



# NAU Waste Minimization Program

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# **Table of Contents**

|   |          |
|---|----------|
| <b>Introduction .....</b>               | <b>2</b> |
| <b>Waste Minimization .....</b>         | <b>2</b> |
| Source Reduction .....                  | 2        |
| Recycling .....                         | 3        |
| Treatment.....                          | 4        |
| <b>Efficient Waste Management .....</b> | <b>4</b> |
| Flammable liquids .....                 | 4        |
| Flammable/Corrosive Compounds.....      | 5        |
| Acids and Bases .....                   | 5        |
| Halogenated Solvents .....              | 5        |
| Aqueous Metals .....                    | 6        |
| Miscellaneous.....                      | 6        |
| <b>Conclusion .....</b>                 | <b>6</b> |

## Introduction

The Arizona Department of Environmental Quality classifies Northern Arizona University as a Small Quantity Generator of hazardous waste. However, Episodic Large Quantity Generator status may occur through building demolition, remodel, laboratory cleanout and other intermittent projects. During ELQG status, a waste minimization program must be in place. The NAU Waste Minimization Program presents guidelines for University personnel to reduce the amount and toxicity of wastes generated at Northern Arizona University.

## Waste Minimization

It is imperative university personnel are aware of the environmental and financial impacts related to hazardous waste disposal. Minimization of hazardous waste begins with the initial buyer. Generators of hazardous waste on campus include laboratories, maintenance shops, garages, machine shops, art studios, and many more. Proper waste management is an integral part of all operating procedures.

This program is designed to assist waste generators in managing their areas with waste minimization in mind. The three general methods of waste minimization are source reduction, recycling, and treatment.

### Source Reduction

Changing practices and processes to reduce or eliminate the generation of hazardous wastes is referred to as source reduction. Source reduction methods may include process modification, chemical substitution, and improved operating procedures. Below are specific examples of reducing chemical waste:

- Do not mix hazardous and non-hazardous waste
- Maintain sound Chemical Hygiene practices to reduce waste
  - Carefully weigh/transfer chemicals to minimize spills
  - Have sanitary secondary containment so that spilled reagents can be reused
- Use micro-scale level laboratory experiments
- Minimize your inventory (buy less, store less, use less)
  - Buy chemicals that will be used now, not several weeks later
  - Practice sound purchasing (a large amount of campus waste is a result of buying too much reagent and it expiring)
  - Don't go for the "buy four get two free" marketing ploy; buy only what you need
- Label all chemical products to prevent unknowns
- Centralize purchasing of chemicals and products within departments/labs to prevent duplicate orders

- Substitute computer simulations/modeling, videos or demonstrations for wet laboratory experiments
- Have students work in pairs/groups on experiments rather than individually
- Evaluate procedures to see if a less hazardous or a non-hazardous reagent can be used, as shown in Table 1

TABLE 1

| Hazardous Chemical                   | Safer Substitute                                | Used For                     |
|--------------------------------------|---|------------------------------|
| Acetamide                            | Stearic Acid                                    | Freezing point depression    |
| Benzene                              | Xylene/Hexane                                   | Solvent                      |
| Benzoyl Peroxide                     | Lauryl Peroxide                                 | Polymer catalysis            |
| Carbon Tetrachloride                 | Cyclohexane                                     | Qualitative halide test      |
| Formalin/Formaldehyde                | Ethanol   | Specimen storage             |
| Halogenated Solvents                 | Non-Halogenated Solvents                        | Extraction/Solvent           |
| Sodium Dichromate                    | Sodium Hypochlorite                             | Oxidation reactions          |
| Sulfide ion                          | Hydroxide ion                                   | Qualitative heavy metal test |
| Toluene based Scintillation cocktail | Non-ignitable Scintillation cocktail            | Radioactive experiments      |
| Chromic acid solution                | Ultrasonic baths, Alconox, base bath, acid bath | Glassware cleaning           |
| Mercury thermometers                 | Alcohol thermometers                            | Temperature                  |
| Solvents                             | Detergents/Hot water                            | Parts cleaning               |
| Oil based paint                      | Latex paint                                     | Painting operations          |

## Recycling

Another method of waste minimization is recycling. Recycled materials are used for another purpose, treated and reused for the same purpose, or reclaimed for another use rather than being discarded as waste. Examples include:

- Re-distilling used solvents (stringent standard operation procedures must be developed for recovering solvents since solvents can be extremely flammable or form explosive peroxides over time)
- Purchasing/renting gas cylinders and lecture bottles from manufacturers who will receive/recycle them after use
- Not contaminating used oil with heavy metals or halogenated solvents
- Collecting and reusing acetone, ethanol, etc. (for drying glassware) several times prior to disposal

## Treatment

The last technique for waste minimization is treatment. Wastes that are neutralized or detoxified and managed at the source can reduce environmental risks that might occur during transportation and handling. EH&S encourages in-lab chemical treatment **as the final step** of an experiment. *If a treatment is not part of the end step in an experiment (i.e. is done separately), it is considered a “hazardous waste treatment.” NAU does not have a permit to treat hazardous wastes in such a matter.* Before initiating treatment procedures please contact EH&S. Examples of final step experiment treatment include:

- Neutralizing acids and bases
- Inject gels directly with ethidium bromide to eliminate large volumes of liquid waste
- Precipitate metals out of solution to reduce volume
- Polymerize acrylamide solutions
- Use/convert through experimentation purchased EPA “P Listed” wastes such as potassium cyanide, osmium tetroxide, methyl hydrazine, 2,4-dinitrophenol, strychnine, vanadium pentoxide, etc. (a full list of P listed wastes can be found here: [https://www3.epa.gov/epawaste/inforesources/data/br91/na\\_apb-p.pdf](https://www3.epa.gov/epawaste/inforesources/data/br91/na_apb-p.pdf))

## Efficient Waste Management

Although waste is a natural product of research, teaching, testing, operations and maintenance, construction, etc. it can be minimized. The management of chemical waste is most efficient when waste types are properly segregated. Proper chemical waste segregation is safer, better for the environment and also reduces disposal costs.

The importance of proper chemical waste separation into various groups cannot be over emphasized. In most circumstances, the volumes and types of waste rather than the concentration, determine the cost of disposal. As a result, EH&S requests waste generators to make an effort not to dilute their waste anymore than necessary. **Do not mix hazardous chemical waste with non-hazardous waste, and NEVER mix hazardous waste with radioactive waste.** This includes Uranium compound mixtures with flammables, acids, bases, poisons, and/or other heavy metals.

The following section provides a brief paragraph on common laboratory reagents and bulleted ideas on how to minimize waste production. In some situations, these suggestions may be difficult or impractical. Use safe practices when considering these situations and consult EH&S with any questions or concerns.

### Flammable liquids

Flammable liquids are usually recycled and burned as a fuel in other manufacturing processes. Therefore, the more water contained in flammable liquids the higher the disposal costs. Suggestions for waste minimization include:

- Minimizing water content
- Keep separate from wastes that contain heavy metals, pesticides, cyanides, or P listed materials (for a list of P listed wastes, follow the link on page 3)
- Recycle or redistill solvents
- Investigate the use of nonflammable or environmentally friendly solvents

### **Flammable/Corrosive Compounds**

Flammable acid and flammable base disposal costs up to four times the amount compared to other flammable liquids. Waste minimization suggestions include:

- Minimizing unnecessary dilutions
- Not mixing acids/bases with flammable solvents
- Investigating the use of non flammable acids/bases
- Keep separate from wastes that contain heavy metals, pesticides, cyanides, or P listed materials (for a list of P listed wastes, follow the link on page 4)

### **Acids and Bases**

If not contaminated with other hazardous wastes, most acids/bases can be neutralized and drain disposed. Once again, this can only be done if the neutralization is **included in the experiment as a final step**. Diluting acids/bases with water is not considered neutralization and not allowed. Some acids and bases (such as chromic acid or barium hydroxide) cannot be rendered non-hazardous due to the heavy metal content. Do not attempt to neutralize hydrofluoric acid, perchloric acid, nitric acid, and other more complex, multi-hazard, caustic compounds.

- Minimize unnecessary dilutions
- Neutralize waste if possible
- Do not mix with other wastes
- Keep separate from wastes that contain heavy metals, pesticides, cyanides, or P listed materials (for a list of P listed wastes, follow the link on page 3)

### **Halogenated Solvents**

Many halogenated solvents are carcinogenic, are difficult to dispose of, and cost up to three times more for disposal compared to non-halogenated solvents. Keeping halogenated and non-halogenated wastes separate helps reduce disposal cost.

- Minimize unnecessary dilutions
- Keep separate from acids/bases
- Substitute non-halogenated solvents in place of halogenated where possible

- Keep separate from wastes that contain heavy metals, pesticides, cyanides, or P listed materials (for a list of P listed wastes, follow the link on page 3)
- Recycle or redistill solvents

## **Aqueous Metals**

Certain heavy metal solutions/compounds are more expensive to dispose of than others. These include any mixture with Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and/or Silver. It is important to note that volume in this category far exceeds concentration. 20 gallons of a 5 ppm Silver contaminated waste is more expensive to dispose of than 1 gallon of waste solution with 500 ppm of Silver. EH&S recommends the substitution of less hazardous metals for procedures that use the metals listed above.

- Keep heavy metal solutions separate from other wastes
- Keep mercury free from all other waste streams including other metal waste
- Minimize unnecessary dilutions
- Use micro-scale techniques
- Substitute/eliminate heavy metal catalysts

## **Miscellaneous**

Miscellaneous items comprise all other types of waste generated on campus. Obviously, this is a broad spectrum that includes used oil, paint, fluorescent light bulbs, batteries, ballasts, cleaning products, electronic devices, and many others. The best minimization practices for these items lie with the members of campus who purchase and work with them daily. If help with minimizing these wastes is needed, please contact EH&S.

## **Conclusion**

By taking responsibility for the byproducts of operations, Northern Arizona University community members can reduce the environmental and financial impact of waste generated on campus. Since individual generators of specific waste streams are the most familiar with their work and materials in their field, they are the best resource for waste minimization. Success of the NAU Waste Minimization Program is dependent on those who choose to participate.

Please direct questions, comments, or concerns about hazardous waste minimization to EH&S by email at [nauehs@nau.edu](mailto:nauehs@nau.edu).