SAFETY
IN
CHEMICAL LABORATORIES

THE UNIVERSITY OF THE WEST INDIES
DEPARTMENT OF CHEMISTRY
MONA CAMPUS

EMERGENCY TELEPHONE NUMBERS

Health Centre	-	2270/2370/927-2520
Hospital	-	927-2537/927-1620-9
Police		
Gibraltar Rd, UWI, Mona	-	2331/2310/927-2298
Matilda's Corner	-	927-8219/926-6517
Toll Free	-	119
Kingston Fire Brigade	-	110

TABLE OF CONTENTS

A. SUMMARY OF RULES

1. Undergraduate students are not allowed to work alone and not without permission from a member of academic staff. They should never begin working until an instructor arrives.

2. All persons working in the Chemistry Department should make an effort, at the beginning of their period of association with the Department, to find out what is required of them in an emergency.

3. Know the location of all the extinguishers, showers and eye wash fountains and how to use them. Ask your Laboratory Instructor to demonstrate their use. Know the location of First Aid material.

4. Label all chemicals and solutions that are stored outside their original containers. Include your name and date of preparation. Handle all chemicals with care. Beware of poisons (avoid smelling and tasting unknown substances; do not use mouth suction on pipettes).

5. Tie up long hair, especially in the presence of open flames, and machinery. Restrain loose clothing.

6. Keep work areas clean and uncluttered; be a good housekeeper.

7. Never bring food, drinks or smoking materials into the laboratory.

8. Never work without approved eye protection (contact lenses should not be worn). Never work without approved laboratory apparel and never wear open-toed or open-top shoes.

9. Never heat **flammable** liquids over an open flame or outside a hood.

10. Do not underestimate the shock hazard of electricity.

Your laboratory instructor almost certainly will have a great deal more to say on the matter of safety. Pay very close attention when safety is discussed.

B. GENERAL RECOMMENDATIONS FOR SAFE PRACTICES IN CHEMICAL LABORATORIES

It is impossible to design a set of rules that will cover all possible hazards and occurrences. Some general guidelines are given below that experience has shown to be useful for avoiding accidents or injuries in the laboratory.

The most important rule is that everyone involved in laboratory operations – from the highest administrative level to the individual worker - must be safety minded. Safety awareness can

become part of everyone's habits only if the issue of safety is discussed repeatedly and only if senior and responsible staff demonstrate a sincere and continuing interest and are perceived by all their associates as doing so. The individual, however, must accept responsibility for carrying out his or her own work in accordance with good safety practices and should be prepared in advance for possible accidents by knowing what emergency aids are available and how they are to be used.

The laboratory worker should develop good personal safety habits: (a) eye protection should be worn at all times, (b) exposure to chemicals should be kept to a minimum, and (c) smoking and eating should be avoided in areas where chemicals are present.

Advance planning is one of the best ways to avoid serious incidents. Before performing any chemical operation, the laboratory worker should consider "What would happen if…?" and be prepared to take proper emergency actions

Over familiarity with a particular laboratory operation may result in overlooking or underrating its hazards. This attitude can lead to a false sense of security, which frequently results in carelessness. Every laboratory worker has a basic responsibility to himself/herself and colleagues to plan and execute laboratory operations in a safe manner.

C. GENERAL PRINCIPLES

Every laboratory worker should think, act and encourage safety until it becomes a habit, and observe the following rules:

1. Know the safety procedures that apply to the work that is being done. Determine the potential hazards (e.g. physical, chemical, and biological) and appropriate safety precautions before beginning any new operation.

2. Know the location and how to use the emergency equipment in your area, as well as how to obtain additional help in an emergency, and be familiar with emergency procedures.

3. Know the types of protective equipment available and use the proper type for each job.

4. Be alert to unsafe conditions and actions and call attention to them so that correction can be made as soon as possible. Someone else's accident can be as dangerous to you as any you might have.

5. Avoid consuming food or beverages or smoking in areas where chemicals are being used or stored.

6. Avoid hazards to the environment by following accepted waste disposal procedures. Chemical reactions may require traps or scrubbing devices to prevent the escape of toxic substances.

7. Be certain that all chemicals are correctly and clearly labeled. Post warning signs when unusual hazards, such as radiation, laser operations, **flammable** materials, biological hazards, and other special problems exist.

8. Remain out of the area of a fire or of personal injury unless it is your responsibility to help meet the emergency. Curious bystanders interfere with rescue and emergency personnel and endanger themselves.

9. Avoid distracting or startling any other worker. Practical jokes of horseplay cannot be tolerated at any time.

10. Use equipment only for its designed purpose.

11. (a) Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in appropriate order, and avoid adding solids to hot liquids.

    (b) Compressed gas cylinders must always be clamped in position, and when transported must be chained to the trolley and the valve protected by its cover.

12. Winchester (WQ) bottles should be carried only in the specially designed baskets.

D. HEALTH AND HYGIENE

Laboratory workers should observe the following health practices:

1. Wear appropriate eye protection at all times.

2. Use protective apparel, including face shields, glove, and special clothing or footwear as needed.

3. Confine long hair and loose clothing when in the laboratory.

4. Do not use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or an aspirator should be used to provide ‘vacuum’.

5. Avoid exposure to gases, vapours, and aerosols. Use appropriate safety equipment whenever such exposure is likely. Fume cupboards should be used when noxious fumes are involved in an exercise.

6. Wash well before leaving the laboratory area. However, avoid the use of solvents for washing the skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent might facilitate absorption of a toxic chemical.

E. FOOD HANDLING

Contamination of food, drink, and smoking materials is a potential route for the intake of toxic substances. Food should be stored, handled, and consumed in an area free of hazardous substances.

1. Consumption of food or beverages (and smoking are not permitted in areas where laboratory operations are being carried out.

2. Glassware or utensils that have been used for laboratory operations should never be used to prepare or consume food or beverages. Laboratory refrigerators, ice chests, and cold rooms should not be used for food storage; separate equipment should be dedicated to that use and prominently labelled.

F. HOUSEKEEPING

There is a definite relationship between safety performance and orderliness in the laboratory. When housekeeping standards fall, safety performance inevitably deteriorates. The work area should be kept clean, and chemicals and equipment should be properly labelled and stored.

1. Work areas should be kept clean and free from obstructions. Clean up should follow the completion of any operation or at the end of each day.

2. Wastes should be deposited in appropriate receptacles.

3. Spilled chemicals should be cleaned up immediately and disposed of properly. Disposal procedures should be established and all laboratory personnel should be informed of them. The effects of other laboratory accidents should also be cleaned up promptly.

4. Unlabelled containers and chemical wastes should be disposed of promptly, by using appropriate procedures. Such materials, as well as chemicals that are no longer needed, should not accumulate in the laboratory.

5. Floors should be cleaned regularly; accumulated dust, chromatography adsorbents, and other assorted chemicals pose respiratory hazards.

6. Stairways and hallways should not be used as storage areas.

7. Access to exits, emergency equipment, controls, and such should never be blocked.

8. Equipment and chemicals should be stored properly; clutter should be minimized.

G. GLASSWARE

Accidents involving glassware are a leading cause of laboratory injuries.

1. Careful handling and storage procedures should be used to avoid damaging glassware. Damaged items should be discarded or repaired.

2. Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated, and hands should be held close together to limit movement of glass should a fracture occur. The use of plastic or metal connectors should be considered.

3. Glass-blowing operations should not be attempted unless proper annealing facilities are available.

4. Vacuum-jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.

5. Hand protection should be used when picking up broken glass (small pieces should be swept with a brush into a dustpan).

H. FLAMMABILITY HAZARDS

Because flammable materials are widely used in laboratory operations the following rules should be observed:

1. Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure.

2. Use an open flame only when necessary and extinguish it when it is no longer actually needed.

3. Before lighting a flame, remove all flammable substances from the immediate area. Check all containers of flammable materials in the area to ensure that they are tightly closed.

I. COLD TRAPS AND CRYOGENIC HAZARDS

The primary hazard of cryogenic materials is their extreme coldness. They, and surfaces they cool, can cause severe burns if allowed to contact the skin. Gloves and a face shield may be needed when preparing or using some cold baths.

Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air because oxygen can condense from the air, which leads to an explosion hazard. Appropriate dry gloves should be used when handling dry ice, which should be added slowly to the liquid portion of the cooling bath to avoid foaming over. Workers should avoid

lowering their head into a dry ice chest: carbon dioxide is heavier than air, and suffocation can result.

J. SYSTEMS UNDER PRESSURE

Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should have an appropriate relief device. If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure build up.

K. UNATTENDED OPERATIONS

Frequently, laboratory operations are carried out continuously or overnight. It is essential to plan for interruptions in utility services such as electricity and water. Operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. Wherever possible, arrangements for routine inspection of the operation should be made and, in all cases, the laboratory lights should be left on and an appropriate sign should be placed on the door.

One particular hazard frequently encountered is failure of cooling water supplies. A variety of commercial and home-made devices can be used that (a) automatically regulate water pressure to avoid surges that might rupture the water lines or (b) monitor the water flow so that its failure will automatically turn off electrical connections and water supply valves.

L. WORKING ALONE

Generally, it is prudent to avoid working in a laboratory building alone. Under normal working conditions, arrangements should be made between individuals working in separate laboratories outside of working hours to cross check periodically. Alternatively, security guards may be asked to check on the laboratory worker. A worker who is alone in a laboratory should not undertake experiments known to be hazardous.

Under unusual conditions, special rules may be necessary. The supervisor of the laboratory has the responsibility for determining whether the work requires special safety precautions, such as having two persons in the same room during a particular operation.

M. ACCIDENT REPORTING

All accidents must be reported in **writing** to the Head of the Department by the person in charge of the laboratory or the room in which the accident occurred. An accident book must be kept for each laboratory.

N. EVERYDAY HAZARDS

Finally, laboratory workers should remember that injuries could and do occur outside the laboratory or other work area. It is important that safety be practiced in offices, stairways, corridors, and other places. Here, decorous behaviour is a safety requirement. Here, safety is largely a matter of common sense, but a constant safety awareness of everyday hazards is vital.

O. FIRE EMERGENCY AND PROTECTION

Introduction

The menace of fire is with us twenty-four hours a day and attacks impartially wherever safeguards are not adequate. The majority of fires that have occurred would not have occurred had certain elementary principles of safety been understood and put into practice by persons directly concerned.

The following have been prepared to help and should be studied and put into practice.

1. Prepare and Practice a FIRE PLAN as under;

    (a) establish a way of escape from each section or room of the building to a place of safety;
    (b) establish an alternative (or another) way out of the building or room;
    (c) practice your fire plan with every member of the Department on a regular basis. (Day and Night).

2. What To Do If Fire Breaks Out:

    (a) raise AN ALARM to warn others of the Emergency;
    (b) get everyone out of the room or building where the fire is; get children and helpless persons out of the building first on every suspicion of fire; and close the doors in order to confine the spread of fire and smoke. (See that everyone gets out of the building);
    (c) keep all doors and windows closed as this reduces the supply of air to the fire and it does not burn so fast;
    (d) do not go back into a burning building; you may not be able to come back out alive;
    (e) in thick smoke keep your head near to the ground where the air will be clearer;
    (f) call the FIRE BRIGADE using the quickest means, therefore make yourself familiar with the quickest means of calling the fire brigade.

3. Tackle the Fire

    A small fire is quickly trodden out or put out by an extinguisher. Note that:

    (a) speed is important in tackling the fire using the nearest available extinguishing agent, the most suitable extinguishing agent for fires in a home is water but water should not be used on electrical or flammable liquid fires;

(b) there are other types of fire extinguishing equipment that can be used and are readily available in some buildings, namely hand fire extinguishers and/or hose reels. For safe and effective use of these equipment, follow the instruction on the label.

Take care that it is not YOUR FAULT that YOUR BUILDING BURNS DOWN.

P. ADDITIONAL REGULATIONS FOR UNDERGRADUATE STUDENTS IN CHEMISTRY AT UWI, MONA

1. Good housekeeping is an important part of safety practice.

2. No student should work alone and unsupervised in any laboratory. There must always be a member of staff or demonstrator present.

3. No student may work outside the time allocated for his/her laboratory class unless the permission of a staff member has been obtained. In any event, such must be carried out only under supervision.

4. Students must have spectacles or safety glasses with them during laboratory sessions. It is recommended that they be worn at all times; they must be worn when directed to do so by a member of staff or demonstrator. They should always be used when working with corrosive or toxic materials.

5. No person other than those officially scheduled to be in the laboratory are allowed in, except by permission of the member of staff in charge.

6. All accidents and incidents must be reported to the member of academic staff in charge of the laboratory. Accidents and incidents to be reported include any case in which cuts or bruises are obtained, and also any case in which chemicals are ingested.

7. No undergraduate is allowed to go into the Technicians' room.

8. No undergraduates should make any adjustments to electrical appliances or fixtures without first consulting the technician or academic member of staff in charge of the laboratory.

9. Students should give thought to, and seek information on the proper and safe way to carry out any exercise. They should take note of the safety and first aid charts posted in the laboratory and learn from them.

10. Fume cupboards should be used when noxious fumes are involved in an exercise.

11. It is important to be aware that many acids and alkalis can damage the skin and clothing. Care should be exercised in the use of the substances.

12. Waste solvents should not be poured indiscriminately down the drain. They should be poured into the labeled containers provided for each solvent.

13. Cellular phones should be TURNED OFF during laboratory sessions where it would be disruptive. If there is an emergency, the cell phone should be placed on the vibrate mode and the lecturer, or other supervisors/persons in charge be notified of the need to keep cell phone on. However, in some cases, as allowed, students could use cell phones to function as a timer, calculator and to download relevant chemical data from the internet.

Q. SELECTED BIBLIOGRAPHY

1. Green, M. E.; Turks, A. "Safety in Working with Chemicals." McMillan, New York, N. Y. 1978.

2. Committee on Chemical Safety. "Safety in Academic Chemistry Laboratories, 3rd Ed." American Chemical Society, Washington D. C. 1979.

3. Committee on Hazardous Chemicals in the Laboratory. "Prudent Practices for Handling Chemicals in Laboratories." National Academy Press, Washington D. C. 1981.

4. L. Breather, (Ed). "Hazards in the Chemical Laboratory, 4th Ed. Chemical Society, London 1986.

5. Steere, N. V., (Ed). "CRC Handbook of Laboratory Safety". CRC Press.

6. Committee on Hazardous Substances in the Laboratory. "Prudent Practices for Disposal of Chemicals from Laboratories." National Academic Press, Washington D. C. 1983.

7. R. E. Hester, (Ed). "Industry and the Environment in Perspective." Royal Society, London 1983.

8. N. I. SAX. "Dangerous Properties of Industrial Materials." Van Nostrand.

9. "Manual in Spills of Hazardous Materials." Technical Services Branch, Environmental Protection Service, Environment CANADA 1984.

10. Manufacturing Chemists Association. "Guide for Safety in the Chemical Laboratory." Van Nostrand.

11. K. Guy. "Laboratory Organization and Administration." Macmillan.

12. K. Guy. "Laboratory First Aid." Macmillan.

13. K. Everett, E. W. Jenlun. "Safety Handbook for Science Teachers." John Murray.