ADVISORY NO. 7.2: WASTE REDUCTION

HAZARDOUS WASTE DISPOSAL CAN BE MINIMIZED BY THE FOLLOWING:

Planning experiments - the planning of every experiment should include consideration of the disposal of leftover starting chemicals and of the products and byproducts that will be generated. Elements to consider are:

- Recovery and reuse of material.
- Acquisition of chemicals only in quantities needed.
- Replacing a hazardous reagent with one that is less hazardous **(see Appendix 7.2A).**

Reduction of the scale of experiments - the use of microtechnology in the study of chemical reactions can lead to significant savings in cost of chemicals, energy, apparatus and space. Such technology makes it possible to optimize on a small scale the conditions for a reaction that is to be carried out on a preparatory scale so that the latter gives a high yield with minimal byproducts. It is now technically feasible to run many reactions with much smaller quantities of chemicals than were needed 25 years ago. Some of the technical advances that have made this possible are:

- Fast microprocessor-based, top loading balances that are sensitive to 0.1 mg.
- Chromatographic techniques that can clean, separate, and purify milligram quantities of substances.
- Sensitive spectrometers that can analyze milligram and microgram quantities of substances.
- Micro-scale glassware for handling reagents and reaction products.
- Flow and transfer systems based on small internal diameter metal and plastic tubing that make it possible to study flow-type reactions, catalysts and multi-step reactions on a very small scale, even under pressure.

APPENDIX 7.2A:

RECOMMENDED SUBSTITUTES FOR HAZARDOUS SOLVENTS

Solvent	Substitute	Comment
Methanol	Isopropanol	Methanol is highly toxic
Methyl Ethyl Ketone (MEK)	Acetone Ethyl Acetate Aliphatic Naphtha	
Toluene	Stoddard Solvent Varsol 1,1,1-Trichloroethane Acetone	
Trichloroethylene(TCE)	1,1,1-Trichloroethane Fluorocarbons	Trichloroethylene is a possible carcinogen and should not be used.
Xylene	Stoddard Solvent Varsol 1,1,1-Trichlorethane Fluorocarbons	

HAZARDOUS MATERIALS SUBSTITUTE

CHROMIC ACID SUBSTITUTES FOR GLASSWARE CLEANING - The following abstract of investigative work done by the environmental health and safety professionals at Rockefeller University is submitted by Terry Stimpfel.

Evaluation of 'Chromic Acid' Substitutes for Cleaning Laboratory Glassware:
by P. Manske, T. Stimpfel, and E. Gershey. The Rockefeller University, NY.

'Chromic Acid' is the traditional glassware cleaning solution of biochemists and chemists. However, the numerous hazards associated with it (not the least of which is the frequent lack of local ventilation to control volatile oxidation products) prompted the search for a less hazardous but equally effective alternative. Several common cleaning solutions in use on our campus were evaluated for their ability to remove known amounts of lipid and protein from glass test tubes, vials and rods. The solutions tested included:

- a dichromate solution added to sulfuric acid
- a preparation of ammonium persulfate added to sulfuric acid (APS)
- a 3:1 solution of sulfuric acid to nitric acid
- EDTA-organosulfanate based detergent added to water (EOS)
- a phosphate based detergent
- distilled water for a control

The efficiencies of these agents for removing dried on lipid (phosphatydal choline) and protein (bovine serum albumin) were evaluated using photochemical and radiochemical techniques following the soaking of coated glassware in the cleaning solutions for periods of 1 to 24 hours. After 1 hour, all solutions were 99% efficient in removing lipid, i.e., < 14 ng of lipid remained per sq mm of glassware.

In challenges with varying concentrations of protein, the dichromate, the 3:1 and EOS solutions were >99.997% efficient after a 24 hour soaking i.e., < 1 pg remained per sq mm of glassware. The APS was > 99.98% efficient (< 10 pg/sq mm surface area). The EOS detergent does not present serious physical or toxicological hazards or leave residues which interfere with standard molecular techniques for cell cultures. It is also economical and may be disposed of in the sanitary sewer. However, when a potent oxidizer is necessary, such as for the removal of insoluble contaminants such as inorganic metals, some of the 'chromic acid' associated problems can be avoided by using solutions of ammonium persulfate/sulfuric acid or the 3:1 sulfuric/nitric acid if a fume hood is available.

The major objection raised by investigators to these cleaning solutions is the lack of a color change as an indicator of effectiveness. This problem can be easily resolved by testing samples of the solutions with 2,2'-diphenylaminedicarboxylic acid, which changes color if the solution is still effective. Thus, substitutes for 'chromic acid' are available and effective for a wide range of glassware contaminants.