**Risk Assessment** → **Safety Protocol**

Risk Assessment: The risk assessment (or hazards analysis) is a comprehensive approach to evaluating the safety challenges presented by a scientific experiment or process. Every aspect of an process must be thought out in advance so that the goal – safety – is achieved by identifying and controlling the hazards inherent in all steps of an experimental process. Each step is analyzed separately to identify the potential for an accident. Then, they are evaluated again collectively to determine if combinations of the elements could impact safety, and further reviewed to try to predict what could go wrong, and to assess the impact of a safety failure.

Safety Protocol (Safety SOP): The safety protocol is a document which describes the protective measures required for each hazard identified in the risk assessment. The safety document should be written so that any lab worker who will perform the experiment (for example the next group of students) would understand what hazards exist and how to safely conduct the work.

Follow the steps below to perform a risk assessment and develop a safety protocol:

1. For an experiment or scientific protocol or process, write the steps for the protocol.
2. Identify Hazards - for each step of the project, list potential hazards related to the materials used, equipment, the process, facilities concerns, human factors, and environmental conditions – anything that may raise a safety concern. Also list the hazards related to changing part of the project or the potential for synergistic effects. Do not forget to include hazards from routine storage, material transport, handling or disposal processes.
3. Review published lab accidents and incidents involving these materials, equipment or processes
4. For each hazard, think through the most likely accident scenarios including those that you may have found in your search. Note what could happen and the safety impact. For example, what might happen if a highly toxic chemical is spilled during weighing, or if a pyrophoric metal is exposed to air?
5. Consult the online [FSU Lab Safety Manual](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/Laboratory%20Safety%20Manual.aspx) and review literature for well-tested safety protocols and guidance.
6. Using the information from these resources, equipment manuals and technical information to identify mitigating precautions that would eliminate or reduce the hazard.
7. Using the information from these resources and what you already know has been or could be implemented, identify a combination of precautions and controls that together create both a primary and secondary safeguard for each hazard and combined hazards. These would include administrative (safety rules, operating procedures, supervisory approval), engineering (exhaust equipment and glove boxes, interlock switches, automatic shut down devices), work practices (e.g. buddy system, drills, scale-down, maintenance), and use of personal protective equipment (PPE) (gloves, lab coat, goggles).
8. **Develop a Safety Plan** that covers the entire process with all of the hazards and hazard mitigation strategies specifically identified. (The safety plan is a written document that describes the hazards and safety issues or concerns, and lists methods for eliminating or mitigating these hazards). List the steps of the scientific protocol and next to each step list the safety mechanisms to be employed. Don’t forget to include emergency response procedures for chemical spills or lab accidents.
9. **Emergency Response Procedures** should be included in the safety plan. Identify what might go wrong that could result in a fire, spill or injury. Identify procedures to address these events, including emergency contact information.
10. **Submit your Hazard Analysis/Risk Assessment/Safety Plan** to your supervising professor or assigned departmental mentor for review. Using the feedback provided, revise your safety plan.

Examples:

Below are some **EXAMPLES** of safety concerns that might be identified by your evaluation. These lists are examples only and are not all inclusive. Contact your supervisor.

Consider the following examples of hazards related to materials: Infectious materials, radioactive materials, hazardous chemicals: for chemicals--flammability, toxicity, explosivity, reactivity, corrosivity, thermal & chemical stability, inadvertent mixing, release of toxic gases, asphyxiant. Consider the potential for injury related to these hazardous materials.

Consider the following examples of potential hazards related to equipment and lab ware: cutting or crushing machinery, failure of materials integrity, incorrect size for volume used, poor maintenance, incorrect piping, electrical hazards, wrong tool for the job, lack of pressure relief systems, requirement for ventilation systems, lack of interlocks or special safety mechanisms, hard to close caps, fragile glassware.

Consider the following examples of process hazards: unsafe quantity or concentration, unsafe temperature, high or low pressure, high or low flow or composition, deviations from previously tested, potential for runaway reaction, increased risk of scaled up reaction.

Consider the effect of a change in design or conditions or the possibility of additive effects or unknowns: potentially more energetic or toxic, increase in potential for materials release, lack of expertise with new design or scale up, lack of knowledge about newly synthesized materials, untested or unfamiliar equipment, materials or processes.

Consider issues related to the facility: inadequate lighting, lack of hand washing sink, blocked egress, inadequacy of electrical circuits, lack of access to emergency electric cut-off switch, lack of proper ventilation and exhaust systems, lack of emergency response equipment, confined space, lack of proper storage, power outage.

Consider the availability for PPE or shielding or other protective devices.

Consider the potential human factors: working after hours, effect of cold or fatigue, inexperienced worker, new experiment, long work hours, poor command of English, student arrived late and is rushed, student is ill or upset, potential to affect medical conditions.

Consider the regulatory concerns: consider if the experiment requires licensing, is not consistent with FSU safety policies, lab is unsure of proper disposal methods, special training is required.

**Make sure that you are aware of emergency response methods. For an immediate emergency, call 911 and clearly explain your emergency.**

The [FSU online Laboratory Safety Manual](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/Laboratory%20Safety%20Manual.aspx) comprises safety policy and guidance for all FSU lab workers. A small search window in the upper right hand corner will permit researchers to obtain all pages that reference the search term. The Manual is created in sections that are listed, and on these pages are links to more information, as well as references to explanatory information and outside resources. The links and resources provided at the bottom of many pages contain important information regarding identification and hazard control. Refer to resources provided.

HAZARD MITIGATION – Strategies for reducing risk from identified hazardous materials, equipment, processes or conditions.

If the risk of injury is high and methods of reducing the risk are unattainable, consider alternative experiments. You should devise control measures to ensure that there is a very low likelihood of a serious worst-case accident.

* Can you eliminate it?
* Can you substitute a less hazardous alternative?
* Can you purchase/handle smaller amounts of the hazardous material or use commercially prepared solutions?
* Can you change the way the task is done?
* Is the facility adequate for the experiment?
* What controls may be used to reduce the risk to an acceptable level?
* Will you have to use personal protective equipment (PPE)? Is it available?
* Have the hazards (and alternatives) been adequately evaluated through research?
* Are regulatory concerns addressed?
* Has the effect on the environment (ultimate fate of materials) been considered?
* Is emergency response equipment available and accessible?
* Have you discussed the hazards with senior laboratory personnel to identify alternatives and to check the efficacy of the safety measures you have in place?
* Have individuals been properly trained regarding all aspects of the experiment and emergency procedures?
* Is there a language barrier that might impede an emergency call? Do you have questions about how to obtain help in an emergency?
* Think again about what could go wrong...has each step of the process been evaluated and address for safety?

The following methods of eliminating or reducing risk are used in planning a safe project. Identify a combination of safety methods and personal protective equipment ([PPE](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/personal%20protective%20equipment%20and%20clothing.aspx)), as described below - including the use of exhaust equipment, special transfer devices, appropriate glass or plastic ware, personal protective equipment, and special handling protocols - to remove or mitigate the hazard. Make sure that the equipment, methods and [PPE](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/personal%20protective%20equipment%20and%20clothing.aspx) are functional and appropriate for the proposed use:

* **Administrative Controls**: Administrative controls are strategies and policies that eliminate or mitigate the risk of harm. These may include personnel policies like training requirements prior to obtaining entry to work areas or class policies for proper attire while performing work. Requirements for following workplace safety rules are essential to maintaining a safe workplace. Among these are requirements for good housekeeping, participation in emergency drills, heeding postings and labels, demonstration of knowledge and understanding of hazards and risks, and participation in safety programs and training.. The use of good facility design, including identification of proper chemical storage areas, is also part of an administrative approach to minimizing risks. Further, students should consult with faculty mentors or other experts for assistance in mitigating a workplace hazard
* **Engineering controls**: The use of exhaust systems is essential to protection against a hazardous materials exposure when working with volatile chemicals, hazardous particulate agents and with processes that could make radioactive or biohazardous materials airborne. Other important engineering controls include the use of shielding; equipment guards, monitors and alarms connected to interlock devices; gloveboxes; safety caps; filters; warning lights; barriers and pressure relief mechanisms.
* **Work Processes**: Incorporate work processes that minimize the risk of illness or injury by utilizing exhaust systems; purchase and handle smallest amount of hazardous materials suitable to the experiment; have only necessary materials in the workspace; follow important safety/scientific requirements for labelling and use of appropriate containers; clean up spills and decontaminate before proceeding to the next step; carefully monitor reactions or have shut-down mechanisms in place.
* **Personal Protective Equipment**: The use of [PPE](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/personal%20protective%20equipment%20and%20clothing.aspx) is often employed to further reduce risks of injury or illness that are already reduced through other measures.  [PPE](http://pub.extranet.fsu.edu/sites/safety/safetywiki/Wiki%20Pages/personal%20protective%20equipment%20and%20clothing.aspx) should not be the first or only method of protection except in rare circumstances, for example, when one is working in the field. Generally, engineering controls are employed, along with administrative controls and special work practices, to “engineer out” the hazard.

Plan ahead to ensure that you completely understand your project, have evaluated the hazards, and have prepared a procedure that is safe to carry out.

* **Become thoroughly knowledgeable** about the processes, equipment and materials. All experimental designs should be discussed with the faculty mentor to identify potential hazards, to learn how to work safely and how to respond if something goes wrong.
* **Document research** your research on hazards so that this information may be utilized in the event of an emergency. Download the chemical SDS or other appropriate sources for hazard information.
* **Discuss experimental design** with the faculty mentor and other departmental staff to address all aspects of safety. Carefully consider each hazardous material, equipment and process and make sure that all questions you have regarding these have been answered. Discuss the use of safety equipment and PPE. Discuss/develop emergency response procedures.
* **Responsibility for Unattended Experiments and Working Alone** – No hazardous work should be undertaken when working alone. For low risk activities, workers using the space after-hours must have permission of their supervisors, who should be made aware of the activities that will be performed. According to the National Research Council as stated in “Prudent Practices in the Laboratory”, “It is the responsibility of the worker to design experiments so as to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water and inert gas. Room lights should be left on, and signs should be posted identifying the nature of the work and the hazardous substances in use. If appropriate, arrangements should be made for other workers to periodically inspect the operation. Information should be posted indicating how to contact the responsible individual in the event of an emergency.”  These methods must be approved by the faculty mentor prior to implementing them for the project. All unattended lab operations must have prior approval of the Faculty mentor or department safety personnel.