

2.2. Laboratory Safety

As with any place of work, safety is an important consideration in soil, plant and water analysis laboratories, and one that is frequently overlooked. A safe working in a chemical laboratory needs special care, both in terms of design and construction of the laboratory building, and handling and use of chemicals. For chemical operations, the release of gases and fumes in some specific analytical operation are controlled through a fume hood or trapped in acidic/alkaline solutions and washed through flowing water. Also, ***some chemical reactions during the process of analysis, if not handled well, may cause an explosion.***

Analytical processes normally carried out at room temperature can be affected by differences in temperature so that an analysis performed in a “cold” room can give a different result to one performed in a “hot” room. Many chemicals are affected by the temperature and humidity conditions under which they are stored, particularly if these conditions fluctuate. The air temperature of the laboratory and working rooms should ideally be maintained at a constant level (usually between 20 and 25 °C). Humidity should be kept at about 50 %.

All staff, irrespective of grade, technical skill or employment status, should be briefed on all aspects of safety upon commencement of work. Periodic reminders of such regulations should be given to encourage familiarity with respect to regulations. Ideally, posters relatively to laboratory safety should be prominently displayed in the laboratory.

While rules pertaining to safety can be extensive, we have endeavored to concisely list the more important ones within different categories of concerns. These have been adapted from laboratory safety guides developed by Kalra and Maynard (1991) and Okalebo et al. (1993).

General Attitude

1. Develop a positive attitude towards laboratory safety
2. Observe normal laboratory safety practices
3. Maintain a safe and clean work environment
4. Avoid working alone

Instrument Operation

1. Follow the safety precautions provided by the manufacturer when operating instruments.
2. Monitor instruments while they are operating.
3. Atomic Absorption Spectrophotometer must be vented to the atmosphere. Ensure that the drain trap is filled with water prior to igniting the burner.
4. Never open a centrifuge cover until machine has completely stopped.
5. Use of balances:
 - The warming-up time of the balances is 30 minutes
 - Spilled chemicals should be removed immediately
 - Never blow away the spilled product
 - Brushes are supplied with the balances

Accidents

1. Learn what to do in case of emergencies (e.g., fire, chemical spill, etc.). Fire-fighting equipment must be readily accessible in the event of fire. Periodic maintenance inspections must be conducted.
2. Learn emergency **First Aid**, such supplies are a necessity and laboratory staff should be well trained in their use. Replacement of expended supplies must take place in a timely fashion.
3. Seek medical attention immediately if affected by chemicals, and use **First Aid** until medical aid is available.
4. Access to eye-wash fountains and safety showers must not be locked. Fountains and showers should be checked periodically for proper operation.

Chemicals

1. Use fume hoods when handling concentrated acids, bases or other hazardous chemicals.
2. Do not pipette by mouth; **always use a suction bulb**.
3. When diluting, **always add acid to water, not water to acid**.
4. Some metal salts are extremely toxic and may be fatal if swallowed. **Wash hands thoroughly after handling such salts or indeed any chemical regardless of toxicity**. Chemical spills should be cleaned promptly and all waste bins emptied regularly.
5. All reagent bottles should be clearly labeled and must include information on any particular hazard. This applies particularly to poisonous, corrosive, and inflammable substances.
6. For the preparation of reagents, only **distilled water (DI)** is used. Note that volatile acids, ammonia, nitrite, chlorine and carbon dioxide have to be removed by means of a column containing resin (deionizer) which will exchange the charged ions, is needed.

Furnaces, Ovens, Hot Plates

Use forceps, tongs, or heat-resistant gloves to remove containers from hot plates, ovens or muffle furnaces.

Handling Gas

Cylinders of compressed gases should be secured at all times. A central gas facility is preferred.

Maintenance

1. All electrical, plumbing, and instrument maintenance work should be done by qualified personnel.
2. **Fume hoods** should be checked routinely.
3. As most equipment operates on low wattage, an Un-interruptible Power Supply (UPS) provides stable power and allows the completion of any batch measurement in the event of power outage.

Maintenance of Pipettes

1. At the end of the working day, wash the pipette with tap water and then several times with distilled water.
2. Dry the pipette in an oven.
3. Keep the pipette upside down in a special clamp.

Eating and Drinking

1. **Do not eat or drink in the laboratory.** This is essential both for reasons of health, to eliminate any possibility of poisoning, and to reduce contamination. Specific areas should be designated for staff breaks.
2. Do not use laboratory glassware for eating or drinking.
3. Do not store food in the laboratory.

Protective Equipment

Body Protection

Use laboratory coat and chemical-resistant apron.

Hand Protection

Use gloves, particularly when handling concentrated acids, bases, and other hazardous chemicals.

Dust Mask

A mask is needed when grinding soil, plant samples, etc.

Eye Protection

Use safety glasses with side shields. Contact lenses should never be worn around corrosives. Make sure that your colleagues know if you wear contact lenses.

Full Face Shield

Wear face shields over safety glasses in experiments involving corrosive chemicals.

Foot Protection

Proper footwear should be used; sandals should not be worn in the laboratory.

Waste Disposal

1. Liquid wastes should be poured carefully down a sink with sufficient water to dilute and flush it away. Keep in mind that local ordinances often prohibit the disposal of specific substances through the public sewerage system.
2. Dispose-off chipped or broken glassware in specially marked containers.

Continuing Education

1. Display in a prominent place posters on "**Laboratory Safety**" which pictorially describe various phases of laboratory activities.
2. Similarly, posters depicting **First Aid** after laboratory accidents should be prominently displayed. Such posters are *not* for ornamentation; they are for the *protection of laboratory personnel*, who should be thoroughly conversant with all procedures and eventualities.
3. If the laboratory is a part of a large institution, the laboratory staff should know the **Safety Officer** or person responsible for safety. If it is a small operation, one laboratory staff member should be responsible for safety.

Contamination

Contamination is a most serious problem in any laboratory; therefore, its sources must be identified and eliminated. Some common sources of contamination are:

- External dusts blown from the surrounding environment
- Internal dust resulting from cleaning operations
- Cross-contamination derived from while handling many samples at the same time (e.g., handling plant and soil samples together)
- Failure to store volatile reagents well away from the samples
- Washing materials, particularly soap powder
- Smoking in the laboratory

Technical Remarks

1. The air-dry moisture in a soil sample taken straight from a hot and humid storeroom (or a very cold one) may be different from that in a similar sample kept in an air-conditioned laboratory; both may be weighed for analysis at the same time as "air-dry" samples.
2. The tap water supplied to a laboratory should be entirely free of pollution, as free as possible from insoluble matter, and under good and steady hydrostatic pressure. It may be necessary to filter the supply to certain pieces of equipment.
3. Drainage should be to a main drain if possible or to good-sized "soak-away". Effluents from soil laboratories contain considerable quantities of waste soil in addition to acid and alkaline liquids. The facilities should be provided in the design of the drainage system for periodic cleaning and removal of solid matter.