3. **Think about what could happen if you use the**

alternatives. It is important that you have gathered all available information before this step so that you can make a realistic comparison of both the good and bad points. Remember that you must also consider the way employees use it and how likely it is that they may be exposed. Choosing an alternative chemical may require changes in:

- the way the work is done,
- the kind of equipment or parts (e.g., O-rings, gaskets or hose materials) needed to be compatible with the substitute chemical,
- the ventilation system that may be required,
- the disposal methods, and
- regulatory requirements that may apply.

4. **Comparing alternatives.** In this step, compare the alternatives with each other, and with the substance or process currently being used. HSE recognizes that it is hard to compare the risks of one chemical that is very flammable with one that is very toxic. They recommend thinking of the effects in simple terms such as “Is the substitute going to explode, or poison people? Will it only affect people who work with it, or could it affect other people in the area?” Remember to consider how and where the alternative will be used.

5. **Decide whether to substitute.** This step is the most difficult. Remember that a change in one step of a process can affect many others. Consult with the workers who will be handling the material directly for their input. It is a good practice to introduce the substitute on a trial or small quantity basis at first.

6. **Introducing the substitute.** Plan the change in material or process carefully. Remember to train and educate the workers involved.

7. **Assessing the change.** Check to see if the substitution has produced the intended results. You may find monitoring the health of the workers, monitoring the level of contaminants in the air, or fulfilling legal requirements useful parameters to measure.

[Additional Resources](#)

Additional Resources

- [The MADE SAFE Hazard List of Chemicals, Materials & Ingredients](#)
- [Hazardous Chemicals Handbook](#)
- [OECD Substitution and Alternatives Assessment Toolbox](#)
- [Chemsec Marketplace](#)

[BACK TO START](#) | [NEXT STEP](#)