FEATURE

Fundamentals of productive laboratory inspections in academia

By Barbara L. Foster

INTRODUCTION
In academia, Safety Directors and Chemical Hygiene Officers oversee the health and safety of students and personnel who work and learn in two unique laboratory environments: the research laboratory and the academic laboratory. Why should we inspect these laboratories on a regular basis? Quite simply, inspections protect the health and safety of laboratory workers and students by identifying unsafe work practices and hazardous work conditions. Appendix A of the OSHA Laboratory Standard, 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories, contains a section entitled “Non-Mandatory National Research Council Recommendations Concerning Chemical Hygiene in Laboratories”. Section D.4.b. of Appendix A suggests that “Formal housekeeping and chemical hygiene inspections should be held at least quarterly for units which have frequent personnel changes and semi-annually for others; informal inspections should be continual.”

When performing laboratory inspections in academia, the inspector should:

- Ensure that the facilities provide a healthy, safe, and code-compliant environment in which to teach and learn.
- Ensure that the employees and students follow departmental and institutional chemical hygiene plans.
- Ensure that all laboratory activities are conducted in a prudent manner to avoid employee and student exposure to hazardous chemicals.

To protect laboratory employees and students from exposure to hazardous materials and unsafe work practices, the laboratory inspection checklist should include the following topics:

- Laboratory housekeeping, personal protective equipment, chemical storage and chemical waste, signs and labels, safety documents, laboratory chemical hoods, gas cylinder storage, emergency safety equipment, and physical plant concerns and security issues.

To facilitate your inspection efforts, an example of a laboratory inspection checklist is included in Figure 1. Note that the checklist is designed to incorporate “yes” or “no” answers and inspector’s comments. When preparing the inspection checklist, you should expand the comment section to allow ample room for the inspector’s written comments. All too often we forget important points after we exit the room. By taking careful notes, one will be able to create a more detailed and relevant inspection report.

THE INSPECTION CHECKLIST

Laboratory Housekeeping
Prudent Practices in the Laboratory: Handling and Disposal of Chemicals states, “There is a definite correlation between orderliness and level of safety in the laboratory.” Furthermore, the Handbook of Chemical Health and Safety states, “Most safety experts will agree that the principal cause of laboratory accidents is poor housekeeping.” Inspection items include:

- Access to aisles, emergency equipment, utilities, and exits should be kept clear (Figure 2). Hallways and stairways should not be used for storage areas.
- Coats, bags, and other personal items should be stored in the appropriate areas, not on the bench tops or on the floor.
- Bench tops and sinks should be clean and free of clutter, broken glass, spilled chemicals, and paper litter. Chemical hazards should be maintained at least two inches from the edge of the bench top.
- There should be no evidence of food or drink in the laboratory or equipment to prepare food or drink (i.e., microwave ovens and coffee makers).
- Drawers and cabinets should be kept closed when not in use.
- Equipment and apparatus should be properly stored when not in use.
- Hoods should be clean and contain only the chemicals that are being used for the work-in-progress.
- Floors should be clean and dry. Do not store chemicals or other materials on the floor.
- Glass disposal boxes must be replaced when full and all sharps should be disposed in proper containers.
- To avoid costly floods, check to ensure that all hose connections are properly clamped.
- Check for defective or frayed electrical cords on equipment.

Personal Protective Equipment (PPE)
PPE must be available to students and employees and must be compatible to the degree of potential chemical hazard. Laboratory workers should

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consult the label and the Material Safety Data Sheet (MSDS) for the hazardous material with which they are working to obtain information about proper PPE.

Inspection items include:

- Safety goggles that conform to ANSI Z87.1-1989, *Practice for Occupational and Educational Eye and Face Protection*, must be worn at all times when working with corrosive chemicals and when a splash hazard exits. A face shield (in addition to safety goggles) should be used when there exists a possibility of explosion or implosion. Protective safety glasses must be worn when working with lasers.
- Visitors and laboratory inspectors should wear appropriate PPE when they enter the laboratories.
- Gloves that are appropriate to the degree of hazard must be worn at all times when handling hazardous materials.
- Lab coats or aprons made of chemically inert materials should be worn in the laboratory.
- Personal apparel, commonly the first line of defense in the event of a chemical exposure, should be protective and appropriate to the degree
of hazard. Laboratory workers should wear clothing that sufficiently covers the upper and lower body. Open-backed shirts should not be worn in the laboratory. Shorts or short skirts are inappropriate apparel in the chemical laboratory. Long hair and loose clothing must be confined. Jewelry should not be worn in the laboratory. Chemicals can seep under jewelry and cause injuries to the skin. Jewelry can become caught in machinery and can conduct electricity.

- Shoes that completely cover the feet should be worn at all times. Open-toed shoes, open-backed shoes, high-heeled shoes, perforated shoes, sandals, or shoes made of cloth material should not be worn in the laboratory.

Chemical Storage and Chemical Waste
Inspecting tip: The four-point stance is very effective when conducting a laboratory inspection. On your hands and knees, you can peer into under-the-cabinet storage and under-the-hood storage to check for chemical compatibility and proper labeling (Figure 3). In-your-face odors in these storage areas may indicate a problem with the storage ventilation or choice of storage venue. Be especially curious about any cabinet or storage area that is blocked by carts, boxes, etc. These areas can frequently hide spectacular surprises for the inspector (i.e., a splendid mix of incompatible materials). Move any items that block your access and be sure to inspect all storage areas in the laboratory. The area that you did not inspect will inevitably contain the 10-year-old peroxide-forming chemical that can and will explode (usually at midnight) before the next scheduled inspection.

Inspection items include:

- Chemicals should be dated upon receipt and must be separated according to category and compatibility.
- Secondary containers must be properly labeled with the name of the chemical, known hazards, and name of manufacturer (Figure 4).
- To protect laboratory workers, chemicals should not be stored above five feet in height (Figure 5). Shelving should have lips to prevent accidents.
- Chemicals should not be stored in the fume hood.
- Do not store food or drink in the laboratory refrigerator or freezer.
- Secondary containment devices, such as trays, should be used where appropriate to avoid costly cleanups and potentially hazardous conditions in the event of a spill.
- The chemical inventory should be up-to-date.
- Chemical waste must be processed according to institutional policies.
Refrigerators and freezers should be cleaned and defrosted on a regular basis. Cleaning the refrigerator can provide a wonderful opportunity to update the laboratory chemical inventory and to make critical decisions about the worth of an item. Containers which have lost their labels or have cracked caps should be removed from the refrigerator. Missing labels and cracked caps must be replaced immediately (Figure 6).

**Figure 4.** Unlabeled beakers and flasks and spilled chemicals on the bench top can compromise the health and safety of laboratory workers and can precipitate substantial fines from federal inspectors.

**Figure 5.** These chemicals are stored on shelving that exceeds five feet in height, creating a health risk and potential disaster for the laboratory worker. The person in the photograph is standing on a stool, reaching up to grasp a bottle containing a liquid material. If she loses her grasp on the bottle, or suddenly loses her balance and tries to grab the shelves to avoid falling, any number of bottles of chemicals could be broken. The laboratory worker could sustain chemical burns, cuts, and exposure to hazardous materials and fumes when incompatible chemicals are mixed during a catastrophic incident.

**Signs and Labels**

The National Fire Protection Association (NFPA) 704 diamond label postings and emergency contact sheet information on the laboratory doors should be kept up-to-date. Record the 704 data for each room on the inspection sheet for your reference. Emergency contact sheets should contain the names, office phone numbers, and home phone numbers of the laboratory supervisor, the departmental safety director, and the director of the Department of Environmental Health and Safety. Lasers, high-voltage equipment, fire alarms, emergency telephones, safety showers, fire blankets, fire extinguishers, and safety eyewashes should be clearly marked with highly visible signs. Warning signs should be posted for areas of special or unusual hazards.

**Safety Documents**

Laboratory workers should have round-the-clock access to MSDS, emergency action plans, and the departmental and institutional Chemical Hygiene Plans. The emergency action plan should include procedures for fires, chemical spills, evacuation, ventilation failure, medical emergencies, and incident reporting. The chemical inventory should be updated on an annual basis and a copy should be available on-site for the laboratory inspector.

**Laboratory Chemical Hoods**

Laboratory chemical hoods should be used when working with toxic chemical vapors, dusts, gases, and volatile substances. Workers should keep their heads and bodies outside of the hood and listen for changes in the airflow. Except for the chemicals that are needed for the work-in-progress, chemicals should never be stored in the hood. Secondary containment devices should be present in all hoods. All chemicals and equipment should be positioned so that they do not block the back baffles and should be placed at least six inches from the hood face to ensure proper airflow. Large pieces of equipment should be raised on racks to facilitate the airflow in the hood. The workspace and the sash glass must be kept clean. The view should not be obstructed with posters, decals, or other items. Hood performance should
and showers must be located within 10 seconds of the hazard. Workers should have access to telephones and fire alarms on a round-the-clock basis. Fire blankets and first-aid kits should be available for use by laboratory workers.

**Physical Plant Concerns and Security Issues**

Make a list of all physical plant concerns, such as leaky faucets, unexplained odors, dirty floors, damaged ceiling tiles, temperature extremes, or light fixtures that require new light bulbs. To avoid theft of equipment and chemicals, check the door closers on all laboratory doors to ensure that they are closing promptly when personnel leave the lab. Frequently, personnel lock the door prior to exiting the laboratory and don’t check to see if the door has closed behind them. If the door closer is malfunctioning, they are unaware that there is a potential security problem. If there was no one in the laboratory during your inspection,

![Image](image_url)

**Figure 6.** Refrigerators and freezers should be cleaned and defrosted on a regular basis. Missing labels should be replaced immediately and unneeded chemicals should be removed from the laboratory. The haphazardly stored and improperly labeled round bottom flasks in the photograph present an obvious safety risk to the laboratory workers (and the intrepid inspector) when the freezer door is opened.

be tested on a regular basis and a tag or label should be attached to the hood to indicate the date of the testing and the test results in feet per minute (fpm).

**Gas Cylinder Storage**

Gas cylinders must be stored upright and properly restrained. Caps should be placed on unused cylinders. Cylinders must not block access to work areas or points of egress. Make note of gas cylinders with old dates and include this information in your report. Gas cylinders must be returned to the supplier on a regular basis to be properly inspected and tested. Gas cylinders are usually rented on a monthly basis from the supplier. The department can save substantial amounts of money in terms of demurrage charges if personnel expeditiously return their empty or unneeded gas cylinders to the supplier.

**Emergency Safety Equipment**

Eyewash stations, showers, and fire extinguishers must be inspected on a regular basis and the inspection dates and initials of the inspector should be written on the attached tags. Eyewashes

<table>
<thead>
<tr>
<th>Room Number</th>
<th>Principal Investigator</th>
<th>NPFA 704 Posting</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>Dr. Ethylene Ligand</td>
<td>4, 4, 4, W, OX</td>
<td>Nitric acid should be stored separately from the other acids. This laboratory should be cleaned and the aisles and emergency exits should be cleared. To avoid accidents, do not store chemicals over five feet in height. Send unused gas cylinder (nitrogen cylinder dated 1998) back to the supplier to save money in demurrage costs. Thoroughly clean and defrost the refrigerator.</td>
</tr>
<tr>
<td>246</td>
<td>Dr. Bunsen Burner</td>
<td>3, 4, 3, W, OX</td>
<td>Do not cover the 704 posting and the room number on the door with papers or decals. Write out all chemical names on the labels, do not use abbreviations. Contact Physical Plant Fire Control to arrange for the installation of a fire extinguisher in this laboratory. Incompatible chemicals are stored together under the hood. Return the compressed air cylinder dated 04-16-96 if not needed to save money on demurrage charges.</td>
</tr>
<tr>
<td>423</td>
<td>Dr. Jane Smith Dr. John Jones</td>
<td>3, 3, 3, OX</td>
<td>The researchers who share this laboratory are to be commended for the excellent level of housekeeping in this laboratory. No violations were noted during the inspection process.</td>
</tr>
</tbody>
</table>

**Figure 7.** Laboratory inspection report.
PART II
INSPECTION SUMMARY
HOUSEKEEPING
“There is a definite correlation between orderliness and level of safety in the laboratory.” I urge the chair to meet with faculty to discuss the results of the laboratory inspections and to plan a course of action to correct the safety violations that were cited. Researchers must adhere to the guidelines that are outlined in the departmental Chemical Hygiene Plan.

CHEMICAL STORAGE
“Strong oxidizers, such as nitric acid, perchloric acid, and sulfuric acid must be segregated from flammable chemicals. Such acids must be stored in separate rooms, separate cabinets, and in break-resistant containers if large glass bottles must be stored in proximity of flammable chemicals.” There are currently no nooks in this facility that were manufactured for use with perchloric acid.

“All chemicals should be stored only to eye level.” Personnel are storing their chemicals on the top shelves. Chemicals should be stored according to the MSDS and compatibility tables. For the researcher’s convenience, I have attached chemical compatibility tables to this report. Acetic acid should not be stored with other acids or bases. Nitric acid should not be stored with acetic acid or sulfuric acid. Concentrated strong acids (especially nitric, chromic, sulfuric, hydrofluoric) can cause severe and painful burns. Leakage from containers can cause corrosion of shelving and if the acids are stored with materials with which they react, accidents can occur from resulting reactions.” In general, chemicals should never be stored in a fume hood, since this may interfere with the proper operation of the hood and may increase the danger or damage in case of fire or explosion.

SECONDARY CONTAINER LABELING
Properly label all secondary containers to avoid accidents. Federal officials have been known to impose substantial fines for each improperly labeled chemical container. The Department of Chemistry must be prepared to pay these fines if the researchers do not choose to follow university, departmental, and federal regulations regarding container labeling in laboratories.

GAS CYLINDERS
Researchers should promptly return all unused/empty gas cylinders to the vendor to reduce the monthly departmental demurrage costs. The monthly demurrage bill could be significantly reduced if researchers returned their cylinders in a timely manner.

EXPLOSION-PROOF REFRIGERATORS
The refrigerators should be defrosted and cleaned in most of the research laboratories. A system is in place for the researcher to borrow a refrigerator on wheels from the Stockroom, place his/her chemicals in the borrowed refrigerator, and clean his/her refrigerator. These appliances are expensive to replace and will last longer if they are properly maintained.

REFERENCES
2. Chemical Hygiene Plan, State University Department of Chemistry; 2000; p. 7.
6. Chemical Hygiene Plan, State University Department of Chemistry; 2000; p. 54.

Inspector’s Name / Date

Figure 7. (Continued).

was the door locked when you arrived? Personnel in academia sometimes have to be reminded of the importance of taking appropriate security measures at all times in the chemical work place. Check the condition of the floor mats. Upturned ends can present a dangerous trip-and-fall hazard. Include the physical plant concerns and security issues in your official report and encourage the laboratory supervisor to call the appropriate officials to initiate the work orders for repairs. The appropriate departmental personnel should address all security issues in a timely manner.

THE INSPECTION REPORT
After the laboratory inspection, the inspector should prepare a detailed report and submit it to the laboratory supervisor, chair, and dean. Arrange a sit-down meeting in a comfortable setting with the laboratory supervisor and who have storage space or help her to find alternative storage sites within the facility. The report should include a date on which the inspector intends to return to perform a follow-up inspection. Be fair. Allow them enough time to rectify the situation. If the follow-up inspection reveals that violations continue to exist in the laboratory, disciplinary action may be taken against the laboratory supervisor by the dean or other university officials. A colleague once asked if disciplinary action was possible in an academic setting. My answer was a resounding “YES”. If the administration (i.e., university president, dean, or chair) is supportive of the departmental safety program, disciplinary action can be taken against personnel who knowingly and wilfully violate the departmental or university CHP or city, state, or federal codes. The key is to provide employees with copies of all requisite regulations and policies, appropriate training, and a friendly and helpful safety director who can and will answer their questions and help them with their safety-related problems.

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After the laboratory inspection, the inspector should prepare a detailed report and submit it to the laboratory supervisor, chair, and dean.
During the inspection process, always remember that your main objective is to protect the workers from exposure to hazardous chemicals and unsafe work practices. File a detailed inspection report with the laboratory supervisor, the department chair, and the dean. Conduct follow-up inspections, as needed. Inspect to protect your employees and students. Work Safely and Teach Safety!

References