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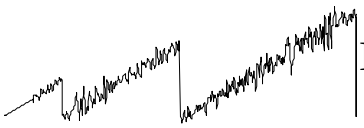

NEES at CU Boulder

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The George E Brown, Jr. Network for Earthquake Engineering Simulation

CU-NEES
Safety Manual and Risk Mitigation

by

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1. CU-NEES Laboratory Specific

Working in any laboratory setting is not without its risks. Recognizing potential hazards and planning in advance is paramount to minimizing the probability of any accidents occurring. Risk reduction is a shared responsibility among all laboratory users and efforts to identify and mitigate all potential hazards are an obligation and condition of use at the SMTL. While the management and staff of the SMTL strive to maintain a safe, quality, testing environment, responsibility for your own personal safety rests with you. Also, be aware that your actions within the laboratory influence the environment we all work in and monitor your own behavior with that in mind. Please feel free to bring any concerns and/or suggestions to the attention of the lab staff at any time.

Below is a summary of the most important safety requirements for the use of the SMTL/NEES facility. Please be sure to review them prior to using the laboratory, as they will be enforced.

All University of Colorado personnel are fully insured through the University Risk Management System. This insurance program, which includes a standard worker's compensation provision, is in force whether the employee is at work on campus or off. This coverage extends only to university employees. It is expected that visiting researchers to the SMTL/NEES laboratory will carry in full force similar coverage from their respective institutions. A waiver acknowledging such must be signed and presented to the Operation's Manager prior to the initiation of any work within the laboratory.

Nothing in this manual or other documents obtained through the SMTL is intended to imply insurance coverage or indemnification of liability that is inconsistent with the provisions of Colorado law.

1.1 Personal Protection Equipment (PPE)

Protect yourself from injury. Wear closed toed and heeled shoes, preferably ones with reinforced toes, and long pants. Safety glasses are required at all times when in the lab. Make use of the laboratory's free safety and protection gear; wear a hard hat when operating heavy/large equipment or when using the forklift or overhead cranes, wear ear protection when using noisy tools, wear proper gloves when handling hazardous materials, use a respirator when dealing with hazardous solutions/fumes, and put on a dust mask when working with dust-producing materials.

Please note that it is the responsibility of the Principal Investigators (PIs), not the SMTL, to provide their researchers with PPE. The SMTL has some PPE available for short-term usage with a priority given to Lab Class students; no consumable safety gear will be given to researchers.

1.2 Notification

Fill out and submit an SMTL Research Information Sheet (Form RIS1B60) to the SMTL staff office at Engineering 1B64, and notify lab assistants WHENEVER you work on anything in common lab space. Calendars of lab activity are posted outside the 1B60 office, and can be used to coordinate activity.

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Civil, Environmental and Architectural Engineering
Campus Box 428
Boulder, CO 80309-0428,
Lab Foreman: michael.eck@colorado.edu
Operations Manager: thomas.bowen@colorado.edu.

1.3 Hazardous Materials

All persons conducting research using ANY chemicals in the SMTL MUST review the information on storage, use, and disposal of hazardous materials located at http://ehs.colorado.edu/. University policy dictates that generators of hazardous waste receive specialized training through the campus department of Environmental Health and Safety (EH&S). Storage and use of all chemicals will be strictly regulated by laboratory staff with final approval of use being determined by the Operations Manager. All laboratory staff has received this training and the Operations Manager is certified to provide guidance and direction in matters relating to hazardous materials. Please refer any questions or concerns to the appropriate laboratory personnel.
Additionally, all chemicals to be used in the SMTL must be listed in the Research Information Sheet(RIS1B60) filled out by each laboratory user prior to initiating any work in the laboratory. Again, this sheet may be found in the appendix of this manual.

1.4 Specified Areas

Only handle hazardous materials in their designated areas. Dispose and store hazardous materials appropriately. If you are not sure of designated areas and/or appropriate disposal and storage locations, please contact Michael Eck in the SMTL office at 303-735-0947 or michael.eck@colorado.edu, or contact Tom Bowen at thomas.bowen@colorado.edu.. We are here to assist you with your research.

1.5 Materials and Machinery

Please use only tools, materials, and machinery you are familiar with and only for their designed purpose; always notify a lab assistant first. When finished, please return all equipment to original location in same condition as they were found. Laboratory personnel are available to assist you. Please ask for their help rather than risking personal injury or damage to any equipment.
Operation of the forklift and overhead crane is restricted to trained laboratory personnel. The Operation's Manager or his designee may make exceptions on a case specific basis.

1.6 Equipment and Tools

Most electrical equipment and tools are contained in a limited access storage area. You may sign-out these items Monday-Friday from 8am - 5pm with a lab assistant. Tool loaning is at the lab assistants' discretion—they must be comfortable with your abilities using the tool. Please remember to return them, so a lab assistant can sign them back in and make them available for other lab users.

1.7 Basic Rules

1. The SMTL is not a walkthrough lab. Be aware of other researchers/experiments.
2. Keep doors closed at all times and locked after 5pm, Monday - Friday and all weekend.
3. Observe Safety Rules for Hoisting
4. Keep Areas Clean and Uncluttered
5. Return Tools as soon as Possible
6. DO NOT Modify Tools for your own use
7. Notify Lab Manager of broken machinery and tools
8. DO NOT store Chemicals in Unlabeled Containers
9. DO NOT Dispose of Chemicals or non-water solvent wastes down the Drain

1.8 Acknowledgement of Safety Introduction and Orientation to SMTL and Liability Waiver

In section 5 you will find 2 pages that must be filled out and returned to the Operations Manager prior to test initiation in the laboratory; a User Agreement and Acknowledgement of Safety Orientation, and Waiver of Liability Form.

Also, see attached EH&S manual for fire safety, hot work, welding/cutting, and work with compressed gas. If necessary, fill out forms included.

2. Safety Protocol and Guidelines for Structures Materials and Testing Laboratory

As always in the lab, correct safety equipment must be worn. This includes closed-toed shoes and glasses as the very minimum. Additional safety measures must be taken when working with specific equipment. Follow these guidelines at all times in the lab.

2.1 Awareness

BE AWARE: This is one of the most important safety rules to follow at all times. Always be aware of your surroundings. Pay attention to the area in which you are working. Make sure that there are not materials lying around that could cause a safety hazard. Also be aware of people around you and those who may walk by. Although this is not a walk-through lab, there are often people in here. If you are unsure about the operation of any equipment or the safety concerns involved, ask someone who knows or look it up. Take all the appropriate steps to ensure your and their safety.

2.2 Power Tool Safety Checklist

2.2.1 General:

When working with any of the power tools kept in the lab, be sure to put on proper safety gear before you use the equipment. This includes: Close-toed shoes, Safety goggles, Gloves, No loose clothing or hair

Make a plan for the use of the equipment and prep your work area before use. Be familiar with the power tool you are planning to use; **if you are not familiar with the equipment ask for assistance.**

Equipment: **Always inspect the equipment for excessive wear before use!!!**
Clean your tools when you are done with them.

2.2.2 Power Saws:

1. Only use the saw as it is intended.
2. Keep hands and body parts away from blade.
3. When applicable, use clamps or guards (i.e. clamp on steel chop saw)
4. If you change a blade, make sure it is the right blade (size, arbor size and style, rpm rating) and that it is in the correct orientation, as well as tightly secured.
5. Be sure to ask for assistance if the object you are cutting is too large for you to handle (i.e. if you need someone to catch when using the table saw)

2.2.3 Power Drills:

1. Be sure to use correct bits (i.e. wood bit for wood, concrete bit for concrete)
2. If using the mill or drill press, be sure not to drill into the platform. Either set a depth stop or use a piece of scrap under the object you are drilling.
3. If possible, use a clamp to prevent the object from spinning out of control. If it is not possible, make sure to have a good grip on the material because the bit can bind in the hole and rip the material out of your hands. This hurts and can cause serious injury, especially if you hand goes into the spinning bit.
4. When cutting metal, always use the proper cutting fluid. If you don't, it will burn up our bits.

2.2.4 Air Nailer/Stapler:

1. Be sure the pressure on the compressor is set to the correct setting for the specific tool. Do Not use excessive pressure.
2. Only use with wood.
3. Make sure the wood is not terribly split out as it may actually split in two when using the nailer.
4. Make sure people are clear of you because the gun has a tendency to double shoot, which can cause the second nail to fly out of the side.

2.2.5 Remington Powder Nailer:

1. Wear additional protective equipment including ear protection and a hard hat. It is loud and the force of the nail can cause the concrete to chunk and shatter.

2. Notify people that you are using this tool and keep people clear because of the noise and flying objects.
3. Only use charges and nails that are approved.

2.2.6 Grinders:

1. Clean and inspect area around you before starting. Make sure there are no flammable things near.
2. When grinding, pay attention to where the sparks are flying.
3. Do not grind aluminum on bench grinders.
4. Use appropriate wheels (size, arbor, material, rpm) and make sure they are in the correct orientation.
5. When using cut-off wheels on the handheld grinders, be sure to position yourself out of danger. The wheels may bind with the material and shoot the grinder back.
6. Make sure wheels are in good shape. Otherwise, they can chunk and shoot pieces of the wheel out.
7. Make sure material is correctly supported so they don't fall on you or others when the cut is complete.

2.2.7 MIG Welder, Plasma Cutter:

1. Make sure you have had hands on training before use. Ask for help if you have not or are not sure of anything.
2. Keep all flammable things away.
3. Be sure there is good contact for ground connection.
4. Make sure pressure on tanks are at appropriate levels.
5. Wear welding mask. Be sure that the lens is the correct one. No light should be shining through.
6. Wear appropriate leather gloves that protect your arms. The material gets extremely hot extremely fast in addition to the sparks flying.
7. Do not attempt to handle material after use. It will be very hot. Allow time to cool.
8. When possible, work outside with door shut. If not, be sure to work in the east lab and turn the hood on.

2.2.8 Slug Cutter:

1. Make sure you have had hands on training.
2. Be sure you have enough cutting fluid.
3. Cut at a steady pace as the material will heat-harden and burn up our bit if you start and stop or jam bit into material with varying force.
4. Follow correct usage procedure from training or manual.

2.3 Lifting Safety

Whenever lifting object above your head, regardless of lifting method, be sure to wear:

1. Safety Glasses
2. Hard Hat

Take the extra time to lift safely and correctly.

2.3.1 Awareness

1. Be aware of people and equipment around you so nobody gets hit with what you are lifting.
2. Make sure you use the correct pick points when lifting equipment.
3. Think about the next person who will be lifting what you are moving
4. Make sure they will be able to get under it to pick it up (put it on blocks)

2.3.2 Crane Safety

Straps: Make sure all straps are in good shape and are rated high enough for what you are lifting. Make sure that the object you are lifting is balanced.

3 ways to use straps:

-Choker- Least strength
-**Vertical-** Medium strength
-**Basket**- Strongest

Clevises: Make sure clevises are in good shape and rated high enough. Tighten clevise completely, then back it off ½ of a turn before lifting.

Tag Line: Always attach a tag line to what you are lifting to keep it balanced and in control while in the air.

Clearance: Make sure you have clearance along any walls you are lifting by, crane can rip stuff off the wall (i.e. pipes, wires, conduit). Make sure you have vertical clearance if moving something over another object (can't go over South Stack).

Moving to the loading dock: Make sure wedge is in before moving crane out the door.

Be sure that crane has capacity to lift what you are moving.

2.3.3 Fork Lift Safety

Parking Brake: Set the parking brake when done with the fork lift. Also set the parking brake when lifting someone in the bucket.

Capacity: Fork lift has a capacity of 3500 Lbs., do not exceed.

When using straps to lift with the fork lift, you must use clamps to prevent straps from slipping off.

***When done with the fork lift, put forks on the ground or hidden under something so no one trips over them.**

2.3.4 Manual Safety

Do not over lift, if it is too heavy get help.

2.4 Hydraulic Safety Protocol

2.4.1 Hydraulic Components in SMTL

On a day to day basis, we may use any of the three hydraulic pumps associated with the lab. This may include working with any of the three MTS machines, any of the three Actuators, and any other component of the hydraulic systems. We may work on hydraulics during periods of routine maintenance as well. The forklift also utilizes hydraulics for lifting.

Hydraulic equipment is designed to accomplish work using confined liquid pressure to produce a greater mechanical force. The operator is subjected to hazards from high-pressure liquids and large mechanical forces. Either of these forces, when out of control, have the potential to cause enormous damage and great bodily injury. All safety devices should be in place and in good condition before the equipment is put into operation. The operator must have a thorough knowledge of how the equipment operates, and the task to be accomplished before the equipment is used. Safety glasses are mandatory when operating hydraulic equipment.

2.4.2 Introduction to Hydraulics

1. Hydraulic systems must store fluid under high pressure using accumulation.
2. Safe hydraulic system performance requires general maintenance.
3. Proper coupling of high and low pressure hydraulic components and pressure relief valves are important safety measures.

2.4.3 Hazards of Hydraulics

1. Burns from the hot, high pressure spray of fluid
2. Bruises, cuts or abrasions from flailing hydraulic lines
3. Injection of fluid into the skin
4. Fire and explosion from Conveyed Fluids, or Static-Electric Discharge
5. Electric shock- hydraulic hoses are conductive and may carry charge

2.4.4 Pinhole Leak Injuries

Pinhole leaks are difficult to locate. A person may notice a damp, oily, dirty place near a hydraulic line. Not seeing the leak, the person runs a hand or finger along the line to find it. When the pinhole is reached, the fluid can be injected into the skin as if from a hypodermic syringe. Immediately after the injection, the person experiences only a slight stinging sensation and may not think much about it. Several hours later, however, the wound begins to throb and severe pain begins. By the time a doctor is seen, it is often too late, and the individual loses a finger or entire arm.

To reduce the chances of this type of injury, run a piece of wood or cardboard along the hose (rather than fingers) to detect the leak.

2.4.5 Improper Coupling

Another hazard is improper coupling of low- and high-pressure hydraulic components. Do not connect a high-pressure pump to a low-pressure system. Do not incorporate a low-pressure component, hose or fitting into a high-pressure system. Component, hose or fitting ruptures are likely to occur.

Make sure to use appropriate hoses for the system. Never use a hose rated lower than the intended pressure for the system. Be aware of the minimum bend radius of hoses, and use elbows and adapters when necessary. Design hoses for change in length due to machine motion and tolerances.

2.4.6 Fire and Explosion Risks

Fires and explosions can occur even with fire-resistant hydraulic fluids under certain conditions. Escaping fluids may form a mist or fine spray, which can explode upon contact with an ignition source. Fluids passing through the hose may generate static electricity, which can ignite fluids under static-electric discharge conditions.

2.4.7 Accumulators

Accumulators can become lethal projectiles if disassembled when pressurized. To ensure safety during disassembly, relieve the nitrogen pressure using the accumulator charging kit. Ensure that hydraulic pressure is at zero before routine maintenance operations. Make sure to use the right type of gas, because mixing gasses can produce unpredictable results. Avoid rapid and extreme pressure changes, which can damage valve seals. Transferring gasses from high to low pressures creates freezing temperatures, this occurs when venting pressurized gas.

2.4.8 Maintenance

An improperly maintained hydraulic system can lead to component failures. Safe hydraulic system performance requires general maintenance.

1. Weekly checks for oil leaks and worn hoses.
2. Keep contaminants from hydraulic oil and replace filters periodically.
3. Check accumulation monthly, more frequently in special cases.
4. Be aware during routine operations of any changes in the behavior of hydraulic systems

2.4.9 Tips for Safe Operation

1. Never service the hydraulic system while the machine engine is running unless absolutely necessary (bleeding the system).
2. Do not remove cylinders until the working units are resting on the ground or securely on safety stands or blocks; shut off the engine.
3. When transporting the machine, lock the cylinder stops to hold the working units solidly in place.
4. Before disconnecting oil lines, relieve all hydraulic pressure and discharge accumulators to avoid lethal projectiles
5. Be sure all line connections are tight and lines are not damaged; escaping oil under pressure is a fire hazard and can cause personal injury.
6. Always use hoses appropriate for the system with correct specifications
7. When washing parts, use a nonvolatile cleaning solvent.
8. To ensure control of the unit, keep the hydraulics in proper adjustment.

3. University of Colorado - Environmental Health and Safety Guideline

3.1 Safety Procedures For The Use Of Compressed Air

The use of compressed air presents numerous hazards, especially when it is used incorrectly to clean off skin and clothing. The following practices are recommended to prevent injuries.

1. Hose and hose connections used for conducting compressed air to utilization equipment shall be designed for the pressure and service to which they are subjected.

2. Workers should never use compressed air for cleaning themselves or their clothing; nor should compressed air be aimed or sprayed at others. Only employees who have been properly trained and suitably protected should be involved in compressed air operations. Others should not be in the immediate work area.
3. Compressed air will blow particles about. Look for other alternative ways of accomplishing the cleaning. Perhaps exhaust ventilation (with filters) would do the job, or an industrial vacuum system could capture waste materials as they are generated or during cleanup.
4. Compressed air for cleaning purposes may not exceed 30 pounds per square inch (PSI), and then only with effective chip guarding and personal protective equipment. Hoses with approved safety nozzles that meet OSHA standards (30 psi) should be used.
5. The condition of air hoses must be checked regularly and before each use. Training sessions should include showing examples of worn or defective connectors or hoses.
6. Flexible air lines should be fastened down to prevent whipping in the case of a broken line. A dislodged or broken hose line, lashing about, can cause serious injury.
7. Before disconnecting a hose from an air line, workers should shut off the source and bleed the remaining air from the line.
8. After use, air hoses should be returned to a safe storage space.
9. Where compressed air is to be used, designate specific cleaning procedures and specify the appropriate personal protective equipment for each operation. In some cases that may be as simple as safety goggles or eyeglasses with side shields; greater exposures may require full face shields or hoodtype respirators. Gloves are often recommended.
10. Pneumatic tools used on or around energized lines have non-conducting hoses and an accumulator on the compressor to collect moisture.
11. Retainers are required on impact tools to prevent the accidental release of fasteners or paints and other fluids.
12. All hoses exceeding one-half inch inside diameter must have a safety device at the source of the supply or branch line to reduce pressure in case of hose failure.

3.2 Precautions For Hot Work

3.2.1 Building Systems

1. Fire sprinklers kept operational
2. Building ventilation protected from smoke and fumes
3. Fire alarm system kept operational; detectors removed only if necessary in the vicinity if they would likely be activated by the work; Facilities Management Fire Alarm Group requires at least 72 hours notice to perform these functions.
4. Cutting and welding equipment in good operating condition

3.2.2 Personnel / Occupant Protection

1. Workers protected from smoke, fumes, toxic materials by use of exhaust ventilation or other approved safety measures
2. Vision screens / barriers in place
3. Confined space entry permit / procedures in place

4. Energized equipment locked / tagged out of service
5. Workers properly trained in use of equipment

3.2.3 Within 35 Feet Of Work

1. Floors swept clean of combustibles
2. Combustible floors swept down & covered with damp sand, metal or other spark / heat shields
3. Combustible and flammable materials removed
4. Fixed combustibles and flammables covered with covers, guards, and/or shields
5. Wall and floor openings covered with non-combustible covers
6. Covers suspended beneath work to collect sparks

3.2.4 Work On Walls Or Ceilings

1. Construction must be non-combustible and without combustible covering.
2. Combustibles moved away from opposite side of wall and second fire watch provided

3.2.5 Work On Enclosed Equipment (tanks, ducts, plenums, etc.)

1. Confined space entry permit / procedures
2. Compressed gases out of confined space
3. Equipment empty, cleaned of residues, pressure released, purged of vapors, gases shut off

3.2.6 Fire Watch (at work site)

1. Fire watcher shall be present during and for 30 minutes after operation. Fire watcher shall search for any smoldering or flaming ignition and extinguish any such sources.
2. Fire watcher shall be supplied with hose and fire extinguishers of proper size and type and be properly trained in use of same.
3. Fire watcher shall be trained in emergency procedures and activating fire alarm.
4. The permit applicant or their representative shall protect all combustibles from hot work ignition sources. This includes sealing of floor and wall penetrations.
5. Fire watcher shall stop hot work if any of the safety precautions cannot be met.

3.2.7 Additional Building Fire Watch Code Requirements Intent Of Fire Alarm System

The intent of National Fire Protection Association (NFPA) 72 for a protected premise connected to a central monitoring station, requires the fire alarm system to: notify occupants to evacuate when there is a fire in the building, notify the central monitoring station (Facilities Management Service Desk) to initiate emergency personnel response, and activate fire protection systems, e.g., release door holders and shut down fans.

3.2.8 When Building Fire Watch Is Required

1. When, in the opinion of the Authority Having Jurisdiction (FM FPG), it is essential for public safety, one or more qualified persons are to be on fire watch duty (Uniform Fire Code, sec.25.117).
2. In the event of temporary failure of the alarm system or an excessive number of accidental alarm activations, the Jurisdiction's authorized representative may require the building owner or occupant to provide stand-by personnel until the system is restored (UFC, sec.14.110).
3. When work necessitates disabling any fire detection, suppression or alarm system component which would conflict with the intent of NFPA 72.
4. Whenever welding or torch cutting is performed in locations where other than a minor fire might develop, or any of the conditions required by NFPA 51B exist, as indicated on the Hot Work Permit.

3.2.9 How Building Fire Watch Is Accomplished

1. Fire watch personnel are to keep diligent watch for fires and are not to perform any other simultaneous duties.
2. Fire watchers are to be familiar with facilities and procedures for sounding an alarm in the event of a fire. The fire watch is to have planned a response method meeting the intent of NFPA 72 (see A.
3. above).
4. Fire watchers are to have fire extinguishing equipment readily available and be trained in its use, including practice on test fires.
5. Fire watchers are to look for signs of fires in all exposed areas, and try to extinguish fires if it can be done safely and within the capacity of the equipment available, and after sounding the building fire alarm to summon emergency response personnel.
6. Fire watch is to be maintained for at least one half hour after completion of hot work operations.

3.3 Ladders And Scaffolding

3.3.1 Ladder Safety

Each year thousands of people are injured while using ladders. At the CU-Boulder campus there are approximately 20 ladder accidents a year. Before using a ladder, you should inspect it thoroughly. Check for loose or damaged hinges, steps, braces, and that ladders are clean and dry. On extension ladders, check that the safety feet are in place and that ropes are not frayed or worn. Metal ladders should be checked for dents and/or bends. Only non-conductive ladders should be used around electrical equipment. Wood ladders should not be stored outdoors where they will be subject to deterioration by weather. Ladders should not be painted, as paint may hide defects. Report any damage or unsafe equipment immediately and clearly label it as "out of service." Select the right ladder for the job. Make sure the ladder is long enough and strong enough for your purpose. Extension ladders should extend 3 feet above the top support. Never position a ladder on a window or window sash or against a door. Ladders used in public areas or exit ways should be provided with proper signs and barricades. Never stand on the top

two steps of a step ladder or the top four rungs of an extension ladder. Spreaders for a stepladder should lock securely in the open position. Place ladders on solid, level surfaces. If the ground is soft, frozen, or moist, use planks under the feet of the ladder. A good rule of thumb for ladder placement is the 4-to-1 rule. That is for every four feet of ladder height, the ladder should be one foot away from the wall. Ladders should be tied off at the top, bottom, or both to prevent accidental movement while in use. Face the ladder and use both hands when climbing or descending. If you need tools, use a rope and a bucket or a tool belt to haul them up. Keep your body centered on the ladder and the ladder centered on the job. Cages or a safety harness and/or tie offs are required when working above 20 feet.

3.3.2 Scaffolding Safety

Scaffolds are used when above-ground jobs require more workers and/or equipment than a ladder can safely handle. Scaffolds should be designed maintained and used in compliance with safety standards and specifications. Use only manufacturers parts when replacing damaged or worn components. A scaffold should be made of strong metal, stress grade lumber, or approved fiberglass. When in use, the scaffold should be secured to the building or wall (mobile scaffolds and ladder stands shall have wheel "locks" to prevent movement). When working on or around a scaffold, a hard hat and safety shoes with nonskid soles should be worn. A safety harness and/or tie offs may be required. The first line of protection in scaffold safety is to inspect a scaffold carefully before each use to look for:

1. Footings that are sound, rigid, and capable of holding the intended weight (boxes, barrels, etc., do not qualify)
2. Guard rails that are 2" X 4" wide and 3 to 3 1/2 feet high
3. Guard rail supports every 10 feet on all open sides
4. Toeboards that are 4" high on all sides
5. Screens between the guard rails and toeboards if people will pass underneath
6. Ladders or other safe methods to get on and off the scaffold
7. Poles, legs, or other uprights that are plumb and secured
8. Planks that extend 6 to 18 inches over the end supports on wooden scaffolds
9. Cross braces on metal scaffolds
10. Pedestrian traffic should be routed away from overhead work

3.4 Welding And Cutting

3.4.1 General Precautions

1. Always receive proper training before working with welding tools, machines and equipment. Only qualified persons may perform welding operations. A Hot Work Permit should be completed before welding or cutting is performed. Preplacement physical examinations, including chest x-rays, are recommended for all personnel engaged in welding.
2. Follow the proper procedures for work in confined spaces. Confined spaces broadly describes the many pits, vaults, vessels, tanks, underground tunnels, pipelines, and

even open-topped spaces more than four feet in depth, that may pose an occupational safety or health hazard.

3. Remove all hazardous, combustible and flammable materials from areas where welding is to be performed. If this cannot be accomplished and the material nearby could be affected by the welding, then the welding area should be enclosed in fireproof blankets or other protective shields.
4. Consult Material Safety Data Sheets (MSDS) for the gases and welding rods you are using and the materials to be welded or cut. Use approved exhaust systems.
5. Purge and check for residues before welding any tank. Tanks should be open, ventilated, and checked for hazardous atmospheres.
6. Always follow safe housekeeping principles. Keep tripping and shock hazards, such as tools and water off the floor.
7. Make sure you do not drag hoses or cables over hot metal scrap when cutting, and keep them away from molten sparks when cutting or burning. Hot metal should be barricaded and/or marked "HOT" with chalk or soapstone, or with a proper sign indicating a hot surface. Always remove these signs when the material has cooled down to the touch.

3.4.2 Protective Equipment

1. Flame resistant gauntlet gloves. Do not use excessively worn or wet gloves.
2. Leather apron or other flame resistant material. These aprons are designed to withstand radiated heat and sparks produced when welding.
3. Safety shoes wherever heavy objects are handled. Do not use low-cut shoes with unprotected tops because of the spark hazard.
4. Head protection, such as hard hats, for protection against sharp or heavy falling objects and skull caps of flame-resistant or leather fabric under helmets (to prevent head burn)
5. Leather capes, shoulder covers or other suitable material for overhead work (not asbestos)
6. Ear protection (wool or rubber plugs or wire screen protectors) for overhead work
7. Hair restraints for employees with long hair, around moving parts of machinery. Keep sleeves and pants cuffs rolled down and collars buttoned up.
8. Wear ANSI approved eye protection. Operators, welders and their helpers should wear goggles, helmets, and shields that give the maximum eye protection.
9. Use a fire resistant vision screen when a welding or cutting operation can be observed by a person nearby.

3.4.3 Electric Arc Welding

1. A Hot work Permit should be completed before electric arc welding is performed.
2. Inspect all equipment before welding. Look for frayed cables, poor electrode connections, proper grounding and shielding.
3. Never look at the arc or flash unless equipped with a shield having the correct shade of glass or lens.
4. When welding in public areas, provide adequate barriers to prevent ultraviolet radiation exposure to passers-by.

5. Shields and welding goggles must be free of cracks and holes to prevent penetration of intense light.
6. Never strike an arc on compressed gas cylinders.
7. Ground all work equipment before turning on welder.
8. Keep floor free of electrodes once you begin to weld. They could cause a slip or fall.
9. Place welding stubs in a metal container.
10. Always wear a helmet when overhead welding and when other overhead hazards exist.

For arc welders, there is a greater danger of shock or electrocution, so basic electrical safety practices should be followed. Additionally: use the correct cable size and be sure insulation is in good condition; turn off power before touching electrical parts; ground what you are welding with a separate electrical connection; do not wear metal jewelry that could become a conductor; and do not weld in the rain or in wet conditions.

3.4.4 Oxyacetylene Welding

1. A Hot Work Permit should be completed before Oxyacetylene welding is performed.
2. Use only certified welding components.
3. Inspect all equipment before welding. Check gas cylinders, flashback arrestors, backflow/ pressure protectors, regulators, hoses, torches and shielding.
4. Check for leaks in the hoses, regulators and connections whenever you change tanks or suspect a leak.
5. Check equipment with soapy water, never a flame. If you detect or suspect a leak in the equipment, stop and effect repairs promptly.
6. Do not use oil on the torch, blow pipe, valves, regulators or any other portion of the equipment as oxygen and oil can start a fire.
7. Do not use pliers on apparatus. Use the proper wrench. Keep wrench on acetylene cylinder valve while in use so it can be shut off quickly if necessary.
8. In the event of a fire emergency, tanks should be shut off and removed from the area. If this is not possible, responding emergency personnel must be notified of the hazard before entry.
9. Do not exceed 15 psi for acetylene or an explosion may occur.
10. Make sure connections are tight when you change tips or other apparatus. Do not over tighten.
11. Do not use oxygen or any other compressed gas to blow dirt off your clothes.
12. Do not permit equipment to run over the hoses; protect them from sharp objects, kinks, and heat sources.
13. Use flint spark lighter; never matches or cigarette lighters.
14. Follow the proper sequence for torch ignition.
15. Use special care when cutting, so hot pieces do not fall onto you or equipment hoses.
16. Lighted torches should never be laid down, hung up or left unattended.
17. Never "crack" a cylinder in the vicinity of an open flame or fire source.
18. Keep cylinders upright and secured. Keep valve caps on cylinder when not in use.

4. Liability Waiver

University of Colorado

Release from Responsibility, Assumption of Risk and Waiver

Name_____
_____
Activity_____Date_____
_____
Address_____
_____
Phone Number (_____)_____ Fax Number (_____)_____

I exercise my own free choice to participate in the above designated Activity. **I understand and assume all associated risks. I agree to assume all risk of personal injury or loss, bodily injury (including death), damage to or loss or destructions of any personal property occurring in connection with or arising out of participation in** _____ **.**
(Activity Name)

I hereby release and discharge, indemnify and hold harmless the Regents of the University of Colorado, and their member officers, agents, employees and any other persons or entities acting on their behalf, and the successors and assigns for any and all of the aforementioned persons and entities, against all claims, demands, costs and expenses, and causes of action whatsoever, either in law or equity, arising out of or in any way connected with any loss and/or bodily injury and/or disability, arising from my participation in the Activity.

I have had sufficient time to review and seek explanation of the provisions contained above, have carefully read them, understand them fully, and agree to be bound by them. After careful deliberation, I voluntarily give my consent and agree to this Release, Assumption of Risk and Waiver.

In the event of an emergency, I grant the University of Colorado permission to authorize emergency medical treatment for _____, (participant) for the duration of his/her participation in this Activity. **I understand that University of Colorado does not carry or provide health or accident insurance that responds to injury or illness as a result of my participation in this Activity.**

Medical Health Insurance Company _____ Policy # _____

Emergency Contact/Phone_____

If the participant is under 18 years of age, the parent or guardian in consideration of this request accepts the above terms and grants permission for the student's participation.

_____

_____

Participant Signature (Parent or Guardian if under 18) Date

5. Laboratory Safety Training Acknowledgement

Structural and Materials Testing Laboratory (SMTL)
Safety Protocol Agreement

For your own safety, and the safety of others, please remember to adhere to the policies of the SMTL. Below is a summary of the most important safety requirements for the use of the lab. Please be sure to review them prior to using the laboratory, as they will be strictly enforced. **You must read and sign this document to use the SMTL facilities and equipment.**

5.1 Personal Protection Equipment (PPE)

Protect yourself from injury. Wear closed toed and heeled shoes, preferably ones with enforced toes, and long pants. Make use of the laboratory's non-consumable safety and protection gear; always use safety glasses, wear a hard hat when operating heavy/large equipment, wear ear protection when using noisy tools, wear gloves when handling hazardous materials, use a respirator when dealing with hazardous solutions/fumes, and put on a dust mask when working with dust-producing materials.

Please note that it is the responsibility of the P.I., not the SMTL, to provide their researchers with PPE. **No consumable safety gear will be provided to researchers by the SMTL.**

5.2 Notification

Please **notify a lab assistant if you plan to begin an experiment or perform any work** that requires tools or equipment, and arrange a suitable time to do so. Calendars of lab activity are posted outside the SMTL office door, and should be used with the assistance of a lab worker to schedule work times.

5.3 Hazardous Materials

All persons conducting research in the SMTL **must receive Hazardous Materials safety training** from the Environmental Health & Safety Program on campus. This is mandated by University policy. All researchers will be given 60 days to comply.

In regards to the Hazardous Materials Used or Produced section on Form 101, please list all materials to be used as they may be considered harmful in different states or combinations with other materials used within the laboratory.

5.4 Specified Areas

Only handle hazardous materials in their designated areas. Dispose and store hazardous materials appropriately. If you are not sure of designated areas and/or appropriate disposal and storage locations, please contact a lab assistant in the SMTL office.

5.5 Materials and Machinery

Notify a lab assistant before using any machines! Please use only tools, materials, and machinery you are familiar with and only for their designed purpose. Lab assistants will be happy to help you become familiar with a machine, but cannot help you significantly with your project without arranging billing and fees through Tom Bowen. When finished, please return all equipment to original location in the same condition as it was found, and clean up any debris or chips created. Only lab assistants may operate the cranes and forklift.

5.6 Equipment and Tools

Most electrical equipment and tools are contained in a limited access storage area. You may sign out these items Monday-Friday from 8am - 5pm after arranging things with lab assistant. **Tool loaning is at the lab assistant's discretion**—they must be comfortable with your abilities using the tool. Return tools promptly when you are finished with them, so they can be made available for other lab users.

5.7 Basic Housekeeping Rules

1. Keep doors closed at all times and locked after 5pm, Monday - Friday and all weekend.
2. Keep areas clean and uncluttered
3. Return tools as soon as possible
4. DO NOT modify tools for your own use
5. Notify lab assistants of broken machinery and tools
6. DO NOT store chemicals in unlabeled containers
7. DO NOT dispose of chemicals down the drain

Agreement

I, _____, have read and understand all the above rules, and agree to follow them. My principal investigator will be contacted should I fail to comply with these safety policies, and my lab use privileges will be removed.

_____ _____

Signature Date

6. Hot Work Permit

This permit is required by the University of Colorado at Boulder when working with heat guns, grinding, cutting, welding, or soldering with portable gas, arc, or other equipment generating heat or spark. The permit can be found at the Facilities Management site:

http://fm.colorado.edu/firesafety/documents/HotWorkPermit2007-v2.pdf