FLORIDA INSTITUTE OF TECHNOLOGY

SAFETY MANUAL

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Unapproved Additions in May 2005 (Appendices M – O)

FLORIDA INSTITUTE OF TECHNOLOGY
SAFETY MANUAL

TABLE OF CONTENTS

OSHA – 29CFR1910.103 **(13 Pages)**

NASA Guide for Hydrogen Hazards Analysis on Components and Systems NASMTM-2003-212059 (40 Pages)

Policy and Purpose

It is the intent of Florida Institute of Technology to provide a safe and healthy environment to all faculty, staff, students, vendors, contractors, visitors, and others who may work at or inhabit the University's facilities and grounds. Said individuals are entitled to work and study in a relatively hazard free environment; therefore, the University will strive to achieve an optimum degree of safety while still providing an intellectual and cultural atmosphere. Federal, State, and Local regulations mandate a minimum level of safety and environmental compliance; however, since the management of Florida Institute of Technology holds safety and environmental compliance in such high regard, we intend to go beyond the minimum standards.

The personal and health of each employee of the University is of primary importance. The prevention of occupationally induced injuries and illnesses is so important that it will be given precedence over operating productivity whenever necessary. Management will provide all mechanical and physical facilities required for personal safety and health.

We will maintain a safety and health program conforming to the best practices of organizations of this type. To be successful, this program must embody the proper attitudes towards injury and illness prevention on the part of supervisors and between supervisor and employee, but also between each employee and his or her co-workers. Only through such a cooperative effort can a safety program that is in the best interest of everyone be established and preserved.

Our objective is a safety and health program that will reduce the number of injuries and illnesses to an absolute minimum, not merely in keeping with, but surpassing the best experience of operations similar to ours. Our goal is zero accidents and injuries.

Our safety and health program may:

a. Provide adequate and proper mechanical and physical safeguards;
b. Conduct a program of safety and health inspections to find and eliminate unsafe working conditions or practices, to control health hazards, and to comply fully with the safety and health standards for every job;
c. Train all employees in good safety and health practices;
d. Provide necessary personal protective equipment for its use and care;
e. Develop and enforce safety and health rules as a condition of employment;
f. Thoroughly and promptly investigate every accident to find out what caused it and to correct the problem so that it will not happen again.
g. Set up a system of recognition and awards for outstanding safety service or performance. We recognize that the responsibilities for safety and health are shared;
h. The employer accepts the responsibility for leadership of the safety and health program, for its effectiveness and improvement and for providing the safeguards required to ensure safe conditions;

i. Supervisors are responsible for developing the proper attitudes toward safety and health in themselves and in those they supervise and for ensuring that all operations are performed with the utmost regard for the safety and health of all personnel involved including themselves;
j. Employees are responsible for wholehearted, genuine cooperation with all aspects of the safety and health program, including compliance with all rules and regulations, and for continuously practicing safety while performing their duties.

Codes of Safety Practices: General Policy

a. All employees of this university will follow these safe practices rules, render every possible aid to safe operations, and report all unsafe conditions or practices to the supervisor/employer.
b. Supervisors will see that employees observe and obey every rule, regulations and order necessary to the safe conduct of the work and will take necessary action to obtain compliance.
c. Anyone under the influence of alcohol and/or drugs will not be allowed on the job while in that condition. Continuous rejection will be grounds for dismissal. Persons with symptoms of alcohol and/or drug abuse are encouraged to discuss personal or business-related problems with the supervisor/employer. The University maintains an Employee Assistance Program to help with problems of this nature.
d. No one will be permitted or required to work while his or her ability or alertness is impaired by fatigue, illness or other causes that might expose the individual or others to injury.
e. Employees should be alert to see that all guards and other protective devices are in proper places and adjusted, and will report deficiencies. Approved protective equipment will be worn in specified work areas.
f. Horseplay, scuffling and other acts that tend to endanger the safety or well-being of employees are prohibited.
g. Work will be well planned and supervised to prevent injuries when working with equipment and handling heavy materials. When lifting heavy objects, employees should bend their knees and use the large muscles of the leg instead of the smaller muscles of the back. Back injuries are the most frequent and often the most persistent and painful type of work place injury.
h. Workers will not handle or tamper with any electrical equipment, machinery, air or water lines in a matter not within the scope of their duties, unless they have received instructions from their supervisor/employer.
i. All injuries will be reported promptly to the supervisor/employer so that arrangements can be made for medical and/or first aid treatment. Emergency, fire, ambulance, rescue squad, and police telephone numbers and 9-911.
j. If an injury and/or death occurs, a Notice of Injury form must be completed within 24 hours. This form is available in the Financial Affairs office.

The spectrum of safety will cover such areas as accident prevention, personal and driving safety. Fire protection/prevention, hazardous materials (HAZMAT) and Right-To-Know, hazardous waste management, laboratory safety/radiation protection, biological exposure control, biohazardous waste, solid waste management (recycling), and general emergency/disaster procedure. All activities and functions performed within any of our facilities or on the grounds therein will be a safety concern. Furthermore, all off-campus school approved activities will fall within the parameters of this policy.

Observance of this Safety Program should provide for a safe campus environment conducive to academic pursuits. Therefore, all faculty, staff, students and others described in the policy statement should abide by the established University safety rules and regulations. Because of this safety philosophy, and in the interest of modern management practice, we will continuously strive toward the following:

a. Maintenance of a safe and healthful academic environment.

b. Consistent adherence to proper operating practices and procedures designed to prevent injury and illness.

c. Conscientious observance of all Federal, State, and University safety regulations.

Responsibility, Authority and Implementation

It is the responsibility of all individuals to work and act safely as well as report any unsafe conditions. Individuals should not interfere with others in a way liable to create hazards nor should they allow others to interfere with their own activities in such a way.

The **Safety Committee** is responsible for:

a. Establishing and administering the University's Safety Program.
b. Developing accident prevention and loss control methods, procedures, and standards.
c. Identifying and appraising accident or loss producing conditions.
d. Disseminating and communicating information relevant to accident prevention and loss control to all involved parties.
e. Measuring and evaluating the effectiveness of the Safety Program.
f. Modifying the Safety Program upon need to achieve optimum results.
g. Minimizing the potential for injury, death, property damage and liability losses caused by intentional or unintentional mishaps.
h. Organization and monitoring of the University's Emergency/Disaster Plan.
i. Insuring the implementation of and compliance with environmental programs in accordance with regulatory requirements of Federal, State, and local agencies.

The above listed responsibilities will be accomplished by providing technical expertise, training, and advice to all departments within the University structure. The Safety

Committee members shall be service oriented, resourceful and accessible members of the University community. The Committee shall develop and maintain a working relationship with all organizational levels to provide open communications in resolving safe problems and concerns.

To ensure compliance, the Safety Committee has the ultimate authority to correct or remedy all safety problems within their area of control or jurisdiction by any means they see fit, provided that the means comply with the rules and regulations set forth in University policy.

In order to provide the University with an efficient as well as cost-effective safety program, the utilization of our people, environment, materials and equipment shall be maximized. With the Safety Committee providing consultation and guidance, implementation of the program is accomplished in four basic steps:

1. Establishment of the University policies, procedures, and standards.
2. Dissemination of policies, procedures and standards to University employees and students.
3. Application and enforcement of established policies, procedures and standards.
4. Measurement of program effectiveness.

Safety Organization and Functions

The Safety Committee is responsible for developing and implementing the Florida Institute of Technology Safety Program. To accomplish this task, the program is subdivided into safety related disciplines along with the department responsible for each section of the program:

a. Accident prevention/Personal Safety (Facilities Management, Security, Student Affairs)
b. Driving Safety (Security)
c. Fire Protection/Prevention (Facilities Management)
d. Hazardous Materials (HAZMAT), Right-To-Know, Hazardous Waste Management (Chair, Safety Committee, Human Resources)
e. Biological Exposure control (Biological Sciences Department, Human Resources)
f. Laboratory Safety/Radiation Protection (Chemistry Department, Radiation Safety Officer)
g. General Emergency/Disaster Plan (Security, Facilities Management)
h. Accident reporting and Workers' compensation (Financial Affairs, Human Resources)
i. Solid Waste Management (Facilities Management)

The Safety Committee is structured so that at least one committee member shall be well versed and cross trained in the other aspects of safety. All Safety Committee members

report to the Chairman of the Safety Committee. The Committee shall also utilize safety technicians to assist the Committee with routine inspections and safety maintenance.

The Safety Committee members will be available throughout each normal work day. During off hours, including evenings, holidays and weekends, the Committee members can be contacted via the Florida Institute of Technology Department of Security.

The Safety Committee is entrusted with the management of risks which impact the finances, property, public image and personnel resources of the University. The main goal is to minimize exposures to loss by providing consultative services in the areas of accident prevention, personal safety, fire prevention, hazardous materials (HAZMAT), laboratory safety, radiation protection, biological exposure control, general emergency/disaster readiness, recycling, and accident reporting/worker's compensation. These services are maintained to educate, communicate and assist the various community members in developing their own Safety Management Programs. The staff member of the organization are also entrusted with helping the University meet requirements which are outlined in various Federal, State and Local regulations concerning occupational health and safety.

The specific functions of the Safety Committee are as follows:

a. Provide consultative services in the following areas:
    1. Accident Prevention/Personal Safety
    2. Fire Protection/Prevention
    3. Hazardous Materials (HAZMAT) and Right-To-Know
    4. Hazardous Waste Management
    5. Laboratory Safety/Radiation Protection
    6. Biological Exposure Control
    7. General Emergency/Disaster Plan
    8. Accident Reporting and Workers' compensation
    9. Solid Waste Management (Recycling)

b. Provide the University administration with information and guidance in responsibilities outlined in numerous Federal, State, and Local regulations regarding occupational health and safety (i.e., Environmental Protection Agency, Occupational Safety and Health Administration, Department of Environmental Regulation, etc.)

c. Reduce financial, property, and personal loss through the practice of Risk Management techniques. These techniques include transfer (insurance) and avoidance as well as loss prevention and reduction. Loss prevention and reduction are the risk Management techniques most utilized by the consultative staff.

d. Educate, communicate and provide assistance to all University members so they may establish their own safety programs.

The Safety Committee is not a regulatory enforcement agency. It is a consultative service providing information and assistance in meeting the occupational safety and loss prevention concerns of the University community.

The Safety committee is staffed by individuals who are knowledgeable in the subjects of insurance, industrial hygiene, accident prevention, fire safety, radiation protection/laboratory safety, hazardous materials (handling and disposal), environmental safety, and solid waste management (recycling).

Safety Committee Meeting

Meetings of the Safety committee are held for several purposes:

a. To learn about safety through talks, films and demonstrations.
b. To discuss the work of the committee, maintain and improve the Safety Program for the University.
c. Make recommendations to the administration.
d. Develop policies and procedures.
e. Oversee the University's General Emergency/Disaster Plan and the appointment of Building Emergency Officers.
f. Make systematic inspection tours of "problem" areas for recommendations as to corrective actions, if necessary.
g. Review complaints or reports of questionable practices and/or procedures.
h. Review circumstances and causes of accidents and recommend corrective measures (this is usually done at the request of someone in authority, not as a routine matter, or upon the initiative of the Safety Committee).
i. To discuss matters of immediate importance to the University, such as new or developing hazards on campus not encountered before.
j. To recommend to University administration the expenditure of funds to initiate a program and/or correct any situation that will bring the University into compliance with any existing or new Federal, State, or Local safety regulation.

APPENDIX A- Accident Prevention

Accident prevention at Florida Institute of Technology is of paramount importance. The increased emphasis on education is based on the conclusions by safety experts that over 80% of all on-the-job accidents are due primarily to unsafe acts of workers. This may be a simplistic approach, as most accidents have multiple causes, but it is clear that people are a big part of the problem. An unsafe act is a result of not knowing (lack of training), not caring (poor management), or it is intentional. This suggests that creating a good and effective safety program can help solve other organizational problems. Here are but a few areas where accidents can be prevented.

Floors, doors and passageways:

a. Walk, don't run or slide
b. When floors are being refinished or washed, observe signs and proceed cautiously.
c. If water or other substance is found on the floor, remove it or report it to Facilities Management at once.
d. Pick up small objects, such as rubber bands, paper clips, pencils, etc. These objects can create slip hazards.
e. When approaching a hall or passageway hidden by a corner, keep to the right and go slowly in order to avoid bumping into someone who may be coming from around the corner.
f. Shoes with broad heels take corners more safely.
g. Chairs, footstools, wastebaskets and other articles are not to be placed in aisles.
h. Telephones and office machines are to be placed so that the cord will not obstruct aisles and passageways.
i. Approach doors with caution and open slowly. Someone may be on the other side. Stand and walk clear of exit ways. Someone coming through the other side may not know you are there. When double doors are involved, use the right sided door.
j. Hallways are to be kept clear to prevent injury during emergency evacuation.

Stairways:

a. Pause before starting downstairs. Never hurry when going either up or down stairs. Proceed deliberately and cautiously.
b. Keep to the right with your hand on the handrail. Make sure you have completely ascended or descended the stairs before releasing your hold on the handrail.
c. Keep your eyes on the steps ahead of you and refrain from doing anything which distracts attention, such as searching in your handbag for keys, turning your head to talk with a fellow employee, etc.
d. Keep stairways free from debris.

e. Defective handrails, lighting and stair treads are to be reported to the Physical Plan for correction.

Restrooms:

a. Keep the floor free from water, soap and other objects that can cause someone to slip and fall.
b. Waste towel containers are not to be used for disposal of cigarettes, glass pins, needles or any other articles that may cause fire or injury to Environmental Services personnel.
c. Do not place drinking glasses, cups and other items on towel dispensers.

Windows:

a. Employees are not to lean out of windows nor are they to sit on the sill or casing of a window, even when the window is closed.
b. Articles are not to be placed on window sills.
c. No object is to be thrown out of a window.

Desks, tables, supply cabinets and filing cabinets:

a. Drawers and doors are not to be left open; someone may fall over and knock against them.
b. Place objects on desks and table in such a manner that they will not fall or be easily distributed.
c. When opening desk drawers, care is to be exercised to prevent them from falling out.
d. Place materials in cabinets so that when doors are opened the contents will not fall out.
e. When a sheet of glass has been used to cover desk tops, counters, or cabinets, the edges and corners should be rounded and smooth. Broken or chipped glass is to be removed immediately.
f. When seating yourself at a desk, do not assume chair is in place. Place your hand on the back or arm of the chair to hold it in place while you sit down.
g. When seated, keep both feet on the floor. Do not sit with one leg folded under you. This can cause poor blood circulation to that leg, numbing it and causing you to fall if you should get up and attempt to walk.
h. Chairs are to be inspected periodically to be sure there are no broken rollers, nuts, bolts, supports, etc.
i. Office furniture is to be kept free of splinters, rough edges and loose and defective parts at all times.
j. Office furniture is not to be used as ladders or step stools. Obtain a ladder that meets the needs of your operations.
k. Have a proper space for boxed supplies. So not leave full or empty boxes in aisles, indiscriminately in offices, or in doorways. Empty boxes are to be removed as soon as possible to prevent tripping and fire hazards.

l. When stacking boxes, be sure each box is placed squarely on the box under it and that they do not tilt. Do not stack above four feet unless the load is secured.
m. When opening boxes, particularly with cutting blades, be careful that the blade does not slip. When not in use, the blade is to be enclosed in a guard. If boxes are opened by pulling the flaps, be careful of staples which may be holding the flaps in place.
n. Where possible, supply cabinets, filing cabinets and other such equipment which may become overbalanced are to be secured by bolting them together to a wall or to a floor.
o. Do not open more than one file drawer at a time particularly the top drawers. It may tip on you. Distribute materials evenly through files.
p. Do not store materials on top of cabinets. Keep them clear.

Electrical Cords and Outlets:

a. Electrical power cords which have become frayed and plugs that broken are to be replaced immediately. Do not attempt to tape a broken plug or damaged power cord.
b. Place equipment near outlets to avoid cords running across floor, aisles and through doorways. If it is temporarily necessary to have cords in an aisle walk, tape the cord in place or provide a cord enclosure guard to avoid creating a tripping hazard.
c. Defective outlets are to be repaired immediately. Prior to repair, such outlets are to be isolated or covered so they cannot be used.
d. Raised outlets (pedestal type) are not to be located in aisles or under the desk in the foot rest region.
e. Unused floor outlets which are flush with the floor must have a protection cover in place at all times.
f. Portable equipment such as fans are to be equipped with three wire grounding connections unless they are double insulated. Portable heaters are not to be used unless provided by the Facilities Management.

Office Machines and Equipment

a. Office machines, particularly data processing machines and copy machines have many hazards such as moving belts, rollers, gears, etc., which are to be adequately guarded before being placed in service. Normally, guards are installed by the manufacturer as standard equipment. If not, they are to be installed locally before the machine is placed in operation.
b. Electrically operated machines, if not double insulated, are to be equipped with a three-conductor cord and grounded. Do not modify plugs to connect them to an ungrounded circuit.
c. Unplug all electrically operated equipment prior to attempting to clear a jam, make an adjustment or alter a malfunctioning part.

d. When changing the ribbon, adjusting the belt or making any other adjustments to the printer, turn the machine off.
e. Do not remove protective guards, open protective hoods, open side doors or remove side panels from machines while the machine is in operation.
f. Insure through periodic maintenance checks that hinges and latches which hold protective guards, hoods, doors and panels in place are in safe working condition. If such guards are found defective, have them repaired immediately.
g. When machines have certain moving parts exposed due to necessity, do not wear dangling jewelry and loose clothing that could become entangled in the moving parts.
h. Do not place objects on top of machines. Vibration from the machine during operation could cause the object to fall off and hit someone or fall into the machine and jam it or cause an electrical problem.
i. When maintenance personnel are working on equipment, do not attempt to help move the machine. Engaging in such activity could cause a muscle strain.
j. Wear earplugs when working with high decibel equipment. Safety eye goggles should always be worn around machinery, especially high-speed cutting equipment, leaf blowers, etc. Care and training should be followed when working in shops where machines are operating (i.e., carpenter shop, etc.). Potentially dangerous equipment in the Print Shop (i.e., reproduction machines, copying equipment, etc.) and food Service (microwave ovens, baking ovens, cutting tools, blenders, etc.) require special handling and safety. All personnel in these areas should be well trained before using equipment/machinery.

Appliances/Food Preparation

a. Policy: Cooking facilities are available in kitchen areas located in the Southgate apartments only. Certain appliances are permitted for use in individual residence hall rooms. These appliances are : small refrigerators (maximum size 3' x 3'), coffee makers, hot pots (enclosed coil only), hot air popcorn poppers and microwave ovens (less than 154 amps and 700 watts.)

The following appliances are <u>NOT</u> permitted in the residence halls under any circumstances: hot plates, electric skillets, fryers, crock pots, toaster ovens, toasters and oil type popcorn poppers.
No extension cords are permitted in the residence halls. If there is a need for additional plugs (i.e., over and above those outlets provided), residences may use a strip outlet which meets the following specifications.

1. Must be UL approved and include a circuit breaker.
2. Must be 15 amps, 14 gauge; or 20 amps, 14 gauge.
3. Must be 120-125 volts.
4. Cannot have a cord more than 6 feet long.

5. Cannot have more than six (6) grounded power outlets per strip, with no more than four (4) in use at any time.

b. Procedure: If you observe any of the prohibited appliances in the residence hall:

1. Confront the resident(s) about the appliance, reminding them of the RL policy as stated in the Guidebook Calendar. Instruct them to remove the appliance from the residence hall within 24 hours.
2. Promptly document with an incident report.
3. Follow up after the 24 hour period to make sure the appliance has been removed.
4. If a fire/fire alarm has been caused as a result of a violation of this policy, document that fact on the incident report. The residents will be subject to disciplinary action and a fine.

Miscellaneous Precautions:

a. Sharp or pointed objects such as knives, pens, pencils, scissors and envelope openers are to be carried in a manner to avoid accident.
b. Handle paper in manner that can avoid cutting the hands on the edges.
c. Avoid a possible eye injury by not throwing pens, pencils, paper clips and rubber bands from place to place.
d. Avoid pinching or puncturing the fingers by carefully loading or clearing jammed staplers.
e. Electric fans are not to be handled while in operation. They are not to be placed on the floor in locations where they are likely to injure employees. Fans are to have blade guards with openings no larger than one-half (1/2) inch unless they are mounted higher than seven feet from the floor.
f. Each employee is to be familiar with the location of emergency exits and fire extinguisher. They must become familiar with the emergency contingency plan.
g. Extension cords when used on a temporary basis for audiovisual equipment or portable tool use are not to be run through doorways or openings in the ceiling, floor or walls.
h. Trash containers or approved construction for use inside Florida Institute of Technology structures must be of the following types:
    1. Metal containers with fire suppression type covers, i.e., fire rings, covers, etc.
    2. Non combustible containers that will not support combustion or allow fire inside the container to propagate.

APPENDIX B- Maintenance and Office Safety Rules

Maintenance Safety Rules:

a. General
    1. Keep all hand tools in safe condition. Cutting tools must be kept sharp.
    2. Use only non-sparking tools when working around inflammable or explosive vapors or gases.
    3. Extension cords for power tools should be checked carefully before using to be sure they are free from defects.
    4. A tool box or holders are the safest way to carry tools.
    5. Never use a defective or broken ladder. Always use the proper type ladder for the type of job to be done.
    6. Do not use stepladders as straight ladders and never stand on the top two steps of a stepladder.
    7. Wear the proper clothing for the job.
    8. Protect your feet with safety shoes when lifting or carrying heavy objects.
    9. Wear safety goggles or glasses whenever there is a possibility of receiving eye injuries from flying particles.
    10. Always shut off valves when working on stems and hot water pipelines.
    11. Lock and tag electrical switches when doing repair work.
    12. Do not overload electrical circuits under any circumstances. Never fuse too heavily.
    13. Inspect your equipment regularly and be sure that the equipment is used correctly.
    14. All necessary safety precautions should be taken before performing any hazardous task.
    15. Use and maintain adequate and proper guarding for all machinery in maintenance shops. Keep guards in place.
    16. Follow the "No Smoking" rules in the maintenance shops and other hazardous locations.
    17. Store all lacquers and thinners in U.L. approved cans or flammable liquid storage cabinets according to State and/or Local fire codes.
    18. Do not allow oily rags, which could produce spontaneous combustion to accumulate.
    19. Check and maintain all stair rails and hand rails in the University.
    20. Place warning signs when work is being performed where it creates a hazard to other parties.
    21. Respond as promptly as possible to the request of any personnel to repair unsafe conditions.
    22. Before any welding, cutting, or hot work is done either by in-house personnel or the Facilities Management as is the procedure for the various campus locations.

23. An extension cord is to service only a single portable lamp or piece of portable apparatus of no more than (and preferably less) than 15 amperes and less than 230 volts. Extension cords shall not be used in conjunction with such things as portable heaters, irons, toasters or similar heat producing devices. They shall not be used in electrically susceptible patient locations, in the presence of flammables or in other high hazard areas.
24. Do not use extension cords as a substitute for permanent wiring.
25. All extension cords must be continuous lengths with no splices or taps, of heavy duty cable of three current carrying conductors one of which is a ground wire, with grounded type receptacle and plug cap. Metal clad plug caps should not be used.
26. Where extension cord lights are used, they shall be guarded with an insulated shield to protect the bulb against breakage and consequent shock hazard to personnel.
27. When working on electrical distribution panels, sub-panels, motor controls, etc., insure that the power source is disconnected and tagged out of service. Use rubber gloves, insulated tools, rubber mats and aprons as necessary and required for the work at hand. When work is complete, test the system before putting it back into service; restore controls to normal operating position and remove any tags and replace the panel covers.
28. When working on piping systems, secure with wire and tag out appropriate cutoff valves. Where work is with high pressure steam or other high hazard material, wire shut and tag out two cutoff valves where available. When work is complete, test the system before putting back into service, remove securing devices, restore system to required operating conditions and remove all temporary securing devices, tags, etc.
29. Clean up any spills or debris, construction products, etc. If unable to do so immediately, block off area to prevent injury.
30. All accidents, no matter how minor, are to be reported and an Injury Report Form completed. A seemingly insignificant injury may develop into a major health problem if left untreated. An accident report must be filled out to establish compensation or insurance benefits. Additionally, prompt treatment serves the extent and the seriousness of the injury. If the accident is serious, the employee may go directly to a hospital emergency room. If you are severely injured, call for assistance in obtaining medical aid. Arrange to have an injury report form completed with the Financial Affairs Office. (For additional information refer to Section L).
31. Equipment that is potentially contaminated (infectious, toxic, or radioactive) must be certified as safe by the appropriate branch, laboratory or department chief before it is repaired or cleaned. The certification should be in writing on a tag attached to the equipment.

This precaution extends to fixed building equipment, such as plenums and vacuum pumps.

32. When batteries are being charged, open flames or other possible ignition sources must be kept away from them and smoking must be prohibited in the area. Hydrogen given off during the charging operation is highly flammable and may flash or explode.
33. Power-actuated tools should be operated, repaired, serviced and handled only be personnel who have been certified by the department supervisor. Certification evidence should be documented.
34. Hot water thermostats, except such facilities as the dietary areas, are to be regulated so that the temperature is between 110-125 degrees Fahrenheit at the faucet.
35. Periodic checks are to be made to determine that all automatic door closures on inside fire stairs are in proper working condition and that no fire doors are blocked open.
36. Requests to repair unsafe conditions must be handled expeditiously.
37. A preventive maintenance system also helps to prevent many accidents and is to be implemented for all equipment.

b. Safe Use of Ladders

1. Safety check your ladder before using.
2. Place all types of ladders so that its feet rest on a firm, level surface. The surface must not be slippery. Use non-slip feet and have the ladder held or tied if there is a slight chance that non-slip feet won't hold.
3. When leaning a straight ladder against a wall, make sure that its feet rest away from the wall at a distance approximately one-quarter of the height of the ladder.
4. Level ladder footing by use of non-skid blocking or safety shoes.
5. Step ladders should be opened fully so that the side braces latch.
6. Always climb a ladder slowly and steadily, facing ladder when ascending or descending. Any shifting is a good indication that it is placed improperly.
7. Work only within convenient arm's length of the ladder without bending the body to the left or right, or assuming other than a normal standing position while on the ladder.
8. Do not carry tools up a ladder unless you can carry them in a pocket. Use a line and haul them up after you get to the top.
9. Never climb a ladder when the rungs or your feet are wet with water, oil or other liquid. First clean and/or dry them carefully to eliminate slips and falls.
10. Protect the ladder from being bumped into by placing warning signs or barriers and have a second person standing by to hold the ladder and warn off others. Never place a ladder in front of an unguarded door opening or lean it against an unstable object.
11. **Never use a metal ladder around electricity.**

12. Keep tools and other materials being used while on a ladder in a safe type of holder, secured to person or ladder, to prevent dropping off and striking someone.
13. Only one person should be on a ladder at a time. Use additional ladder or erect a scaffold if others must work with you on a job.
14. Use caution when carrying a ladder so that you don't strike anyone or so someone will walk into it.
15. Be as careful when using a four foot step ladder as you would a thirty foot extension ladder. Don't be lulled into a sense of false security just because the ladder is low. A fall from either height may be fatal.
16. All equipment or machinery which present a hazard to the operator should have the danger are clearly marked in accordance with OSHA safety standards. Aisle ways, hallways, foyers, vestibules, entrances and exits should be kept free of objects, obstructions and debris.

Office Safety Rules:

a. General
    1. Firm footing is the first safeguard against a bad tumble.
    2. Wear "sensible" shoes. They prevent fatigue and give sure footing. Wear shoes that fit comfortably and securely. Have rundown heels repaired.
    3. When you have to climb, use a safety ladder or foot stool.
    4. Do not run or walk fast around blind corners, past doorways, on stairs and in corridors. Do not stand and talk in front of closed doors that may open suddenly.
    5. Watch out for telephone cords, office equipment wires, paper clips, waste paper, rubber bands and pencils underfoot. Keep the floors free of unwanted articles thus eliminating trip hazards.
    6. Use handles when closing file or desk drawers or disappearing typewriter desks. Use handles or knobs when closing doors. Report "hard to open" file and desk drawers.
    7. Keep file drawers, desk drawers, desk slides and locker doors closed when not in use. Open only one file drawer at a time. This will prevent the file from tipping over on you.
    8. Keep razor blades, pins, pen points, jack knives, shears, hand awls, thumbtacks, and all other sharp objects in the proper place. Handle them carefully. Disposal should be in sealed designated containers.
    9. Be sure your typewriter/computer is securely fastened in place.
    10. Adjust or clean power-driven office machines only when they are stopped and unplugged. Use all machines only for the purpose intended and in the way intended.
    11. Do not throw cigarette butts in the trash cans. Guard against fires!
    12. Do not block emergency egress (pathways or doors) with desks, chairs, etc.

13. Extension cords or multiple outlet adapters should never by used except for temporary use such as with audiovisual equipment or portable tools.
14. Report all frayed electrical cords and/or cracked plugs to maintenance for repair and do not use the equipment until properly repaired.
15. Use earplugs if noise levels are excessive and cannot be avoided.
16. Radios, stereos, audio equipment, etc. Should be played at medium to low range.

b. Evacuation: Know the sound of your fire alarm and pre-plan your evacuation should the alarm sound.

APPENDIX C- Inspection and Compliance

In order that the efforts to provide a safe and healthful campus environment at Florida Institute of Technology are carried out, there is a need to inspect (audit) the safety and health conditions of the facilities of the University.

In the complex university environment many items affect the faculty, staff, students, visitors and the surrounding community. It is imperative that the environment be closely monitored and controlled. One method in achieving this objective is to perform inspections. The basic operating procedure involves periodic inspections of all University physical facilities and the operations performed therein, with the results documented in permanent record form. Inspections will be made by a representative of the Safety Committee with opportunity through notice to its chairman, for a member of the department, residence, etc. to participate. Inspections are also to be performed by the supervisor in charge of a particular job or shop, University wide.

Reasons for inspections:

a. The University is subject to various types of inspections which serve the University in many ways. Some of which are:
    1. To detect unsafe and unhealthy conditions and/or actions.
    2. To demonstrate the administration's sincerity in accident prevention and the health and welfare of the faculty, staff, students and visitors.
    3. To help inform employees of the Safety Committee as to hazardous activities associated with facilities.
    4. To enable the members of the Safety Committee and other individuals with safety related responsibilities to work with departmental personnel in improving institutional environment.

Inspection Techniques:

a. Inspections will be made utilizing prepared checklists (See checklists attached).
b. The persons who make inspections should prepare themselves as follows:
    1. Analyze incident experience of the area(s) to be inspected.
    2. Familiarize themselves with the types of hazards inherent in the area(s) to be inspected.
    3. Review of previous inspection reports.

c. Inspection personnel should be tactful in pointing out unsafe acts to employees and should notify the supervisor immediately.
d. The person in charge of the area to be inspected should be consulted prior to the inspection and given the opportunity to participate in the inspection process. Other faculty and staff members may participate to the extent of commenting upon and bringing possible violations to the attention of those making inspection.

e. Inspections should cover all areas of the University, but certain emphasis may be put on those areas where excessive numbers of employee incidents (accidents) occur.
f. Pictures may be used by the Safety Committee to document unsafe conditions and to compare with corrected facilities.

Inspection Types:

a. Periodic inspections – Scheduled to be made at regular intervals. Such inspections may be monthly, semi-annually, quarterly or at other suitable intervals.
b. Intermittent inspections (walk-through) – This type of inspection is made at irregular intervals and may include a specific department, piece of potentially hazardous equipment, etc. Intermittent inspections tend to keep supervisors alert to find and correct unsafe conditions.
c. Special inspections (including imminent danger actions) – Often necessary because new and/or potentially hazardous equipment procedure has been implemented. In the event any manipulation, action or condition is discovered which in the opinion of the Safety Committee is considered to constitute unsafe situations with imminent danger potential, the Chairman of the Safety Committee or his representative may order the immediate cessation or modification of such manipulations, actions or conditions as may be deemed necessary. A special inspection may also be conducted as a follow-up to an incident investigation.
d. Agency Inspections – This type of inspection is made at irregular intervals by OSHA, Department of Environmental Regulation, the city of Melbourne fire Department, the Department of Health and Rehabilitative Services (HRS), the Office of the State Fire Marshall, insurance companies and others that pertain in environmental health and safety.
e. Complaint Based Inspections – Violations and deficiencies observed by affected persons may be reported by such persons directly to the Safety Committee which will inspect in response to valid complaints. Notification of the results of the inspection will be given to the complainant if requested. The rights of affected personnel in reporting complaints of matters affecting occupational health shall be exercised without retaliation on the part of any other person.

Inspection Personnel:

a. The inspectors should have the following qualifications:
    1. Knowledge of the incident experience of the area to be inspected.
    2. Familiarity with the incident potential in the area to be inspected.
    3. Ability to make practical recommendations for corrective action.
    4. Diplomacy when interacting with personnel.

b. Inspectors should set an example by always wearing proper clothing in special areas.
c. The inspector may be:
    1. Representatives of the Safety Committee.
    2. Department heads/supervisors for in-house periodic (quarterly) inspections.
    3. Official governmental agency inspectors or insurance company inspectors for agency inspections.
    4. If possible, the Safety Committee inspectors should be assigned to areas in which they have knowledge but do not necessarily work.
    5. Representative from the Safety Committee shall accompany all inspectors who perform Agency inspections and shall assist safety and health committee members with their inspection efforts.

Inspection Process:

a. Inspection process: the three general components of inspecting are:
    1. Solicit the assistance of the person in charge of the area
    2. Walk around to observe for unsafe conditions or actions
    3. Close conference with the person in charge of the area

    Helpful inspection suggestions are as follows:
    1. Make a note when the unsafe condition or action is discovered.
    2. Use the checklist when making the survey, if applicable.
    3. Always indicate the exact location and nature of the hazard.
    4. Avoid citing trivial items, as this will undermine inspection credibility but not them verbally to the person in charge.
    5. Conducting of a closing conference will help expedite corrective action.
    6. Inspections should be done systematically and thoroughly.

b. Inspection reports:
    1. An Imminent Danger Report is used to report conditions requiring immediate action. This is done by submitting a work order, discontinuing an unsafe practice, etc.
    2. Observed violations of safety and health standards, deficiencies, and non-compliance items observed during General, Special, Periodic and Intermittent Inspections will be recorded in written inspection reports for Safety Committee records. The original inspection report of all recorded violations will be sent to the Safety Committee for disposition. The faculty or staff person responsible for the area inspected will make arrangements for and accomplishment of appropriate corrective action. The responsible person should respond to the Safety Committee indicating corrective action taken with regard to each reported violation, or the reason for lack of abatement of violations. Such reasons should be set forth in sufficient detail to

permit determination by the Safety Committee and/or the administration if further action is required.

Report Disposition:

a. Supervisor's inspection reports should be sent to:
    1. The Safety Committee for review.
    2. Appropriate person in charge of the area inspected.

b. The Safety Committee's reports are to be sent to:
    3. The appropriate person in charge of the area inspected.
    4. The immediate supervisor of the person in charge of the area inspected.

c. All agency inspection reports are to be sent to the Chairman of the Safety Committee who will send the report or the applicable actions to those responsible for correcting any problems. These must be answered and the Safety Committee will report to the inspecting agency as to corrective steps taken.

Remedial Action:

a. The person responsible for the area inspected should take all corrective actions necessary for the resolution of the items noted on the inspection form.

b. The Safety Committee should be consulted when necessary on the type of corrective actions to be taken to ensure that such actions are adequate to correct the problem.

Follow Up Action:

a. Generally, a 15 day abatement period, longer if needed, will be allowed before initiating the "no Response Memorandum."

b. If no response is received the Safety Committee relative to the inspection report, the immediate supervisor and/or the appropriate department chairman may be contacted to assist in securing compliance.

c. Additional follow-up may be necessary if all violations have not been corrected within a reasonable time period.

Inspection Checklist:

a. For the convenience of the Safety Committee and the various department/section supervisors who must perform inspections of their areas,

an inspection checklist is included at the end of this appendix. Space has been provided at the end of this report to include recommendations and other information. Please note this inspection checklist has a column for "S" (Satisfactory) and "NS" (Non-Satisfactory). Non-Satisfactory items must be corrected within a reasonable time period.

FLORIDA INSTITUTE OF TECHNOLOGY
ANNUAL SAFETY INSPECTION REPORT

Building_____

Date _____ **Time** _____

Inspected By _____ **ID#** _____

Check each item below as Satisfactory (S) or Unsatisfactory (U). All items checked as Unsatisfactory need to be explained on the last page.

1. PROTECTION SYSTEMS:	**S**	**U**
A. Alarm Systems (Fire and Security)		
1. Alarm Panel; Accessible, Functional, Undamaged	___	___
2. Door Contacts; Affixed, Undamaged	___	___
3. Motion Detectors; Affixed, Undamaged, Not Blocked	___	___
4. Smoke and Heat Detectors; Affixed, Undamaged, Not Blocked	___	___
5. Pull Stations; Affixed, Undamaged, Accessible	___	___
B. Fire Extinguishers		
1. Accessible, Clearly Visible	___	___
2. Properly mounted on Wall	___	___
3. Container and/or Hanger Undamaged	___	___
4. Extinguisher Serviced and Charged	___	___
C. Sprinkler and Standpipe Systems		
1. Exterior- Fire Dept. Connections (FDC)		
A. Accessible and Visible	___	___
B. No Visible Signs of Damage	___	___
C. Caps in Place	___	___
2. Interior		
A. Riser Accessible	___	___
B. No Visible Leakage	___	___
C. Connections Accessible, Capped, No Leakage	___	___
D. Sprinkler Heads, 18 inch Clearance From Any Storage	___	___
E. Sprinkler Heads, No Damage or Leakage	___	___
D. OTHER:_____		
_____		
_____		
_____	___	___

2. **HOUSEKEEPING**	**S**	**U**
A. Aisles, Corridors, and Stairways		
1. General Housekeeping	___	___
2. Adequate Lighting	___	___
3. No trip, slip, or fall hazards	___	___
4. Uncluttered and clear passageways	___	___
5. Carpets and Entry Mats: Secure and in good repair (not frayed, ripped, torn)	___	___
6. Emergency Lighting: functional, affixed, and undamaged	___	___
7. Stairways: Unobstructed, tread-secure, firm, non-slip	___	___
8. Other: _____		
_____		
_____	___	___
B. Offices, Classrooms, Labs, Misc. Rooms		
1. General Housekeeping	___	___
2. Adequate Lighting	___	___
3. No trip, slip, or fall hazards	___	___
4. Floor area clean and uncluttered	___	___
5. Furniture: stable and in good repair	___	___
6. No blockage of Electrical Switches, Outlets or Circuit Breakers	___	___
7. Switches, Outlets and Circuit Breakers have proper covers that are secure and undamaged	___	___
8. Lighting Fixtures and Lamps:		
a. Fixtures are affixed and undamaged	___	___
b. Covers and shades in place	___	___
c. No combustible materials stored close to light fixtures or lamps	___	___
9. Extension Cords:		
a. Cords are not worn, damaged or spliced	___	___
b. Cords are not covered by rugs, carpets, etc.	___	___
c. Cords are not overloaded (1 item per cord!)	___	___
d. Cords not attached to walls by nails, staples, etc.	___	___
10. Shelves: stable, not overloaded	___	___
11. Gas Outlets: Secure, affixed, undamaged, no leakage	___	___
12. Chemicals: Properly labeled and stored	___	___
13. Any signs of leakage or spills	___	___
14. Safety Equipment: Accessible and Functional	___	___
15. Other: _____		
_____		
_____	___	___

		S	U
3.	**ELECTRICAL, MECHANICAL, HEATING, A/C ROOMS**		
	A. Lighting: adequate and functional	___	___
	B. Rooms uncluttered and accessible (good housekeeping)	___	___
	C. Doors open freely and doorways not obstructed	___	___
	D. No water leakage	___	___
	E. No bare, exposed, or damaged wiring	___	___
	F. Switches and outlets securely affixed, covers undamaged	___	___
	G. Circuit Breaker Panels:		
	1. Accessible, no obstructions	___	___
	2. Panel has a functional cover in place	___	___
	3. Panel is labeled as to what it services	___	___
	4. Breakers are clearly and accurately labeled	___	___
	H. Water Heaters, Gas and Electric:		
	1. In good repair, no leaks	___	___
	2. No storage on top of or next to heater	___	___
	I. Other: _____		
	_____		
	_____	___	___
4.	**ELEVATORS**		
	A. Current Inspection Certificate	___	___
	B. Lights: adequate and functional	___	___
	C. Alarm Bell: functional	___	___
	D. Floor in good repair: no trip, slip or fall hazard	___	___
	E. Emergency Telephone: functional and in good repair	___	___
	F. Emergency Key Operations	___	___
	G. Normal Operations: All buttons functional	___	___
	H. Other: _____		
	_____		
	_____	___	___
5.	**BUILDING ENTRANCES AND EXITS**		
	A. Exterior Approaches: surfaces clean and unbroken	___	___
	B. Adequate Lighting	___	___
	C. Doorways unobstructed	___	___
	D. Entry Mats: secure and in good repair	___	___
	E. No slip, trip, or fall hazards	___	___
	F. Doors are self closing and locking mechanism functions	___	___
	G. Exit Lights: affixed, undamaged, and functional	___	___
	H. Other: _____		
	_____		
	_____		
	_____	___	___

6.	**SPECIAL HAZARDS**	**S**	**U**
	A. Electrical Equipment:		
	1. Accessible	___	___
	2. Electrical cords in good repair, not frayed, damaged or spliced.	___	___
	3. No combustible stored on or near equipment	___	___
	B. Mechanical Equipment:		
	1. Accessible, clean, and in good repair	___	___
	2. All safety devices and guards in place	___	___
	3. No obvious hazards	___	___
	C. Generators:		
	1. Accessible, clean, and in good repair	___	___
	2. Fuel tank: capped and no leakage of fuel	___	___
	3. No bare or exposed electrical wires	___	___
	D. Gas: L.P. and/or Natural (Metered):		
	1. Meters and tanks accessible and in good repair	___	___
	2. Supply lines: in good repair, no leakage	___	___
	E. Gas Cylinders:		
	1. Accessible, upright, secured, in good repair	___	___
	F. Hazardous Materials:		
	1. Properly stored and labeled	___	___
	2. Material safety data sheets: present, accurate, accessible and readable	___	___
	G. Other: _____		
	_____		
	_____	___	___
7.	**SIDEWALKS, RAMPS, AND PLATFORMS**		
	A. Adequate Lighting	___	___
	B. No obstructions or clutter	___	___
	C. No slip, trip, or fall hazards	___	___
	D. Handrails: affixed, solid, and in good repair	___	___
	E. Other: _____		
	_____		
	_____	___	___

8.	**PARKING LOTS, DRIVEWAYS, SERVICE ROADS, AND FIRE LANES**	**S**	**U**
	A. Adequate Lighting	___	___
	B. No obstructions or clutter	___	___
	C. No slip, trip, or fall hazards	___	___
	D. Signs and asphalt clearly marked	___	___
	E. Other: _____		
	_____		
	_____	___	___

APPENDIX D – Campus Personal Safety

General Campus Safety and Security Policies:

In order to achieve campus safety and security, all members of the community must work together through observation and communication. First, we need to have an understanding of protective programs and systems. Second, we must have a means of communication and action in order to reduce or eliminate safety and security threats or hazards.

Florida Institute Technology faculty, staff and students should report all criminal incidents, threats, injuries, property loss, accidents, safety hazards, etc. to the Campus Security Department. Prompt notification will facilitate Campus Security's reporting to the authorities. Timely reporting will assist in further documenting trouble spots where corrective measures can be taken, thereby, enhancing crime prevention. The Campus Safety Department operates 24-hours a day and can be reached by calling 8111.

In the event of a serious emergency, such as an immediate threat to life or limb, please call the local police/fire/emergency medical service. These emergency services can be reached by calling **911** (from outside campus) or **9-911** (from the campus phone system).

General Security:

Uniformed Campus Security Officers patrol the campus in marked vehicles, including bicycles and golf carts. However, this does not guarantee your complete safety. These officers observe and detect crimes, acting as an informational and advisory unit, rather than a regulatory agency. Campus Security personnel are not sworn or armed police offices. Primarily, the officers protect the campus from outside threats by restricting campus access only to authorized students, staff and faculty (or their guests). The inspection and maintenance of locks, doors, windows, lights and alarms are coordinated by both the Campus Security and the Facilities Management departments. A coordinated effort is made between these two departments through sharing of radio communication. This increases the level of service, along with response time when urgent circumstances arise.

Preventive measures may be taken by students which will increase their personal security, as well as the security of their residences, vehicles, and personal property. The Florida Institute of Technology Campus Security Department encourages you to take responsibility for your actions, to enhance the safety and security of all. These preventive measures include, but are not limited to, the following:

a. Keep your doors locked, and don't lend the keys. Keys can be duplicated. If you lose a key or believe that someone has a key to your room, report this immediately to the office of Residential Life, and the Facilities Management will re-key the lock. Your residence or car should be locked at all times, whether occupied or not. Good locks on windows and doors make it difficult for assailants or burglars to get in, there by acting as a deterrent.

b. Do not "prop" doors open. This presents a threat to the security of the building by allowing unauthorized persons to enter. An open door may also permit a fire to spread unchecked.

c. When you are in residence or working late in University buildings, close the shades/curtains/blinds after dark.

d. Exercise, travel or jog with a friend or partner. Tell someone where you are going and when you expect to return. Stay in well-lighted areas, and don't walk alone at night. Remember, there is safety in numbers.

e. Be aware of unusual or suspicious persons or conditions. Trust your intuition or "gut" instinct in your observations. It is better to be safe than sorry.

f. Don't offer or accept a ride to/from individuals you don't know, even if they say they are students.

g. Call Florida Institute of Technology Campus Security at 8111 to report crime or suspicious activity.

h. If you suspect danger, or are threatened, call the Melbourne police first (**9-911 on campus**), (**911 off campus**), then call Florida Institute of Technology Campus Security.

i. If you let someone in, and then have second thoughts, be assertive and demand that the person leave, or leave yourself. Anyone who refuses to leave is a trespasser, and you should call the police to have them removed. Another alternative is to pretend that you are not alone be mentioning a friend or family member is asleep in the next room or working in the next office. In addition, you may wish to call a friend, fellow student, or co-worker to come over.

j. Make sure hallways, entrances and grounds are well-lit. Leave outside lights on all night. When away from residence for the night, or when you expect to return after dark, leave an interior light on in one or two rooms, and draw the shades. Keep the radio on to give the impression that someone is home.

k. Never open the door to strangers. Maintenance personnel, police, etc., carry identification and will present it upon request. Ask to see their identification.

If you are still unsure, before permitting entry call Campus Security or the police. No soliciting is allowed on campus, violators should be reported to Campus Security. If someone comes to your door requesting to use your phone, do not open the door and let that person in. Instead, offer to make the call for them.

l. Get to know your neighbors so you can go to them for help if necessary. Become familiar with faces and routines of your neighbors, to help alert you to an unfamiliar person or situation.

m. Avoid giving out information about yourself, or making appointments with strangers over the phone.

n. Photocopy all important papers, such as your driver's license and credit cards, and keep the photocopy in a safe place. This information will be invaluable if you lose your license or cards.

On Campus:

Escort Service:

The Florida Institute of Technology Campus Security Department operates and escort service 24-hours a day. This service is provided to all campus community members. Call the Campus Security dispatcher and request an escort. The dispatcher will check with the office on patrol for their estimated time of arrival at your location. If this short delay causes you anxiety, tell the dispatcher and they will stay on the line with you until the patrol officer arrives. In addition, if you are arriving on campus late at night and are unable to find a parking place near your residence hall, either use the emergency phone near the parking lot, or drive to the Campus Security office for assistance.

Elevators:

Elevators can be potentially dangerous areas. Following simple precautions which you may take to minimize your risk:

a. Trust your intuition. If you feel uncomfortable, you do not have to use the elevators. Use the stairs or call Campus Security.

b. If you are in an elevator and someone suspicious enters-leave! If you cannot leave, stand near the controls. If necessary, you can press all the buttons or use the emergency alarm.

On the Street:

It is always advisable to travel with friends. There is safety in numbers, so use the "buddy" system whenever possible. Criminals are looking for an easy target or victim,

and two or more people walking together provide additional complications that a criminal may not want to face.

Other precautions are as follows:

a. Be alert. Look around you, and be aware of others on the street. Make it difficult for anyone to take you by surprise. Women should carry a whistle on a key chain. Walk with keys in your hand.

b. Stay on populated, illuminated streets if at all possible, avoiding dark or concealed areas. Walk in the middle of the street if it appears safer.

c. If you feel like someone is following you, turn around and check so that you are not caught off guard. Cross the street, or change direction if necessary.

d. If you are being followed, walk or run toward people, traffic, or lights. Consider confronting the aggressor with a loud, firm voice, "Don't follow me." Try to find an occupied building, or throw something through a window to attract attention.

e. If a car follows you or stops near you and asks for directions, do not approach the car. Change direction if you feel threatened, and walk or run toward an area of activity.

In Your Vehicle:

a. Park in areas of high visibility at night and check the street before leaving the car.

b. Walk to the car with your keys ready. Attach a small flashlight to your key ring, so that you will have sufficient light to quickly unlock the car door.

c. From a distance, check the parking lot carefully to make sure that no one is lurking nearby. In addition, check underneath your car for persons who may be hiding from you. Before entering the vehicle look inside, checking both the front and back seats for anyone hiding there.

d. As soon as you enter the vehicle, day or night, be sure to lock the doors, so that no one can jump in at a red light.

e. Keep enough gas in your tank for emergencies.

f. If you are being followed by another vehicle, drive to a police station or a business that has lights on and people inside. You may not want to go directly home with someone following you.

g. If your car breaks down, lift the hood, put the emergency flashers on, get back into your car and lock the doors, and wait for assistance. If someone stops ask them to call the police.

h. Don't stop for stranded motorists. You can assist them better by calling the police.

i. With the advent of new car alarms, sometimes keys are not needed to enter a vehicle. The owner simply uses an alarm device to open the door. This feature should not encourage vehicle owners to leave keys in the ignition. All alarms can be defeated, and leaving the keys in the ignition is an invitation for that vehicle to be stolen.

Jogging:

a. Try to jog with another individual and always have identification with you. Be aware of people around you.

b. Stay on well-lit paths in open areas, as you may fall and injure yourself and require assistance. Vary your route, and be suspicious of people you pass frequently.

Sporting Events:

Sporting events present particular problems relating to personal safety and protection. Potential criminals find it easy to blend in with the crowd, making detection or apprehension difficult. In addition, with the spectators' attentions focused on the sporting event, personal possessions become easy targets. In the parking lot, the wide choice of vehicles may facilitate the ability to commit crime. It is particularly important that you remember to lock you vehicle. Some suggestion in safeguarding yourself and your possessions are as follows:

a. Do not bring personal possessions to the event, unless they remain on your person the entire time. Storing your possessions, such as rings and watches, in a container on the sidelines is virtually inviting theft.

b. Write your name and telephone number on your softball glove, basketball, tennis racket, etc.

c. Carry identification with you, especially your health insurance information in case of injury.

d. Remember, you will be engrossed in activity. If you are on the playing field, the area is a wide open space that affords a criminal an opportunity to observe you unnoticed. It is important that safety precautions are followed. If someone with criminal intent observes your precautions, you will not appear

to be a potential victim. Reduce your risks by leaving in a group or with another person.

e. Know where the nearest emergency phone is located in relation to your activity.

Personal Injury:

Campus Security does not transport injured persons from Student Health Services to medical facilities. If the injured person has no other means of transportation, an exception may be made and Campus Security may transport that individual. If Campus Security is unavailable, or in Emergency situations, an ambulance will be called immediately.

Campus Telephones:

There are 11 emergency telephones located throughout campus. The phones have no hand sets, the user simply depresses the button located on the face of the unit. If any emergency service is needed, such as police/fire/ambulance, the Campus Security dispatcher will contact them. Campus community members should familiarize themselves with the location of the emergency telephones.

Campus Security and The Police:

Report all crimes to the Florida Institute of Technology Campus Security Department and to the Melbourne Police Department. Our primary concern is the safety and well-being of the victim. Second and third concerns are the apprehension of the assailant and the preservation of evidence of the crime.

The Florida Institute of Technology Campus Security Department and the Melbourne Police Department maintain a strong working relationship. If you feel uncomfortable in contacting the police directly, please feel free to use the Campus Security Department as a liaison to facilitate your problem-solving needs.

Telephone Numbers:

Florida Institute of Technology Campus Security	**8111**
Emergencies and Non-emergencies	
Melbourne Police Department	**9-911**
Emergencies on Campus/Non-emergencies	
Brevard County Sheriff's Office	**9-911**
Emergencies on Campus/Non-emergencies	
Poison Control	**1-800-282-3171**
Rape Crisis Center	**1-904-258-7273**

FLORIDA INSTITUTE OF TECHNOLOGY CAMPUS SECURITY CRIME PREVENTION CHECKLIST

_____ Do I keep telephone numbers of local emergency services on or near the telephones?

_____ Do I have a plan of escape from my residence in case of fire or other emergency?

_____ Do I practice the BUDDY SYSTEM, which includes letting someone know where I am going, when I plan to return, what routes I will take and how to reach me?

_____ Do I report all suspicious persons or situations to the Campus Security Department?

_____ Do I have a plan of action in case my safety is threatened?

_____ Do I let friends and dates know what I consider appropriate behavior? Trust your instincts. If a situation does not feel right, change the situation or get away from it.

_____ Do I recognize that alcohol can cloud my judgment and make me vulnerable to suggestions or actions I would normally reject?

_____ Do I walk in an alert and confident manner, and keep to well-lit, highly traveled areas? Do I pay attention to those walking around me?

_____ Do I maintain a safe walking distance from bushes, parked cars, alleys, and strangers?

_____ Do I utilize Florida Institute of Technology's escort service when on campus?

_____ As I approach any car, do I have my keys in hand and do I look underneath the car and in the back seat for potential attackers?

_____ Do I keep my car locked at all times and the windows closed, even when I'm in it?

_____ Do I have a "Call Police" emergency banner in my car?

_____ Do I keep valuables out of plain view when in and out of my car?

_____ Do I park in well-lighted areas whenever possible?

_____ Do I check for loiterers before leaving my car

APPENDIX E – Fire Prevention and Protection

Fire prevention is the most important step in fire safety. If carried out carefully and conscientiously, the rest of the fire safety program may never have to be implemented.

a. Keep all exit corridors, stairwells, hallways and foyers clear of obstructions and/or debris at all times.

b. Turn off electric or heat producing equipment such as automatic coffee pots when not in use. Automatic timers can be used for such purposes.

c. Trash receptacles should be metal or FM/UL approved plastic. Containers located in hallways and exit corridors must be covered or equipped with a self-extinguishing lid assembly. All trash containers in classrooms, laboratories and offices which are five gallons or less in size need not to be equipped with covers.

d. Parking or storing bicycles or gasoline powered vehicles (i.e. mopeds, motorcycles) in entrance foyers, stairwells, corridors or any other spaces in buildings, including porches and entrances or exits to buildings is strictly prohibited. Bicycles, motorcycles or mopeds blocking exits or entrance ways will be removed at the owners expense.

e. Use only metal or approved plastic ashtrays. Don't dispose of cigarettes in trash receptacles. They should be put in proper ashtrays and not disposed in trash cans until the material is wet and left to soak for 10 minutes.

f. Do not smoke in areas where oxygen or flammable liquids are used.

g. Keep work areas clean. Combustible materials should not be allowed to accumulate in quantities which will create safety hazards.

h. Keep sprinkler heads and fire alarm or fire suppression equipment free of obstructions.

i. A "Hot Work" permit for welding, cutting or burning must be obtained from Facilities Management prior to commencement of any such operation, and all applicable safety rules must be followed.

Reporting of all fires promptly and emergency evacuation are of paramount importance to life safety and property protection. Automatic fire alarm systems, where provided in buildings, activate general alarms in that building. At present, not all alarm systems are monitored at a station such as Campus Security. Alarm installations are being implemented in a phased in manner.

a. Following activation of an alarm, the resetting of the system and verification of its "All Clear" position will be accomplished by either the Campus Security officer at the scene, maintenance personnel involved in the fire and safety or the Fire Department Chief in charge, should they be called. No other persons are authorized to adjust, reset or otherwise manipulate fire alarm systems.

b. In some buildings there are automatic fire detection devices (smoke and heat detectors). If activated, they will sound the building alarms. The same course of action toward evacuation and reporting as previously noted must be carried out. No one is to tamper with these detectors.

c. Pre-plan your response to a fire emergency. Know where the nearest fire alarm, extinguisher, and fire exit or stairwell are located.

d. If you discover a fire in any location, you should, in general:
    1. Pull the nearest fire alarm.
    2. Call the Fire Department.
    3. Rescue anyone in immediate danger if possible.
    4. Alert others and evacuate the area.
    5. Close the door to contain smoke and fire.
    6. Report the fire:
        -to Campus Security
        -to Facilities Management

e. If you hear the fire alarm, prepare for immediate evacuation but listen for instructions via the public address system (if so equipped), which may direct you away from the fire while proceeding with evacuation. If no PA system exists in your building, don't delay; evacuate the building immediately using the nearest available exit or stairwell.

f. Once outside, stay clear of the building and congregate at safe points out of the way of fire personnel.

g. Do not re-enter the building until an "All Clear" is issued by the Fire Department or Campus Security officials.

Remember, in general:

1. **Pull the fire alarm.**
2. **Call the Fire Department.**
3. **Evacuate the area.**
4. **Report the fire:**
    -to Campus Security
    -to Facilities Management

Fire protection systems can be considered as two parts: Automatic systems and Manual operations.

a. Automatic fire extinguishing installations exist in some or parts of some University buildings. Installation includes water sprinkler systems, halon systems, and installations. You should be familiar with those available in the building where you work study, or sleep.

b. The maintenance of automatic sprinkler systems, standpipes, hose installations and other fixed fire extinguishing systems is the responsibility of the Campus Security.

c. The furnishing, installation and maintenance of the proper type, capacity and number of portable fire extinguishers in buildings are the responsibility of Campus Security.

d. Portable fire extinguishers shall be conspicuously located and mounted where they are readily accessible.

e. Portable fire extinguishers shall not be obstructed or obscured from view.

f. The Campus Security will inspect and recommend placement of changes in the type, capacity, number and location of portable extinguishers as necessary to comply with statutory rules and regulations, including OSHA and NFPA.

g. The Safety Committee will foster a program or periodic maintenance, inspection and testing of fire extinguishing systems.

If a small fire occurs, "First Aid" fire fighting may be initiated by using portable fire extinguishers. A small fire would involve trash cans and electrical equipment, appliances and small pieces of furniture, etc. Florida Institute of Technology personnel are not trained or are they expected to fight fires other than incipient small fires. However, if the fire is any larger than a trash can size fire, or involves considerable amounts of smoke and toxic gases, fire suppression must not be attempted. No one is obligated to fight a fire. Incipient fire suppression procedures are as follows:

a. Locate the fire extinguishers in your area. They are mounted in hallways, kitchens, equipment rooms, laboratories, etc. by the maintenance personnel at the various campus locations, who also perform periodic inspections and maintenance procedures on these units.

b. Learn what type of fire the equipment will extinguish. The labels on the extinguisher will include such information:

    1. Class A – Combustibles (i.e. paper, wood, trash, cloth, etc.)
    2. Class B – Flammable and combustible liquids (grease, chemicals, etc.)

3. Class C – Energized electrical equipment (motors, etc.)
4. Class D – Certain chemicals (i.e. metals such as sodium, magnesium, etc.)

c. When operating the extinguisher hold it upright, pull pin, stand six to ten feet away from the fire, aim nozzle at base of fire and squeeze handle. The type of extinguisher used in Florida Institute of Technology buildings are of the stored pressure variety and include water (A), chemical (BC), Halon (ABC) and dry powder chemical (ABC and BC Units).

d. Never turn your back to a fire and never let the fire come between you and your way out of the fire area. Re-ignition may occur with some types of fires.

e. There are fire hoses located in the hallways and stairwells of many Florida Institute of Technology buildings. Hoses are designed and approved for use by the Fire Department. Unless trained to use these, you are not expected to do so. Florida Institute of Technology students and employees are not expected to use them.

Trapped in a room - If you hear an alarm or smell smoke outside your room, carefully carry out the following procedures:

a. Feel the door handle and upper part of the door. If they are hot or warm to the tough, DO NOT OPEN the door. If no second exit is available, do not panic even though you are trapped in the room. You are safer in the room than in the area outside your room.

b. If possible, use clothing or towels, etc. to seal all openings where smoke or toxic gases could enter the room, around doors air conditioning vents, pipes, etc.

c. If water is available, wet down the door and walls.

d. If the room becomes smoky, break the window carefully or open it, if possible at the top to allow heated gases and smoke to escape.

e. Also, open or break the window, about four inches at the bottom. Cover your head and body with a wet curtain, sheet, coat, etc. and seal, as best you can around the opening which will allow you to breathe the outside air.

f. Signal for help. Listen for instructions from rescuers. Keep calm.

Training – Upon request, the Campus Security will arrange for the Fire Department to conduct demonstrations and training sessions on the proper use of portable fire extinguishing units and life safety procedures.

Fire and Safety Equipment:

Policy: It is unlawful to interfere with apparatus or to send false fire alarms. It shall be unlawful for any person to break, destroy, or in any manner, interfere with or to obstruct, cover, or cause to be hidden any fire equipment. (Florida Statute 806.101)

Theft of fire extinguishers may be punishable by law. (Florida Statute 812.014 (2)(b)(6))

Any student, who in an unauthorized manner, tampers with or improperly handles fire and/or safety equipment (including but not limited to fire extinguishers, fire hoses, smoke alarms) shall be removed from the residence hall and shall be subject to University disciplinary action which shall include:

a. Referral to the University Disciplinary Committee for adjudication which could have as a consequence either disciplinary probation and appropriate penalties or suspension from Florida Institute of Technology; and possible a

b. Request for the issuance of a warrant for the student's arrest. *

*Improper and unauthorized use of fire and safety equipment is a violation of Florida State law and could result in prosecution.

Procedure: If you observe that fire or safety equipment in your hall has been tampered with, you should take the following steps:

a. Report the incident to your dormitory Resident Assistant, or,

b. Report the incident to the Security Office

APPENDIX F – HAZMAT

Hazardous Communication Standard and Right-to-Know

Purpose:

a. To enhance Florida Institute of Technology's commitment to provide a safe and hazardous free environment for faculty, staff, students and visitors, the University will comply with the guidelines and requirements of the Occupational Safety and Health Administration (OSHA) as promulgated in 29 CFR.

b. To insure that there is a comprehensive education and training program on hazardous materials available to each employee.

c. To insure that job performance reflects training and safe handling practices.

d. To promote the health and safety of faculty, staff, students and visitors.

e. To insure the tracking of all hazardous materials from point of entry to point of disposal.

f. To provide proper response in case of a hazardous spill.

g. To insure documentation reflects safe handling practices.

Scope:

This document applies to all Florida Institute of Technology property and is available to all University faculty, staff and students.

Test:

a. Labeling and other forms of warning:

    1. All chemicals will be properly labeled with an identification of the chemical, appropriate hazard warnings and the manufacturer's name and address.

    2. In some cases, signs placards, process sheets, batch tickets, operating procedures or similar accessible written materials are used in lieu of affixing labels to individual containers.

3. Do not remove or deface existing labels on incoming containers of hazardous chemicals unless the container is immediately marked with the required information.

4. Vendors who supply the University with hazardous materials are required to provide proper labeling for all their products. These labels normally are provided as "crack and peel" labels or are silk screened on the container itself. All departments are responsible to ensure that all containers in use in their departments are properly labeled.

b. Material Safety Data Sheets (MSDS):

1. MSDS's are written or printed data sheets concerning a hazardous chemical which are prepared and distributed with chemicals by chemical manufacturers and/or distributors. A sample MSDS follows this appendix.

2. MSDS's are to be maintained for ALL hazardous chemicals used or handled. A master MSDS file will be maintained in the Biological Sciences Department Office. The University HAZMAT Chairman and/or Campus Security Officials should be contacted for MSDA information.

3. MSDS's are available to ALL employees, are printed in English or appropriate language and contain:
    a. Chemical identification
    b. Hazardous ingredient data
    c. Physical data
    d. Fire and explosion data
    e. Reactivity data
    f. Spill or leak procedures
    g. Special protection data
    h. Special precautions

c. Employee Information and Training:

1. All employees, both present and new, will be trained in accordance with OSHA's 29CFR. Training for OSHA's Hazardous Communication Standard is based on the requirements of the Standard itself and the chemical hazards present in the workplace. Employees need to learn about their Right-to-Know, the written Hazard Communication Program, warning labels, the availability and utilization of MSDS's, the hazards to which they may be exposed, the determination of the presence of hazards and the means of protection available to them. These items will be covered in the General Training Program.

2. The General Training Program will include written materials which will be distributed to employees to reinforce audio-visual training.

3. Hazard Communication posters and notices will be displayed throughout Florida Institute of Technology. These posters and notices will, among other things, identify employees' Right-to-Know and the person to contact for more information.

4. Each University department is required to provide additional employee training concerning workplace hazards when:

    a. Chemicals with new hazards are introduced into the workplace.

    b. Process or equipment changes are made which could cause new or increased employee exposures.

    c. Procedures and work practices are introduced or changed which could cause new or increased employee exposures.

    d. Employees are transferred from one work area to another where different hazards may be present.

d. Hazardous Chemical List:

    1. A list of hazardous chemicals known to be present in the workplace should be maintained in each department.

    2. In accordance with OSHA and EPA Community Right-to-Know laws, a copy of the University Hazardous Chemical List has been provided to the Melbourne Fire Marshall.

e. Non-routine Tasks:

The supervisor of an employee performing a non-routine task is responsible for adequately training that employee concerning the task. The training includes any applicable procedures designed to address a given task, such as Hot work, confined space entry, etc. The employee is responsible for insuring that the supervisor is aware that a non-routine task will be performed. Some non-routine tasks require special procedures to be follows, such as Lock and Tag Out procedures. It is the responsibility of employees to follow these procedures in order to ensure their own safety.

f. Contractors:

1. Upon initial entry onto the premises, contracted employees or supervisors should be advised of the University safety regulations. Contractors must comply with all OSHA standards while working on University property. Contractors are expected to take appropriate measures to protect themselves from any hazards present. They will be informed of any hazards to which they maybe exposed in the working environment and will be notified of the availability of MSDS's for hazardous materials in the work area.

2. Contractors will notify the University of any hazards to which they may expose the University employees and provide MSDS's for any hazardous materials they introduce to the work environment at the University.

g. Assignments of responsibility for Florida Institute of Technology officials and/or departments under the HAZMAT Program:

    1. Program Administrator:
        a. Serves as Chairman of the Safety Committee.
        b. Reviews program progress through administrative meetings and departmental progress reports.
        c. Supports mandatory departmental training.

    2. Hazardous Materials (HAZMAT) Chairman:
        a. Monitors and reviews program progress.
        b. Must be familiar with guidelines and requirements of OSHA Hazard Communication Standard, Florida Right-To-Know Law, Environmental Protection Agency and the Florida Department of Environmental Regulation.
        c. Assures that Material Safety Data Sheets (MSDS) are available to all departments for each hazardous material.
        d. Provides annual report to Safety Committee.
        e. Monitors hazardous materials tracking procedures and records.

    3. Department Head/Manager:
        a. Monitors and reviews program progress.
        b. Must be familiar with MSDS to assure department compliance to specific job standards.
        c. Must complete mandatory education on all new employees within the first 30 days. Training must be documented.
        d. Must assure annual review of the Hazard Communication Program to all existing employees. Training must be documented.
        e. Must assure training to all employees on NEW Hazardous materials prior to the use of the new product. Training must be documented.

f. Must assure that there is a MSDS for each identified hazardous material and that the MSDS's are available to each employee upon request.
g. Must notify all employees of where the Hazardous Communication Standard and MSDS's are located.
h. Must consult with HAZMAT Chairman:
    -If there are any questions about hazardous materials
    -Before changing from one hazardous material to another of greater or lesser toxicity.
    -If hazardous material containers are not properly labeled.

i. Must notify the HAZMAT Chairman with:
    -Addition of new hazardous materials to departmental stock.
    -Deletion of hazardous material from stock.

j. Must indicate on the purchase order when a MSDS is required by placing "Material Safety Data Sheet" after the product name.
k. Must label each container of a hazardous material with the chemical name and appropriate hazard warnings, unless the existing label conveys the necessary information.
l. MUST NOTIFY HAZMAT CHAIRMAN BEFORE DISPOSAL OF ANY HAZARDOUS MATERIAL THAT REQUIRES REMOVAL OFF SITE.
m. Report any hazardous substance spill to the HAZMAT Chairman so that the Brevard County HAZMAT Response Team may be notified.
n. Report any hazardous substance spill to the HAZMAT Chairman so that the Brevard County HAZMAT Response Team may be notified.

4. First line supervisor/faculty instructor:
    a. Attends mandatory education and training for all:
        -Hazardous material currently in use.
        -New hazardous materials.

    b. Must know and be able to safely demonstrate each job task dealing with any hazardous material within their workplace.
    c. Must be familiar with Materials Safety Data Sheets and their use.
    d. Must assure employee/student compliance to specific hazardous material job standards and safety procedures.
    e. Must train all employees in the proper storage and use(s) of each hazardous material.
        -Prior to starting the job, and,

-Annually thereafter

f. Must observe all employees/students using hazardous material for signs and symptoms of adverse reaction from hazardous materials.
g. Must refer all employees/students with signs of adverse reaction to the Health Center.
h. Must document all training on hazardous materials.

5. The employee and/or student:
    a. The employee must attend mandatory training and education sessions at the time of hiring and annually as a condition of employment.
    b. The employee will be responsible for learning, knowing and practicing each job task safely.
    c. The employee and students (receiving University payroll) must use proper safety equipment and establish safe procedures when handling hazardous materials.
    d. The employee/student must report any hazardous condition to the supervisor or Department instructor respectively.
    e. The employee/student has a right to information about hazardous materials. This information is provided by:
        -A poster placed in each department/lab/workplace
        -Material Safety Data Sheet copies which are available to:
            --The employee or student
            --Employee or student's designated representative

6. Purchasing and other departments:
    a. Will request MSDS from all hazardous material suppliers, listed on the University Hazardous Chemical List.
    b. Will request MSDS from all hazardous material suppliers thereafter as indicated by:
        -Lack of MSDS on file.
        -When specifically requested.

    c. Will forward all MSDS received to the Department of Biological Science and/or HAZMAT Chairman.

h. Florida Right-To-Know:

1. The Florida Right-To-Know law imposes an obligation to inform all employees of the toxic substances to which they are exposed in the workplace and to provide training, safe handling practices and emergency procedures. It also requires notification to local fire departments of the location and characteristics of substances regularly present in the workplace.

2. What is a Toxic Substance? A toxic substance is any chemical substance or mixture in a gaseous, liquid or solid state, if such substance or mixture:
    a. Appears on the "Florida Substance List" promulgated by the Department of Labor and Employment Security.
    b. Is manufactured, produced, used, applied or stored in the workplace.
    c. Causes significant risk to safety or health during handling.

3. Florida Institute of Technology requirements:

    a. Each department within the University that normally uses items listed in the "Florida Substance List" is required to:

        - Post a notice, provided by the department of Labor and Employment Security, informing workers of their rights under the law.
        - Obtain and maintain a Material Safety Data Sheet (MSDS) for each listed toxic substance present.
        - Make the MSDS's available upon request to an employee within five (5) of the employee's working days.
        - Insure that all containers with hazardous materials are properly labeled in accordance with paragraph a.
        - Provide instruction to employees within their first thirty (30) days of employment and at least annually thereafter, on the adverse health effects of each listed toxic substance with which they work in the workplace, how to use each substance safely and what to do in the case of emergency.
        - Advise employees of their right to obtain further information from the Hazardous Materials (HAZMAT) Chairman.
        - Notify the local fire department of the location and characteristics of each listed toxic substances regularly present in the workplace.

    b. Rights of Florida Institute of Technology Employees Under the Law:

        - The right to know of the listed toxic substances represented in the workplace.
        - The right to obtain a copy of the Material Safety Data Sheet for each listed toxic substance present.
        - The right to refuse to work under specified circumstances with a listed toxic substance if not

provided with a list of the Material Safety Data Sheet for that substance within five (5) days of requesting

- The right to instruction within thirty (30) days of employment and at least annually thereafter, on the adverse health effects of each listed toxic substance with which they work in the workplace, how to use each substance safely and what to do in case of an emergency.
- The right to obtain further information on the properties and hazards of listed toxic substances from the Hazardous Materials (HAZMAT) chairman.
- The right to protection against discharge, discipline or discrimination for having exercised any of these rights.

APPENDIX G – HAZMAT- Hazardous Waste Management

Purpose:

a. To establish and implement a Hazardous Waste Management Program at Florida Institute of Technology.

b. To insure Florida Institute of Technology is in compliance with the Florida Department of Environmental Regulation program for small quantity generators of hazardous waste.

c. To insure proper management of hazardous waste from cradle to grave.

Scope:

a. This Hazardous Waste Management Program applies to all Florida Institute of Technology departments – faculty, staff and students.

Text:

a. Background:

1. In 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA) to protect public health and the environment from improper management of hazardous waste. RCRA was primarily written to regulate hazardous waste managed by industry, the larger generator.
2. Since the initial enactment, RCRA has been amended to regulate the previously exempted small quantity generators.
3. The State of Florida has adopted by reference the federal regulations governing the small quantity generators.

b. The small quantity generator will:

1. With the most recent federal amendments published by the Environmental Protection Agency (EPA) on March 24, 1986, in the Federal Register (40 CFR), the 100-1000 kilogram per month generator will be required to:
   a. Use a multiple copy manifest when removing hazardous waste.
   b. Obtain an EPA/DER identification number.
   c. Store up to 6000 kilograms for no longer than 180 days.
   d. Write and implement a Preparedness and Prevention Plan.
   e. Use an EPA approved transporter for off-site shipment of hazardous waste.
   f. Dispose hazardous waste only at permitted RCRA facilities.
   g. Maintain a copy of the manifest for a period of three (3) years.
   h. File an exception report when a copy of the manifest is not returned from the disposal facility within sixty (60) days.

2. Florida Institute of Technology informed the DER that the University was a small quantity generator of hazardous waste on 28 August 1986 and on 04 June 1987 the University was classified as a Conditionally Exempt Small Quantity Generator and was in compliance.

c. Hazardous Waste:

1. Florida Institute of Technology as a generator of hazardous waste is required by law to identify and evaluate its waste. RCRA, in Chapter 40 Code of Federal Regulations (CFR) Parts 260-265, contains lists specifying wastes that are regulated and characteristics for identifying non-listed hazardous waste.

2. Chapter 40 CFR 261.31 through Chapter 40 CFR 261.33 identifies certain waste that the U.S. EPA has specifically listed as hazardous. Florida Institute of Technology handles the listed hazardous wastes and is subject to regulation. The University submitted an EPA form 8700-12, Notification of Hazardous Waste Activity to the Florida Department of Environmental Regulation and received-

IPA/DER I.D. #FLD 053-369-669

3. Characteristics of hazardous waste:

a. **Ignitability:** The waste material must have a flash point of less than a 140 degrees F. and/or be an aqueous solution with an alcohol content of greater than or equal to 24 percent. Examples are solvents and paint thinners. The hazardous waste number is D001.

b. **Corrosivity:** The waste material must be a liquid and have a pH of less than 2.0 or greater than 12.5. Examples are acids and caustics. The hazardous waste number is D002.

c. **Reactivity:** Waste material that is reactive to water, shock, heat, pressure, and undergoes rapid of violent chemical reaction. Some examples are perchlorates, peroxides, cyanides. The hazardous waste number is D003.

d. **TC Toxic:** This category includes eight (8) heavy metals and thirty-one (31) organic chemicals including ten (10) pesticides. There have been assigned numbers **D004-D043**. Waste in this category need only contain very small amounts of arsenic, lead, mercuryor one of the other heavy metals, or organics such as benzene, viny chloride, or one of ten pesticides.

d. Preparedness and prevention plan:

1. Florida Institute of Technology will be maintained and operated to minimize the possibility of fire, explosion or any unplanned release of hazardous waste or hazardous waste constituents to the environment.

2. Hazardous waste will be stored at the individual generation sites (Satellite facilities) and periodically purged via a DOT authorized Hazardous Chemical Transporter for proper disposal by an authorized TSDA (Treatment, Storage, and Disposal Facility). Fire extinguishers and telephone communictions have been placed within 25 feet of the building. This equipment will be tested semi-anually to insure it is in proper working condition.
3. All persons involved in the handling operation of hazardous waste must have access to either internal or external alarm or communication equipment.
4. Sufficient aisle space will be maintained in and around hazardous materials to insure unobstructed movement of personnel and equipment to any area in the event of an emergency.
5. Florida Institute of Technology will provide the Melbourne Fire Marshal with a complete list of hazardous chemicals and their locations on the University.

e. Contingency Plan and Emergency Procedures:

1. The Florida Institute of Technology emergency coordinator is the Chief of Campus Security. This individual will be available 24 hours per day and should be contacted immediately regarding hazardous material problems.
2. Campus Security will serve as the on-site emergency response office. Campus Security will be provided the name and phone numbers of the emergency coordinator, location of the fire extinguishers and spill control material and the phone number of the local Fire Marshall.
3. In the event of an emergency and/or spill involving a hazardous waste/material, the following will be notified in this order:
    a. Melbourne Fire Department (Note: Melbourne Fire Department **WILL NOTIFY** the Brevard county HAZMAT Team) Phone 9-111
    b. Emergency Coordinator (Mr. Jeffrey McCutcheon) Phone: 8111. Non-duty hours: Contact is made through Campus Security 8111.
    c. Division of Emergency Management. Department of Community Affairs. Phone: 1-904-488-1320
    d. National Response Center. Phone: 1-800-424-8802

    A follow-up written report will be provided to the Florida District Office, Department of Environmental Regulations, 3319 Maguire Boulevard, Suite 232, Orlando, FL, 32803
4. The essence of a plan to handle emergencies is best summarized by the acronym **"NEAR"** – **N**otify, **E**vacuate, **A**ssemble, **R**eport.

Establish who notified whom! Usually, of course, "who notifies" is a person involved in or witnessing the incident. Depending on the severity and complexity of the incident, that person may or may not be able to evaluate and wisely determine the actions to be taken next. For example, even for a small fire, persons closest to the scene may inadvertently choose an inappropriate means to extinguish the flame and thereby intensify the consequences.

Although at first it may seem foolish to notify someone else instead of acting immediately to control events, it is often wiser to notify instead of acting directly. Obviously, the person notified should be known to be capable of making proper and prompt decisions.

Evacuation may or may not be in order; the decision should be made by the person who is notified.

Evacuees should assemble at a pre-established location and report their arrival to a prior name alternative. It is important to be certain to determine if persons are or are not missing. Note particularly that it ma be unwise to conclude too quickly on the basis of incomplete information that persons are not present at the assembly point and are, therefore, trapped within the incident area.

The best emergency procedure plan required detailed planning by the University management staff, as well as employee/student training in advance of an accident with frequent drills to make sure that those involved will act prudently and promptly should an accident occur.

5. A detailed Contingency Plan for Florida Institute of Technology is published under separate cover.

f. Containers:

1. Good housekeeping procedures are required when handling and storing hazardous waste. This especially applies to the use of storage containers.
   Containers must be:

   a. In good condition and do NOT leak.
   b. Containers must be compatible with the hazardous waste stored in them and must meet D.O.T. standards.
   c. Containers holding hazardous waste must be closed during storage.
   d. Containers are not to be handled in a haphazard way so as to cause leaking or rupture.
   e. Containers will be inspected at least weekly to check for leaks and sign of corrosion.

f. Incompatible wastes must not be place in the same container. This can cause fires, leaks and other reactions
g. Each container must be marked with each period that storage began and marked with the words “hazardous waste.”

g. Manifest:

1. Disposal of hazardous waste in sanitary landfills is prohibited in the State of Florida. An alternative is to ship hazardous waste out of state to a RCRA hazardous waste disposal facility.

2. The Uniform Hazardous Waste Manifest (EPA Form 8700-22) is a special shipping document that must accompany all hazardous waste shipments of 100 kilograms (220 pounds) or more.

3. The following items on the manifest MUST be completed:

a. Item #1: EPA Identifiction Number
b. Item #3: Generator Name and address (business address)
c. Item #7: Transporter and ID number
d. Item #9 and #10: Designated facility name, site address, and ID number
e. Item # 11: U.S.D.O.T proper name, hazard class and ID number (UN/NA) for each waste as identified in 49 CFR 171-177

DM = Metal Drums, barrels, keys
DW = Wooden drums, barrels, keys
DF = Fiberboard or plastic drums
TP = Tank portable
TT = Cargo tanks (tank trucks)
TC = Tank cars
DT = Dump Truck
CY = Cylinders
CM = Metal boxes, cartons, cases
CW = wood boxes, cartons, cases
CF = Fiber or plastic boxes, cartons, cases
BA = Burlap cloth, paper or plastic bags

h. Packaging and Labeling:

1. Select a treatment and disposal facility that is authorized to receive hazardous waste. The FDER maintains a list of authorized TSDF’s (Treatment, Storage, and Disposal Facility).

2. Each container must be marked with the following:
   a. “Hazardous Waste’ Federal Law Prohibits Improper Disposal. If found, contact the nearest police or Campus security authority or the US EPA.”
   b. Generator’s name and address.
   c. Manifest document number

d. Proper DOT shipping name and identification number.

APPENDIX H – HAZMAT

Chemical Hygiene Plan

Purpose:

a. To bring Florida Institute of Technology into compliance with OSHA's Laboratory Standard (29CFR 1910.1450, subpart Z)

b. To protect laboratory employees from harm due to chemicals while they are working in a laboratory.

Scope:

a. This chemical hygiene plan applies to all Florida Institute of Technology faculty, staff and students who ordinarily spend full time working in a laboratory.

b. For the purpose of the Laboratory Standard and the Chemical Hygiene Plan, "laboratory employee" is defined as faculty, staff, students, office, custodial, maintenance and repair personnel, and others who, as part of their duties, regularly spend a significant amount of their working time within a laboratory environment.

Text:

a. General rules:

1. Never work alone in a laboratory or chemical storage area.
2. Wear appropriate eye protection at all times.
3. When working with flammable chemicals, be certain that there are no sources of ignition near enough to cause a fire or explosion in the event of a vapor release or liquid spill.
4. Use a personal safety shield for protection whenever an explosion or implosion might occur.
5. For the chemicals they are working with, all Florida Institute of Technology employees should know and constantly be aware of:

    a. The chemical's hazards as determined from the MSDS and other appropriate references.
    b. Appropriate safeguards for using that chemical, including personal protection equipment.
    c. The location and proper use of emergency equipment.
    d. How and where to properly store the chemical when it is not in use.
    e. Proper personal hygiene practices, related to the experiments and chemicals.

f. Appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal.

b. Personal Hygiene:

1. Wash immediately whenever a chemical has contacted the skin.

2. Avoid inhalation of chemicals; do not “sniff” to test chemicals.

3. Do not use mouth suction to pipette anything; use suction bulbs.

4. Wash well with soap and water before leaving the laboratory; do not wash with solvents.

5. Do not drink, eat, smoke, or apply tobacco, or cosmetic products into chemical storage or use areas.

c. Protective Clothing and Equipment:

1. Eye protection worn when working with chemicals should meet safety standards.

2. When working with corrosive liquids, wear gloves made of material known to be resistant to permeation by the corrosive chemical and tested by air inflation (DO NOT INFLATE BY MOUTH) for the absence of pin-hole leaks.

3. When working with allergenic, sensitizing or toxic chemicals, wear gloves made of material known to be or tested and found to be resistant to permeation by the chemical and tested for the absence of pin-holes.

4. Always wear low heeled shoes with fully covering “uppers”; do not wear shoes with open toes.

5. Whenever exposure by inhalation is likely to exceed the threshold limits described in MSDS’s, use a hood.

6. Carefully inspect all protective equipment before using. Do not use defective protective equipment.

d. Housekeeping:

1. Access to emergency equipment, showers, eyewashes and exits should never

be blocked.

2. All chemical containers must be labeled with at least the identity of the contents and the hazards those contents present to users.

3. Keep all work areas, especially laboratory benches, clear of clutter.

4. Keep all aisles, hallways and stairs clear of all chemicals.

5. All chemicals should be placed in their assigned storage areas at the end of each workday.

6. Waste should be properly labeled and kept in their proper containers.

7. Promptly clean up all spills; properly dispose of the spilled chemical and cleanup materials.

8. All working surfaces and floors should be cleaned regularly.

e. No unauthorized experiments will be carried out without prior approval.

f. Spills and Accidents: (See Appendix G, Hazardous Waste Management)

g. Procedures for Toxic Chemicals:

1. The MSDS for many of the chemicals used in the laboratory will state recommended limits or OSHA mandated limits, or both, as guidelines for exposure. Typical limits are threshold limit values (TLV), permissible exposure limits (PEL), and action levels. When such limits are stated, they will be used to assist the chemical hygiene officer (CHO) in determining the safety precautions, control measures and safety apparel that apply when working with toxic chemicals.

2. when vapors are produced from any chemicals, fume hood will be used.

h. Procedures for Flammable Chemicals:

1. In general, the flammability of a chemical is determined by its flash point, the lowest temperature at which an ignition source can cause the chemical to ignite momentarily under certain controlled conditions.

2. Chemicals with a flash point below 200 degress F. (93.3 degrees C.) will be considered “fire-hazard chemicals.”

3. OSHA standards and the National Fire Protection association (NFPA)

guidelines on when a chemical is considered flammable apply to the use of flammable chemicals in the laboratory.

4. Fire-hazard chemicals should be stored in a flammable-solvent storage area or in storage cabinets designed for flammable materials.

5. Fire-hazard chemicals should be used only in vented hoods and away from sources of ignition.

i. Procedures for Reactive Chemicals.

1. Reactivity information is given in manufaturers' MSDS's and on labels. It is further defined as material that is reactive to water, shock, heat, pressure, undergoes rapid or violent chemical reaction.

2. A reactive chemical is one that:

a. Is ranked by the NFPA as "3" or "4" for reactivity.

b. Is identified by the DOT as an oxidizer or an organic peroxide.

c. Is in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense or will be come self-reactive under conditions of shock, pressure or temperature.

j. Procedures for Corrosive and Contact-Hazard Chemicals:

1. Corrosivity, allergenic and sensitizer information is sometimes given on Manufacturers' MSDS's and on labels. Also, guidelines on which chemicals are corrosive can be found in other OSHA standards and in DOT 49 CFR and EPA 40 CFR.

2. A corrosive chemical is one that:

a. Fits the OSHA definition of corrosive in Appendix A of 29 CFR 1920.1200.

b. Fits the EPA definition of corrosive in 40 CFR 261.22, (has a pH greater than 12.5 or less than 2.5)

c. Is known or found to be corrosive to living tissue.

3. A contact-hazard chemical is an allergen or sensitizer that:

a. Is so identified or described in the MSDS or on the label.

b. Is so identified or described in the medical or industrial hygiene literature.

k. Ventilation:

1. Toxic chemicals with low air concentration limits or high vapor pressures, should always be handled in a hood. Fume hood should provide 70 to 90 linear feet per minute of air flow. This will be checked periodically by the Facilities Management maintenance/HAZMAT personnel.

2. Laboratory employees should understand and comply with:

a. A fume hood is a safety backup for condensers, traps or other devices that collect vapors and fumes. It is not used to dispose of chemicals by evaporation unless the vapors are trapped and recovered for proper waste disposal.

b. The apparatus inside the hood should be placed on the floor of the hood at least six inches away from the front edge.

c. Fume hood windows should be lowered (closed) at all times except when necessary to raise (open) them to adjust the apparatus that is inside the hood.

d. The hood fan should be kept "on" whenever a chemical is inside the hood, whether or not any work is being done in the hood.

e. Insure that the hood vent ducts and fans are in operating condition.

f. Hoods should never be used as storage areas for chemicals, apparatus or other materials.

l. Flammable-liquid Storage:

1. Fire-hazard chemicals in quantities greater than TWO liters should be kept in metal safety cans designed for such storage. The cans should be used only as recommended by the manufacturer, including the following safety practices:

a. **Never** disable the spring-loaded closure.

b. Always keep the flame-arrest screen in place; replace if punctured or

damaged.

2. Cabinets used for storage of flammable materials should be properly used and maintained. Read and follow the manufacturer's information and also follow these safety practices:

    a. Store only compatible materials inside a cabinet/building.

    b. Do not store paper or cardboard or other combustible packaging material in a flammable-liquid storage cabinet.

m. Eyewash Fountains and Safety Showers:

1. Personnel will be made aware of locations of all eyewash fountains and safety showers. These must be located so they can be reached from any point in the laboratory.

2. Check the functioning of eyewash fountains and safety showers and periodically measure the water flow. Promptly repair any facility that does not meet the water flow requirements.

3. Be sure that access to eyewash fountains and safety showers is not restricted or blocked by temporary storage of objects or in any other way.

n. Respirators:

1. Respirators are available but should be used only when other engineering controls become ineffective and that employees might be exposed to vapor or particular concentrations greater than the PEK, action level, TVL or similar limit, whichever is the lowest.

2. The requirements of 29 CFR 1910.134 should be followed. All employees who are likely to use respirators must be trained int heir proper use, inspection and maintenance.

3. Do not use odor as a means of determining that inhalation exposure limits are or are not being exceeded. Whenever there is reason to suspect that a toxic chemical inhalation limit might be exceeded, wheteher or not a suspicious odor is noticed, notify Facilities Management.

o. Procedures for Carcinogens, Reproductive Toxins and Chemicals of Acute and Unknown Toxicity:

1. These procedures are applicable when performing laboratory work with greater than 10mg of any carcinogen, reproductive toxin, substance that has a high degree of acute toxicity or a chemical whose toxic properties are unknown.

2. The definitions of carcinogen, reproductive toxin, a substance with a high degree to toxicity, or chemicals whose toxic properties are unknown, as stated in 29 CFR 1910.1450 and on the applicable MSDS's will apply. Chemicals that fall in the four categories are called "inimical."

3. A designated area will be defined as a hood, glove box, portion of a laboratory room designated as the only area where work with quantities of the inimical chemicals in excess of the specified limit shall be conducted. Only those persons trained to work with inimical chemicals will work with those chemicals in a designated area. All such persons will:

    a. Use the smallest amount of chemical that is consistent with the requirements of the work to be done.

    b. Store and lock inimical chemicals and remove them from work areas.

    c. Prepare wastes from work with inimical chemicals for waste disposal in accordance with specified disposal procedures consistent with the Resource Conservation and Recovery Act (RCRA) and as designated by the University HAZMAT Chairman.

    d. Because the decontamination of jewelry may be difficult or impossible, do not wear jewelry in designated areas.

p. Records and Record Keeping

1. 29 CFR 1910.20 which requires the Laboratory Standard, also required that certain other records be maintained and retained for periods of time.

2. The laboratory Standard requires that records of air concentration monitoring results, exposure assessments, medical consultations and examinations be maintained for at least 30 years and that they be accessible to employees or their representatives. These records will be maintained in the Office of the Facilities Management.

3. It is recommended that documentation such as "sign-off" records be prepared and retained on each employee that certifies that the employee has read, understands and knows how to locate, in an expeditious manner, material safety data sheets (MSDS).

4. Specific records may be required in the event of loss work time resulting from an exposure or accident on the job. OSHA Form 200 should be used to record lost workdays.

5. It is further recommended that records be kept that document any employee exposure complaints and suspected exposures, regardless of the outcome of an exposure assessment.

6. The EPA and other Federal and State agencies have special record keeping requirements. For example: Record keeping of allegations and the reporting of suspect hazards from the adverse effects of chemical exposure are required under Section 8(c) and 8(e) of the Toxic Substances Control Act. (Refer to 40 CFR 716 and 717)

q. Radioactive Material Program Policies and Procedures:

1. Florida Institute of Technology is authorized to conduct a program using radioactive materials in accordance with the conditions set forth in the State of Florida Radioactive Materials License Number 433-1, Amendment 9.

2. The University program must be operated in accordance with "Florida Control of Radiation Hazards," Chapter 10D-91, F.A.C.

3. The University must possess radioactive materials only in quantity and form indicated in the license.

4. Radioactive materials are to be used only for the purpose(s) indicated in the license.

5. The University must notify in writing, the Office of Radiation Control, State of Florida Department of Health and Rehabilitative Services (HRS) of any changes in mailing address, ownership or controlling interest in the University.

6. The University must request and obtain an appropriate amendment if there is a change in location(s) of radioactive materials, or make any other changes in the facility or program which is contrary to the license conditions or representations made with the Office of Radiation Control, HRS.

7. The University must submit a complete renewal application or termination request at least 30 days before the expiration date of the license. Possession of radioactive materials without a current license is a violation of Florida regulations.

8. The University will be periodically inspected by the Office of Radiation Control, HRS. failure to conduct the program in accordance with Florida regulations,

license conditions and representations in the license application will result in enforcement action.

r. Extensions of Florida Institute of Technology HAZMAT officials:

1. Chemical Hygiene Office (CHO) – Extension 7433

2. HAZMAT Chairman – Extension 8865

3. Radiation Safety Officer (RSO) – Extension 7134

APPENDIX I – HAZMAT

Biological Exposure Control Plan and Biohazardous Waste Management

Biological Exposure Control Plan:

Purpose:

a. To limit the risk of exposure to viruses carried in human blood, especially the AIDS virus and Hepatitus B virus, to those employees subject to "occupational exposure" to such viruses.

b. For the purpose of this plan, "Occupational Exposure" shall be defined as a reasonable anticipation that the employee may contact human blood as the result of performance of the employee's duties.

Definition:

a. BLOOD means human blood, human blood components, and products made from human blood.

b. BLOODBORNE PATHOGENS means pathogenic micro-organisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to: Hepatitus B Virus (HBV) and Human Immunodeficiency Virus (HIV).

c. CONTAMINATED means the presence or reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

d. CONTAMINATED LAUNDRY means laundry which has been soiled with blood or other potentially infectious materials and may contain sharps.

e. CONTAMINATED SHARPS mean any contaminated object that can penetrate the skin including, but not limited to: needles, scalpels, broken glass, broken capillary tubes and exposed ends of dental wires.

f. DECONTAMINATION means thee use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface of item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe of handling, use or disposal.

g. EXPOSURE INCIDENT means a specific eye, mouth, other mucous membrane, non-skin or parenternal contact with blood or other potentially infectious materials that results from the employee's duties.

h. HBV means Hepatitus B Virus

i. HIV means Human Immunodeficiency virus.

j. OCCUPATIONAL EXPOSURE means reasonable anticipated skin, eye, mucous membrane or parenternal contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

k. OTHER POTENTIALLY INFECTIOUS MATERIALS means (1) the following body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; (2) any unfixed tissue or organ (other than intact skin) from a human being (living or dead); and (3) HIV-containing cell or tissue cultures, organ cultures, and HIV-or HBV containing culture medium or other solutions; and blood, organs or other tissue from experimental animals infected with HIV or HBV.

l. PARENTERNAL means piercing mucous membranes or the skin barrier through such means as needle sticks, human bites, cuts and abrasions.

m. PERSONAL PROTECTIVE EQUIPMENT is specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts or blouses) not intended to function as protection against a hazard are NOT considered to be personal protective equipment.

n. REGULATED WASTE means liquid or semi-liquid or blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

o. SOURCE INDIVIDUAL means any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure to the employee. Examples include, but are not limited to, hospital and clinic patients; trauma victims; residents of hospices and nursing homes; human remains; and individuals who donate or sell blood or blood components.

p. STERILIZE means the use of a physical or chemical procedure to destroy all microbial life including highly resistant bacterial endospores.

q. UNIVERSAL PRECAUTIONS is an approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if know to be infectious for HIV, HBV and other bloodborne pathogens.

r. WORK PRACTICE CONTROLS means controls that reduce the likelihood of exposure by altering the manner in which a task is performed.

Scope:

a. Affected employees will fall under one of two levels of exposure risk, depending upon their jib classification.

1. Level 1 – Job classifications in which all employees are affected by this standard, and will be offered pre-exposure hepatitis B inoculations.

a. Student Health Center:
Doctors, Nurses, Nurses' aides and other medical personnel. Medical personnel in this context is used to include any person employed in the Student Health Center serving in the capacity of a health care provider.

b. Sports Medicine:
Trainers, Assistant Trainers who may be involved in providing emergency attention and/or may serve in the capacity of a health care provider.

2. Level 2 – Job classifications in which only some employees are affected by this standard, and the related tasks and procedures which would place them at risk. These employees will receive post-exposure prophylaxis, including hepatitis B vaccination within 24 hous of possible exposure, or in situations where first-aid was rendered.

a. Campus Security Officers:
Emergency/accident response, where injured persons may be bleeding, and/or contact with blood or other potentially infectious materials may be anticipated.

b. Building Services (Housekeepers, Custodians, and General Maintenance Workers):
1. Cleaning of Student Health Services and Sports Medicine areas.
2. Cleaning of any area contaminated as a result of incident or injury involving loss of blood, where there is a possibility that blood or infected materials may be present.

c. Life Guards:
Lifesaving/First-Aid procedures, where injured persons may be bleeding, and/or contact with blood or other potentially infectious materials may be anticipated.

Policies and Procedures – Methods of Compliance:

a. Universal Precautions:
Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials. In order to prevent contact with blood and potentially infectious materials, the following **Universal Precautions** AND **Work Practice Controls** are to be observed by all employees.

1. Gloves must be worn when coming in contact with blood or body fluids.

2. Masks must be worn when there is a possibility of a splash of blood or body fluids to the face.

3. Goggles must be worn when there is the possibility of a splash or blood/body fluids to thee face.

4. Goggles or aprons must be worn when there is a possibility of exposure to blood.body fluids.

5. **WASH HANDS!** Wearing gloves is **NOT** a substitute for washing hands. Employees must wash hands and any other skin immediately or as soon as feasible after removal of gloves or other personal protective equipment.

6. Contaminated sharps shall not be bent, removed, or recapped. They must be placed immediately or as soon as possible after use in an appropriately labeled sharps container manufactured specifically for this purpose.

7. Eating, drinking, smoking, applying cosmetics or lip balm and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of exposure.

8. Food and drink shall not be kept in refrigerators, freezers, shelves, etc., where blood or other potentially infectious materials are present.

9. Mouth pipetteing/suctioning of blood or other potentially infectious materials is prohibited.

10. Broken glassware which may be contaminated shall not be picked up directly with the hands. It shall be cleaned up using a brush and dust pan, forceps or tongs, and placed immediately or as soon as possible after use in an appropriately labeled sharps container.

11. Contaminated laundry shall be handled as little as possible, and bagged or containerized at thee location where it was used. If the laundry is wet, it shall be placed and transported in a leak-proof container which has biohazardous identification on it.

12. Work sites and equipment subjected to possible contamination shall be decontaminated with a solution of industrial strength cleaner to remove visible soil and shall be disinfected with one of thee following:

    a. Hypochlorite solution containing 100 parts per million (ppm) available free chlorine.

    b. Iodine solution containing 25 ppm available iodine.

    c. Chemical germicides that are registered by the EPA as hospital disinfectants, are tuberculocidal when used at recommended dilution.

b. In addition to the above listed Universal Precautions, the following policies and procedures are to be observed by those employees designated as having "occupational Exposure."

    1. Employees having "occupational exposure" must use personal protective equipment, which will be provided free of charge by the university. No affected employee shall knowingly risk exposure to blood or infected materials by failing to use the personal protective equipment provided.

    2. All employees under the Level 1 job classifications must have personal protective equipment readily available at their job site for their use at all times.

    3. All employees under the Level 2 job classifications must have personal protective equipment at their disposal when the potential for an exposure exists.

    4. When personal protective equipment has been contaminated, they must be placed in red "Biohazardous Material" bags before leaving the work area. Personal protective equipment will be decontaminated, disposed

or, repaired and/or replaced when necessary at no cost to the employee.

5. Employees having "Level 1 Occupational Exposure" will be offered the hepatitis B vaccine after appropriate training and within 10 days of initial assignment at no coat to the employee.

    a. If the employee initially declines hepatitis B vaccination but at a later date while still employed in a position that has "occupational exposure" decides to accept the vaccination, it shall be made available to the employee at no charge.

    b. Employees who decine to accept the hepatitis B vaccination must sign the declination statement on the "Hepatitus B Vaccination Acceptance/Declination" form (see attachment). Blank copies of this form may be obtained from the HAZMAT office in the Facilities Management. The signed form will become part of the employee's personnel record.

6. Employees having "Level 2 Occupational Exposure" will receive appropriate training within 10 days of initial assignment, and will be offered hepatitis B vaccinations within 24 hours of an exposure incident, at no cost to the employee.

7. An employee involved in an exposure incident must notify the Personnel Office before the end of the work shift, and shall be provided post-exposure medical evaluation and follow-up care at no cost to the employee.

c. Training and Documentation:

1. New Personnel who will have "occupational exposure" will be required to read this appendix as part of the hazard communication training program. Such training must take place at the tie of initial assignment, and annually thereafter.

2. A complete record of training sessions shall be maintained by the Personnel Office for three years from the date of the training.

3. After training, all employees have "Level 1Occupational Exposure" and will be required to sign either the acceptance or declination statements on the Hepatitis B Vaccine Acceptance/Declination form.

4. An accurate and confidential record of exposure incidents shall be maintained by the Personnel Office for the duration of employment plus 30 years. This shall be accomplished by completing the "Occupational Exposure Record" which may be obtained from the HAZMAT office in Facilities Management.

Biohazardous Waste Managament:

Purpose:

a. To establish procedures for the proper handling, control and disposal of biohazardous waste.

b. To ensure that Florida Institute of Technology is in compliance with OSHA 29 CFR 1910.1030 and the State of Florida Department of Health and rehabilitative Services (HRS), Chapter 10D-104, Florida Administrative Code on Biohazardous Waste.

c. To ensure that all records and documentation are maintained by Florida Institute of Technology, pertaining to the removal and disposal of biohazardous waste from University offices and departments and that thee records are kept on file for the required length of time specified by HRS.

Scope:

a. These biohazardous waste management policies and procedures apply to the Student Health Center, Athletic Department, and Biology Department; and any other University department that handles and disposes of biohazardous waste.

Text:

a. Identification and/or definitions:

1. Biohazardous waste: Any soild or liquid waste which may present a threat of infection to humans. This includes but is not limited to, non-liquid human tissue and body parts; laboratory and veterinary waste that contains human disease causing agents; discarded sharps, human blood, human blood products and body fluids.

2. Biohazardous waste also includes used absorbent materials such as bandages, gauze or sponges supersaturated, having the potential to drip or splash, with blood or body fluids from areas such as operating or treatment rooms.

3. Body fluids: Fluids that have the potential to harbor pathogens, such as HIV and Hepatitis B.

4. Body excretions such as nasal discharges, saliva, sputum, sweat, tears and vomit shall NOT be treated as biohazardous waste, unless visibly contaminated with blood.

5. Sharps: Devices with the physical characteristics capable of puncturing, lacerating and/or penetrating the skin. These devices include but are not limited to needles, scalpels, staples, glass, lancets, pipettes, and sutures.

b. Handling of Biohazardous Waste:

1. Point of Origin; The room or area where the bandage, sponge or other object becomes contaminated with body fluids or blood.

2. Biohazardous waste shall be identified and segregated from other solid waste at the point of origin within thee office.

3. When a sharp is used, it must be placed into an approved sharps container that is leak resistant, rigid, and puncture resistant and designed primarily for sharps. It must be clearly marked with a biohazard symbol and labeled biohazardous waste. A non-sharp biohazardous waste article must be bagged in the treatment room, in a approved biohazardous waste bag, sealed and taken to the area where the biohazardous waste is stored prior to its treatment.

4. All hypodermic needles and syringes must be rendered unusable before disposal. The needle should be slipped from its hub and the hub clipped from the syringe.

5. Biohazardous waste bags must be impermeable, red, polyethylene plastic bags. Biohazardous waste bags shall have the physical properties as listed in 10D-104.003(F) of the Florida Administrative Code (HRS).

6. Sharps containers must be approved and meet with the standards of the Department of Transportation, 49CFR 178.210.

c. Containment, General Handling and Structure of Containers:

Non-human biohazardous waste, where applicable, shall be steam autoclaved to render any contaminates harmless. This will be indicated bby the use of autoclave tape or similar indicator. Once successfully sterilized, its material will be disposed of as common trash.

1. Containment of biohazardous waste before or during disposal must be effected in such a manner that no discharge or release of any waste occurs. Biohazardous waste prepared for transport off campus shall be labeled as required by paragraph 17-712.400(3)(E) FAC. Packaging shall be appropriate for the type of waste generated with Florida Institute of Technology name, address and date on each container.

2. Disposable single-use containers used for the storage of biohazardous waste shall be destroyed during the disposal process. Single-use containers shall be rigid, leak resistant, puncture resistant, burst resistant, and tear resistant under normal conditions, handling and use.

3. Packages of biohazardous waste shall remain intact until treatment or disposal. There shall be no recycling efforts nor intentional removal of waste from its packaging prior to the waste being treated or disposed.

4. Persons loading or unloading bags and packages of biohazardous waste from trnafer vehicles shall wear impermeable gloves and protective clothing.

5. Bagged biohazardous waste being prepared for off campus transport prior to final treatmentor disposal shall be enclosed in a rigid-type container. Authorized transporters must be in compliance with DOT 49 CFR 178.205 prior to removal from University grounds.

6. Any biohazardous waste that is combined with hazardous waste shall be managed as hazardous waste in accordance with applicable requirements of the Florida Department of Environmental regulation (FDER).

d. Labeling:

1. All bags containing biohazardous waste and sharps containers shall be labeled as required by Subsection 10D-104-005(3) FAC.

2. Biohazardous waste shall be labeled immediately after packaging.

3. The label shall be securely attached or permanently printed on each bag and outer layer of packaging being clearly legible and easily readable. Information included shall be Florida Institute of Technology, address, date the waste was generated or packaged, and the international biohazardous waste symbol in red, orange or black on contrasting background.

e. Storage:

1. All on campus storage of biohazardous waste shall be in a designated area away from general traffic flow and accessible only to authorized personnel. Storage of biohazardous waste shall not be for a period greater than 30 days. The 30 day period shall commence when the first item is placed into a red bag or when the sharps container is full.

2. all areas primarily used for the storage of biohazardous waste, other than the points of origin, shall be constructed of smooth, easily cleanable materials, that are impervious to liquids and capable of being readily maintained in a sanitaryr condition. Vermin and insects shall be excluded from such areas.

f. Transfer:

1. Off-campus transfer will be handled in accordance with applicable state and federal regulations.

2. On campus transfer includes the biohazardous waste to be segregated at the point of origin, bagged and sealed, then transferred to a storage area designated for biohazardous waste.

g. Treatment and Disposal:

1. Biohazardous waste pickup and service will be by a company that is registered by the DOT. A copy of their registration will be kept on file in Student Health Center. The pickups will be accomplished on a regular schedule, not to exceed the 30 day limit. Proof of pickup and a log will be maintained in each department at pickup times.

2. Biohazardous waste picked up from Florida Institute of Technology by BFI Medical Waste Systems, Inc. (Campus) and Waste Management, Inc. (BioWest)and is incinerated. Proof of incineration is furnished to those vendors by thee transport company. The incinerator used must be the one that is approved by the FDE and operates in accordance with ther requirements of chapter 17-2, FAC.

h. Contingency Plan:

1. Spills or leaks of biohazardous waste shall be cleaned with a solution of industrial strength detergent to remove visible soil and shall be disinfected with one of the following:

a. Hypochlorite solution containing 100 parts per million available free chlorine.

b. Iodine solution containing 25 parts per million available iodine.

c. Chemical germicides that are registered by the EPA as hospital disinfectants and are tuberculocidal when used as recommended dilutions.

2. Should a leak or spill of biohazardous waste occur on the University, the HAZMAT Chairman shall be notified as soon as possible.

a. Office of Financial Affairs, Ext. 8865

b. Non-duty hours: contact is made through Campus Security, Ext 8111.

i. Records and Documentation:

1. All biohazardous waste records will be maintained for three years.

2. Records which include receipts, manifests, treatment records, FDER, and HRS regulations, a copy of the transporter’s registrations and a log.

j. Training:

1. New personnel will be required to read this Appendix along with HRS regulations. There should be a department meeting with the new employee to go over their understanding as to what they have read.

2. New Personnel should spend a minimum of four hours in training on the subject of biohazardous waste. Review sessions on biohazardous waste procedures should be one hour per month.

3. The biohazardous waste information coordinator is responsible for maintaining all biohazardous waste records and keeping all employees informed on any changes that take place concerning the handling of biohazardous waste.

4. The University biohazardous waste information coordinator is Mr. Alex Lindsey, Ext. 7134.

Hepatitus B Vaccine
Acceptance/Declination Form

ACCEPTANCE:

I understand that due to my occupational exposure to blood or other potentially, infectious materials, I may be at risk of being infected by bloodborne pathogens, including Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV). This is to certify that I have been informed about the symptoms and the hazards associated with these viruses, as well as the modes of transmission of bloodborne pathogens. I have been given the opportunity to be vaccinated with the Hepatitis B vaccine, at no charge to myself. In addition, I have received information regarding the efficacy, safety, method of admission, and the benefits of receiving the Hepatitis B (HBV) vaccine. Based on the training I have received, I am making an informed choice to accept the Hepatitis B (HBV) vaccine.

DECLINATION:

I understand that due to my occupational exposure to blood or other potentially, infectious materials, I may be at risk of acquiring hepatitis B Virus (HBV) infection. I have been given the opportunity to be vaccinated with Hepatitis B vaccine, at no charge to myself. However, I decline Hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring Hepatitis B, a serious disease. If, in the future, I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with Hepatitis B vaccine, I can receive the vaccination series at no charge to me.

CHECK ONE:

_____ I ACCEPT Hepatitis B vaccine inoculation.

_____ I DECLINE Hepatitis B vaccine inoculation.

_____ _____
Employee's Name (Print) Employee's Signature

_____ _____
Date Signed Witness's Signature

APPENDIX J
ACCIDENT REPORTING AND WORKER' COMPENSATION

When an accident occurs, an Employee accident/Injury Report (see attachment) need sot be filled out and returned to the Office of Financial Affairs. This report is to be filled out by the employee and Supervisor. By providing these reports to the Office of Financial Affairs in a prompt and efficient manner action can be taken to help the injured employee.

Phone notification should be made immediately to the Office of Financial Affairs (x7340) if there is a serious and/or fatal accident.

When an accident and/or injury occurs, the employee should report immediately to their supervisor. Once your accident has been reported to your supervisor and the Employee Accident/Injury Report has been filled out medical treatment for a non-emergency can be obtained through one of the providers authorized by the insurance company and their managed program.

The Injury:

The employee must report an injury within thirty (30) days of its occurrence to the employer. The thirty (30) days, however, is seldom enforced due to the exceptions.

The employer must report an injury within seven (7) days of actual knowledge of the injury to the insurance company, or servicing agent, and the employee. Failure to give prompt notice to the insurance company or servicing agent will result in a civil penalty not to exceed $500 for each such failure.

Any injury which results in death must be reported to the division by the employer within twenty-four (24) hours by telephone or telegraph.

If the injury results in death, or has caused the employee to have missed seven (7) or more consecutive days of work, the carrier or self insured employer must report an injury to the division within thirty (30) days of receipt of the Notice of Injury. A penalty not to exceed $500 will result from falure to do so.

The employer must give the employee who reports an injury a clear and understandable summary of the employee's rights, benefits and obligations under the law.

The signature of the employee on the Notice of Injury Form and giving the employee a copy of said form constitutes employer's motice to the employee. The employee's copy of that form will contain a summary of rightsprinted on the back. It is the employer's duty to mail the signed form to the carrier or servicing agent within seven (7) days of knowledge of injury.

If the employer is unable to secure the employee's statement and signature, the employer must still mail the Notice of Injury to the insurance company and employee within seven (7) days or suffer a $500 civil penalty for failure to report the injury in a timely manner.

Medical Treatment:

The **employee must advise the employer** of his need for medical treatment. Knowledge by the employer or his agency of the injury or treatment may be sufficient notice to the employer.

The law requires the employer to furnish the injured employee, medical treatment, care and attendance for such time as the nature of the injury or its process or recovery may require. When thee employer fails to furnish medical treatment to the injured employee, the injured employee may seek medical treatment at the employer's expense.

The injured employee has the right to request a change of physician and the employer/insurance company, or servicing agent has a duty to select another physician unless the deputy commissioner decides that such a change of physician is not in the best interest of the employee.

There can be no coercion of the employee by the insurance company or the employer in the selection of a physician. Being found guilty of coercion is punishable as a misdemeanor of the second degree.

The time limit for filing a claim is two (2) years from the date of the injury or the date of last payment of compensation or the date of last remedial treatment remedial treatment has now been defined to be the issuance of a prescription for medication.

Doctors must report initial medical treatment of disabling injuries in workers' compensation cases within ten (10) days to the employer; if self insured, to the servicing agent or the insurance company. Failure to make such report may render claim for treatment invalid. All medical reports must be given to the insurance company, servicing agent and to the division.

For medical only or first aid cases, the insurance company, servicing agent or self-insured employer must report the cost of these medical claims to the division within thirty (30) days following one calendar month in which the medical costs are incurred. Failuer to file this form in a timely manner can result in panalties.

HEALTH CARE PROVIDERS CANNOT BILL THE EMPLOYEE FOR TREATMENT OF WORKERS' COMPENSATION INJURIES.

Temporary Total:

If an employee is unable, after a seven (7) day period, to work because of an on-the-job injury the employee is entitled to temporary total disability benefits. If the temporary total

disability lasts longer than fourteen (14) days, temporary total disability benefits are payable retroactively from the first day such disability began. Payment for temporary total disability benefits continues for as long as the disability lasts, not to exceed three hundred fifty (350) weeks.

Temporary Total Compensation:

Compensation is paid to the injured employee at 66 2/3% of his wage, not to exceed 100% of the atatewide average weekly wage. The minimum payment shall not be less than $20. No compensation benefits are payable to the temporary total for any week in which the injured employee receives unemployment compensation benefits.

Those employees who suffer the loss of an arm, leg, hand or foot, or total loss of use of such member because of organic damage to the nervous system, shall be eligible for catastrophic loss benefits fo 80% of the injured employee's average weekly wage, not to exceed $700 and not to be collected longer than six (6) months from the date of the injury. If the injured employee is still a temporary total after the collection of catastrophic loss benefits, he may continue to receive temporary total benefits as long as the disability lasts, not to exceed three hundred fifty (350) weeks, including the time during which catastrophic loss benefits were collected.

Permanent Total:

A permanent total is an employee who, because of his injury is total and permanent in nature, is unable to work and earn a wage.

Loss of both hands, both arms, both feet, both legs, both eyes or any two thereof, or if the injured employee is a paraplegic or quadriplegic may cause the injured employee to be a permanent total where there is no conclusive proof of a substantial earning capacity. An employee must prove he or she is not engaged in, or physically capable of engaging in, gainful employment.

Once an injured employee id rehabilitated to the extent he or she establishes an earning capacity and continues to earn a wage and is no longer a permanent total, he or she may be eligible for wage loss benefits. The injured employee is able to undertake a trial period of re-employment without jeopardizing his permanent total status.

Permanent Total Compensation:

Compensation is paid to the injured employee at 66 2/3% of his or her average weekly wage not to exceed the maximum of 100% of the statewide average weekly wage but not to be less than $20. Compensation benefits continue for the period of the total disability and could possibly continue for life.

Compensation may be subject toreduction by the amount of social security benefits the employee or his dependents are qualified to receive. The total compensation and social security payments combined cannot exceed 80% of the employee's average weekly wage.

Rehabilitation:

An employee who suffers an injury which will not allow the employee to earn a wage which is equal to the wage earned prior to the injury, due to physical limitations, is entitled to training and education.

Upon request by the employee or the employer, the division shall provide the employee with appropriate training and education for suitable gainful employment at the time that an employee is entitled to training and education benefits.

Prior to entering into education and training, the employee must be evaluated by a non-interested entity to determine whether or not the injured employee is in fact entitled to the training and education benefits.

If rehabilitation is necessary and desirable in order to return the injured employee to suitable, gainful employment, thus reducing payment of wage-loss benefits, thee employee shall receive up to twenty six (26) weeks of training and education. This period can be extended for an additional twenty six (26) week period if found necessary and proper by the deputy commissioner. Nothing prohibits the employer or insurance company from voluntarily extending beyond such period if the injured employee is in need of rehabilitation.

An Individualized written Vocational Rehabilitation Plan requiring three (3) or more counseling sessions, vocational evaluations, training, work evaluation or placement must be prepared and filed within thirty (30) days and within thirty (30) daysafter the completion of a rehabilitation plan, and can be filed electronically.

Temporary total disability benefits are paid during the time an employee is receiving training and education but does not extend past the therr hundred fifty (350) week limitation for both temporary total disability and rehabilitative temporary total disability.

If the deputy commissioner finds that rehabilitation is necessary and the injured employee refuses rehabilitation, the weekly compensation benefits to be received by the injured employee shall be reduced by 50% for each week of refusal.

EMPLOYEE ACCIDENT/INJURY REPORT (pg 1 of 2)

CONTACT FINANCIAL AFFAIRS @ 674-7340 IMMEDIATELY REGARDING AN EMPLOYEE'S INJURY
EMPLOYEE AND SUPERVISOR MUST FILL OUT REPORT

EMPLOYEE INFORMATION: PLEASE PRINT CLEARLY:

Employee Name: _____ SSN: _____
:
Address: _____ Date/Time of Accident: _____

City, State, ZIP: _____ Date of Hire: _____

Residence Phone: _____ Dept. Ext.: _____

Marital Status: _____ # of Dependants: _____ DOB: _____

Supervisor: _____ Weekly Wage: _____ Job Title:_____

Where did accident occur: _____

Part of Body Injured: _____

What were you doing when injured: (Be specific)

Name tools, equipment or hazardous material and what you were doing with them:

List all witnesses:

EMPLOYEE ACCIDENT/INJURY REPORT (pg 2 of 2)

Give description of accident: (Tell what happened and how it happened. Give full details on factors which led to injury/illness.)

Do you feel your injury/illness is directly related to your work?

Yes: _____ No: _____ Don't Know: _____

Employee Signature: _____ Date: _____

_____

To be filled out by the Supervisor:

Do you agree with the description of the accident? _____

What corrective action will take place to prevent accident from recurring? _____

_____

Supervisor's Signature: _____ Date: _____

APPENDIX - K

Solid Waste Management (Recycling)

Purpose:

a. To establish a policy and procedures to reduce solid waste in the University waste stream earmarked for the Brevard County Landfills.

b. To support the solid Waste Management Act of 1988 that requires all counties in the State of Florida reduce solid waste to the State landfills by 30% by the end of 1994.

c. To support the University environmental groups' efforts to:

1. improve the environment

2. to implement a solid waste management plan to use materials not detrimental to the environment.

3. to recycle those materials for use in other medium.

Definitions:

a. CONSTRUCTION AND DEMOLITION (C&D) DEBRIS is generally made up of old building materials, sheet rock, wood, roofing materials, etc., and is separated from the waste stream and segregated in separate areas in the landfills.

b. METALS includes aluminum cans, white goods, ferrous metals, and other non-ferrous metals. At the present, identified receptacles are on location at the Southgate apartment complex. Recycling items include: newspaper, aluminum can, and bottles.

c. OTHER PAPER includes corrugated, office and other paper. NOT newsprint. A dumpster has been placed on campus for the purpose of cardboard recycling. The University pays for use of the dumpster. The money generated by the sale of the cardboard is donated tp "PRO ARC," a non-profit organization for the handicapped. Bins are placed in every campus building for the storage of computer and copy (non-colored) that is retrieved by Alpha Phi Omega, a not for profit service fraternity at Florida Tech. The revenue from the sale of the paper is donated to "PRO ARC."

d. RECYCLABLE MATERIALS are materials which after initial use are collected from various scrap and waste generating sources and processed for the purpose of resale to industry for use as raw material inputs to production or manufacturing operations.

e. SOLID WASTE is trash of all types including sludge that is removed to a landfill.

f. SOURCE CONTAMINATION is the mixing of recycling materials so that they are unacceptable to the recycling vendor. Contaminated material is separated and disposed of by an outside vendor.

g. SOURCE SEPARATION is keeping the different recycling products apart and segregated.

h. WASTE STREAM is the collection of waste products that make up the total waste disposal.

i. YARD WASTE is debris from trees, shrubs, grass, bushes, etc. that is normally composted. Yard trash is separarted and disposed of by Facilities Management.

Scope:

a. The Solid Waste Management (recycling) programapplies to all Florida Instituteof Technology departments – faculty, staff and students.

Text:

a. Facilities Management is responsible for the Solid Waste Management (recycling) program.

b. The movement of recyclable materials to the Recycling Complex behind the Carpenter Shop is the responsibility of facilities Management. The recycling program is augmented by environmental students who collect recyclable materials on every floor in all University buildings.

c. Recyclable materials are collected based on “call-ins” to extension 8038. After a call is received, the materials are picked up in a golf cart and moved to the Recycling Complex behind the Carpenter Shop. At the complex is a “Rhino” recycling container with five compartments, three igloos for glass and newspaper, a cardboard baler, and a Styrofoam densifier.

d. Recyclable materials collected at Florida Institute of Technology:

1. Aluminum
2. Plastic (Plastic Liter bottles)
3. Cardboard (without food, not waxed, etc.)
4. Computer paper
5. Glass (green, brown and clear)
6. Yard Waste (composted at landfill)
7. Newspaper
8. Used Oil
9. Batteries

e. Glass products that are NOT recycled by glass container vendors are:

1. Mirrors
5. Light bulbs

2. Ceramic cups/plates
3. Clay flowerpots
4. Crystal
6. Window glass
7. Heat resistant ovenware
8. Drinking glasses

f. Paper products that are NOT acceptable material for paper recycling vendors:

1. Magazines and catalogs

2. All coated/glossy paper
3. Phone books
4. Kraft envelopes and file folders
5. Carbon paper
6. Adhesive stickers or labels
7. Paper plates, cups, food wrappers, and containers
8. Vellum sheet protectors
9. Rubber bands, clips, metal fasteners/bindings
10. Blueprints

g. Florida Institute of Technology waste stream is made up as follows:

1. Yard Waste – 16%
2. Metals – 9%
3. Plastic – 7%
4. Glass – 4%
5. C&D – 15%
6. Food – 8%
7. Newspaper – 5%
8. Other paper (including cardboard) – 27%
9. Styrofoam – 1%
10. Miscellaneous – 9%

h. a shift in the focus to accomplish recycling comprises the following four elements:

1. Revising the way one thinks about and processes solid waste.

2. Reducing the amount of products that enter the waste stream, from both purchasing sources to end user waste.

3. reusing materials whenever practical.

4. Recycling

APPENDIX L
REFERENCES TO PRIOR APENDICIES

1. Florida Handbook: Small Quantity Generators of Hazardous Waste, FDER, October 1986.

2. Understanding the Small Quantity Generator waste Rules: "A Handbook For Small Business," EPA, Office of Solid Waste and Emergency Response, Washington, D.C.

3. Toxic Program Commentary: Florida STP – Specialty Technical Publishers, Inc. Reference 4912, 1989.

4. U.S. Occupational Safety and Health Administration (OSHA) Hazard Communication Standard.

5. Regulatory Compliance for Facilities Managers, Association of Facilities Management Administrators of Universities and Colleges (APPA), 1989.

6. "Occupational Exposures to hazardous Chemicals in Laboratories, " OSHA, January 31, 1990 (Federal Register, page 3300).

7. Florida Department of Health and Rehabilitative Services (HRS), Chapter 10B, 104.001, April 3, 1990, "Biohazardous Waste."

8. Florida Right-to-Know Law, Florida Statuts 442.000, Occupational Health and Safety.

9. Code of Federal Regulations (CFR) – 29 CFR (OSHA); 40 CFR (EPA); and 49 CFR (DOT).

10 Developing A Chemical Hygiene Plan,Young-Kingsley-Wahl, American Chemical Society, Wasington, DC, 1990.

11. The BBP Safety Management Handbook, Bureau of BusinessPractice, PRENTICE HALL, Waterford, CT., 1990. 5th edition.

APPENDIX M – Basic Machine Tool Operations Policy

Thanks to

Dan Simpson for Writing this Policy

John Lee for information on the shop

Sara Parent for typing up the manual

Meriba Hoglund for adding pictures and editing

July 2003

Table of Contents

Florida Tech MACHINE SHOP RULES

1. Students are not allowed to work without supervisor in the Machine Shop. An approved Florida Tech faculty or staff member must be present at all times.
2. When working in the shop two people must be present at all times.
3. All tools must be signed out and returned (this includes cutting tools) before leaving. If you need to leave tools out for the next person you must get the tool crib attendant and supervisor approval before leaving shop.
4. To enter the shop all must sign-in and out at the sign-in counter, wear their shop personnel badge and notify the shop supervisor when leaving.
5. All must be badged and have completed training before entering shop if you are not badged you must be accompanied by a supervisor.
6. No sandals or sneakers. Work boots or shoes only.
7. Penalty for not returning tools after completing work or failure to do proper cleanup: 1. Offense warning, 2. Warning report to Lab Director, 3. One-week suspension from shop, 4. Removal – revoke badge. It is recommended to ask cleanup approval from supervisor before leaving shop.
8. Safety glasses must be worn at all times. Stay at counter until given safety glasses.
9. All workers must be badged to enter shop. Non-badged observers are the responsibility of the supervisor and cannot enter without his approval. Observers must have the supervisor present for the duration of his/her stay.
10. Work request forms must be completed (reviewed by the shop supervisor or lab director for errors, then corrected) and signed by lab director or shop supervisor.
11. Do not enter material storage/staging area without permission
12. Stealing is cause for immediate badge removal suspension from shop.
13. Do not enter tool crib without attendant or supervisor permission. Do not exit tool crib without proper tool sign out.
14. Only badge-trained individuals can use the CAM Lab without approval of supervisor. Each CAM Lab user must also sign-in sign-out at counter.
15. The Supervisor must check all machine setups before you begin machine operation.
16. Accidents, machine problems, must be reported immediately to the supervisor. The Lab Director and faculty will be notified to determine possible disciplinary action when failure to report a problem promptly, lying, or false statements take place.
17. All drawings must have a Florida Tech legend unless it is from a non-proprietary outside source. Digital drawings must be 1 to 1 scale and be compatible with our systems.
18. Jobs are done on a first come first serve basis. Problems causing work stoppage that are not the fault of the Florida Tech Machine Shop may cause the job to go to bottom of the schedule.
19. Material Safety Data Sheets, HAZMAT material must be supplied on chemical material not listed in our MSDS before work can begin.
20. No arguing or horseplay in the Shop. This is a place of Serious Business. Be courteous to your fellow workers or you will be asked to leave.

21. DO NOT enter the shop under the influence of drugs or alcohol.
22. Badge carrying and Trained work-study students have authority over badge workers. They are required to report rule breaking, improper machine operation; any arguing with a work-study is not tolerated, they help operate the shop. Problems should be directed to the supervisor.
23. Work Studies should set an example for shop workers. Therefore rule breaking, repeated improper shop practice would be reason for dismissal and disciplinary action. Improper actions by a work- study should be reported to the supervisor immediately.
24. A fact sheet on all Approved workers will be kept. Any Individual can access his/her record at anytime, as it is a public record. You must be present when entries are made.
25. Projects cannot be kept in shop area without permission of the shop supervisor. You must have permission of the shop supervisor to retrieve your project from the staging area. If the staging area is full you must find alternate storage; your project will not remain in the shop area.
26. All material, cutting tools, or hardware cost must be recorded on your work request or should be paid for on in advance, unless approval was given.
27. Tool crib attendants must assess all tools returned to tool crib. Damage to tool is responsibility of department that is requesting work and should be recorded on work request. Damage to tools should be reported to supervisor immediately for initiating a replacement.
28. Walk-in work is only allowed through supervisor approval. You will be assessed an agreed fee according to the labor and tooling cost. The Supervisor has the right to refuse any work until a work request is completed. Only badged workers can do walk-in work.
29. Only badged workers can sign out tools on a long-term basis and are responsible for them. Tools returned damaged or not returned must be replaced at your cost. If you damage a tool you may not be assessed a charge if you show compliance with the rules and that it was an accident or normal use wear. Dishonesty or misuse will result in removal of shop privileges.
30. Personal work is only allowed upon approval of the Lab Director and Supervisor and is performed by badged workers.
31. All badged workers and work-studies must record his/her time worked on the work request as well as his/her material used on the project that was not supplied with the job.
32. Do not throw anything away unless you are sure that it is garbage first. Please the ask Supervisor.
33. Class projects cannot be done in shop unless students have completed shop training. However, shop training can be part of class syllabus.
34. Non-badged students, faculty, staff must stop in or call the supervisor for an appointment time for project consultation and access to shop.
35. Dropping off Items or Work Requests at the shop counter: An individual dropping off anything at shop must sign in and give a description of action as well as contact info.

36. Badged students, faculty and staff can call for or come in for immediate consultation with projects.
37. The Florida Tech Machine Shop will no longer donate parts, hardware, raw material, or tools to projects or individuals unless special permission from the Lab Director is given.
38. All class, capstone and research design / application projects; maintenance to be supported by the machine shop, must go through the Lab Director for approval and scheduling. If a project or job is dropped off at shop an estimate of technician time, and material cost will be placed on the work request and given to the Lab Director. The Director or Supervisor will checked for compliance of design standards, and cost requirements, and then scheduled the machine shop to do the work.
39. The Florida Tech Machine Shop may request complete design disclosure. All assembly, detail drawings, method of operation sheets, parts list, and other specifications (physical parts may need to be supplied) before attempting to build your project. Failure to supply these criteria may be reason to not supply support for a project.

This rule is used for manufacturing time constraints. We do not want to attempt a project when the engineering is not complete. Do not release parts for manufacturing before design and procurement of material and assembly parts are complete and available.

- **Walk In Work Rules**

1. EVERY ONE MUST WEAR SAFETY GLASSES – Badged workers will have there own and visitor will be provided SAFETY GLASSES at the entry door of the Shop.

2. Badged workers only can do walk-in work but are required to get supervisors approval before work is started. In addition, the worker is required to follow standard shop rules and practices.

3. Non-Badged workers cannot work in shop; they must have a badged worker do all operations. Non-Badged workers are allowed to be observing the work or dropping off the work, but supervisor must approve and be present when work is being done. The shop floor is closed to all individuals unless they are badged. Non-Badged individuals are only allowed on shop floor with an observers pass.

4. Job must be simple and not require more then 30 minutes of machine or bench time. Work must not be dangerous to equipment or personnel.

5. Supervisor has right to refuse any walk in work.

6. The individual the work is being done for is responsible for all damages as well as the worker, so be careful!

7. Shop fee must be agreed on or waived before Job is started.

POWER TOOL SAFETY

Safety Tips:

- Use the proper tool for the job
- Never carry a tool by the cord or hose
- Keep cords and hoses away from heat, oil, or sharp edges
- Disconnect tools when not in use, before servicing and when changing accessories
- Keep all guards in place and make sure they are working properly
- Wear proper apparel. Loose clothing, long hair, and jewelry can become caught in moving parts
- Wear personal protective equipment, including safety glasses and hearing protection

Take these precautions when using these power tool types:

Electric

- Make sure tools are grounded
- Use double-insulated tools when possible
- Do not use electric tools in damp or wet locations, and store the tools in a dry place
- Never yank the cord to disconnect it from the receptacle

Hydraulic

- Use approved fire-resistant fluid rated for the most extreme temperatures to which it will be exposed
- Do not exceed the manufacturer's recommended safe operating pressures
- Do not check for leaks using your hands because fluid under pressure may puncture skin

PNEUMATIC

- Always wear eye and hearing protection
- Use a safety clip or retainer to prevent attachments, such as chisels on a chipping hammer, from being unintentionally shot from the barrel
- Fasten air hoses together securely with wire or a locking device

FUEL

- Store and transport fuel only in containers approved for this application
- Shut off the engine and extinguish all open flames before refueling

When Operating equipment in closed areas, be sure there is proper ventilation

The Badge and Approval To Work Process

1. There is a required training course for all individuals wanting to work in the shop. Training will include safety, shop operation, equipment use, drawing layout, and other training directed towards work safety and productivity. There is a $150 Dollar Fee for a toolbox with tools that is kept by the person taking the training when the training is completed.

2. At completion of training individual will receive a Badge and go into a database to track tools and time in shop. At the end of the training the supervisor will assess the student competencies. If the student fails the training process, the student can get a full refund after returning the toolbox or complete extra training as required. The training is mandatory before entering shop and all aspects must be completed.

3. When entering the shop the approved individual is required to pickup his badge, sign in, and then can begin work according to the rules of the shop. This will insure that there is a control atmosphere and that only properly trained individuals are allowed to work in the shop.

4. The student can train in shop anytime with supervisor approval but must be observed by either trained work- study or supervisor (faculty). This work time can be assessed towards the training time. However the student must pass all verbal, practical, and written tests before getting badges.

5. This process will apply to all individuals. If an individual is deemed skillful enough to work in shop without FIT training, this includes pervious work- studies and outside training, they will not be required to take the training course but will still be required to pass all verbal, practical, and written tests before receiving a Badge. If this individual fails to meet the requirements they will be asked to take the training course. In addition, the supervisor can reassess the individual at anytime as skill issue arises.

6. All Work-study students in the Shop will receive training as a priority. They can buy the toolbox and will be encouraged to do so after they have been trained. A highly trained work-study may attain supervisor status, this is only on approval of Lab Director, Dept Head or Shop Supervisor.

7. Skill Level will be shown on badge as a colored dot
   Red- Trainee Yellow- passed skills training Green- advanced skills

Florida Tech Machine Shop Training Record

Student Phone Email Age
Major Year

Shop Safety Rules_____ Procedures_____

Drawing & Manufacturing Basic Dimensioning_____ Design Issues_____ CAM_____ Lab/Software_____ Plotter_____

Precision Instruments Micrometers_____Calipers___Gage Blocks____Gage Pins____Layout__
Height Gage____

Cutting Tools Milling Cutters _____ Drills _____ Reamers _____ Carbide Tooling _____ Turning Tools _____

Milling Machine Machine Operation_____ Basic Setup _____ Milling / Fly Cutting _____ Drilling_____ Boring___ Skills Test_____ CNC Basic Operation__ Horizontal Mill _____

Saws Vertical ____Horizontal ____Blade Change/Blade Selection _____
Speed Selection _____

Welding Machine Operation _____ Machine Set Up _____ Safety Operations _____

Cutting torch Basic Operation, Set Up _____ Regulator Set Up _____ Safety Operations _____

Lathe Machine Operation_____ Basic Setup _____ Basic Turning /Cutter Geometry _____ Drilling_____ Boring____Skills Test_____ CNC Basic Operation_____

Hand Tools Filing ____Deburing ___Air Tools _____ Punching __
Hand Tapping ___ Power Tools _____

Bench grinder& sander Operation _____

Sheet metal Shearing _____ Bending _____ Rolling _____
General practice___

Signature _____

Florida Institute of Technology
College of Engineering
Student Contract

I _____am certified to operate the following machines: (Check one or more of the following)

Milling Machine
Band Saw
CNC Milling Machine
Circular Saw
Router
Chop Band Saw
Drill Press
Bench Grinder and Belt Sander
Lathe
Hand Drill
Jig Saw

Certified Safe operation of the above equipment _____

I understand that I must follow all the safety regulations when working in the machine shop. Which includes the following:

1. There must be at least two people in the shop at all times. I will not work in the shop alone
2. I will wear safety goggles at all times
3. I will leave the shop clean and return all the tools I have borrowed
4. I will report any tools that are broken, or missing
5. I will remove any rings, watches, or any jewelry that I am wearing
6. I will tie down any loose clothing and roll up my long sleeve shirt
7. I will not smoke in the machine shop or the building

Student Signature _____ Date_____

Approved By _____ Date _____

FORMS

FLORIDA TECH INTERNAL MACHINE SHOP WORK ORDER
BUILDING 538 DATE _____

1. PRINT NAME of Person requesting work:
_____

(Check/Complete only one of the following:)

A. [ ] Student Project: _____
(Course Number)

Instructor Approval:
_____
(Signature)

B. [ ] Research Project: _____
(Project Number)

Principal Investigator Approval: _____
(Signature)

_____ _____
Department Charge Code & Number

Department Head Approval: _____

2. (a) Job Description (add more sheets if necessary):
_____
_____
_____
_____
_____
_____
_____

(b) Drawing attached: [ ] Yes [ ] No

(c) Person to contact when completed: _____
Tele. No. _____

(d) Date Required: _____

3. Estimated (a) Cost of Material_____
(b) Shop Time _____
(c) Process Engineering Time _____

4. MACHINE SHOP USE ONLY:

(A) TIME/DATE RECEIVED: _____ JOB NO._____

(B) TIME/DATE COMPLETED:
_____

(C) ACTUAL COST OF MATERIAL:
_____

(D) ACTUAL SHOP TIME: _____

Approval to do the work: _____ Date _____
Director of Labs or Machine Shop Supervisor

College of Engineering
Materials Request Form

Name_____ Date_____ Phone_____
e-mail_____
(Check/complete only one of the following:)

A. [ ] Student Project_____
(Course Number)

Instructor Approval _____
(Signature)

B. [ ] Research Project_____
(Project Number)

Principal Investigator Approval_____
(Signature)

C. [ ] Other_____

_____ _____
(Academic Unit) ***(Budget Charge Code)***

Academic Unit Approval _____
(Department Head or Program Chair Approval)

Type of Material Required_____
Quantity _____
Dimensions: ***(Material estimation must be done in standard sizes-Reference Alro Catalog in Library)***

Height_____
Width_____

Length_____
Thickness_____

Shape_____
Part #_____

Source_____
Page #_____

Company Contact _____
Phone # of Company_____

Address of Materials Company_____
_____

Other Specifications_____
_____
_____

Estimated Cost for Material_____

Date required_____

Request forwarded to Dan Simpson – College of Engineering

Additional Items:

Type of Material Required _____
Quantity _____
Dimensions: ***(Material estimation must be done in standard sizes-Reference Alro Catalog in Library)***
Height_____ **Width**_____

Length_____ **Thickness**_____

Shape_____ **Part #**_____

Source_____ **Page #**_____

Company Contact _____ **Phone # of Company**_____

Address of Materials Company_____
_____

Other
Specifications_____
_____
_____

Estimated Cost for Material_____

Date required_____

Type of Material Required _____
Quantity _____
Dimensions: ***(Material estimation must be done in standard sizes-Reference Alro Catalog in Library)***

Height_____ **Width**_____

Length_____ **Thickness**_____

Shape_____ **Part #**_____

Source_____ **Page #**_____

Company Contact _____ **Phone # of Company**_____

Address of Materials Company_____
_____

Other

Specifications_____
_____
_____

Estimated Cost for Material_____

Date required_____

Request forwarded to Dan Simpson – College of Engineering

MEASURING

Industry regularly makes measurements to a millionth (0.000001) part of an inch. A distance this small is called a MICROINCH. If the microinch were the thickness of a dime, and inch would be as high as four Empire State Buildings.

In addition to the English measurement (inch, foot, etc.), industry, to a limited extent, also uses the metric system of measurement (meter). The United States has tentatively adopted the simplified and clarified metric system devised by the International Standards Organization (ISO). All of the states are in the process of converting to the metric system of the next several years.

Regardless of how fine industry can measure, the job at hand is to learn to read the rule to 1/64 in.; progress through 1/1000 (0.001) in. by micrometer and Vernier type measuring tools; and finally to 1/10000 (0.0001) in. by the Vernier scale on the hub of some micrometer calipers.

Metric based measuring tools will offer no problems. As a matter of fact, many think they are easier to learn to read than inch based measuring tools.

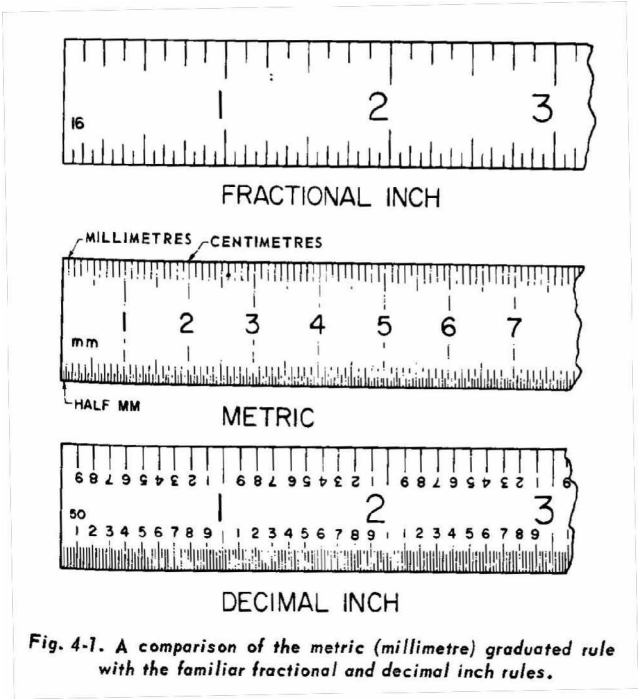


Fig. 4-1. A comparison of the metric (millimetre) graduated rule with the familiar fractional and decimal inch rules.

The Rule

Types of Rules

The steel rule, often incorrectly referred to as a scale, is the simplest of the measuring tools found in the shop. See Fig. 4-1 for the three basic types of rule graduations. A few of the many rule styles are shown in Fig. 4-2a to 2g.

Reading The Rule

A careful study of the enlarged section of the rule, Fig 4-3, will show the different fractional divisions of the inch from 1/8 to 1/64 in. The lines representing the divisions are called GRADUATIONS. On many rules, every fourth graduation is numbered on the 1/32 edge, and every eighth graduation on the 1/64 edge.

The best way to learn to read the rule is to:

1. Become thoroughly familiar with the 1/8 and 1/16 measurements.
2. Do the same with the 1/32 and 1/64 measurements
3. Practice until you become proficient enough to read measurements accurately and quickly.

Some steel rules (inch based) are graduated in 10^{ths}, 20^{ths}, 50^{ths} and 100^{ths}. Additional practice will be necessary to read these rules accurately and quickly.

Fractional measurements are always reduced to the lowest terms. A measurement of 14/16 is 7/8, 2/8 is 1/4 etc.

Care of the Rule

The steel rule is precision made and, like all tools the quality of service depends upon the care it receives. Here are a few suggestions:

1. Use a screwdriver to loosen and tighten screws and to open paint cans. DO NOT use a rule.
2. Keep the rule clear of moving machinery. Using it to clean metal chips

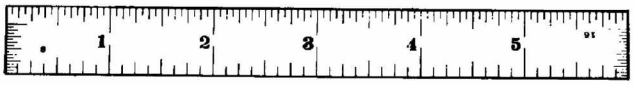


Fig. 4-2a. 6 in. – pocket rule.

Fig. 4-2b. Narrow rule.

Fig. 4-2c. Flexible rule.

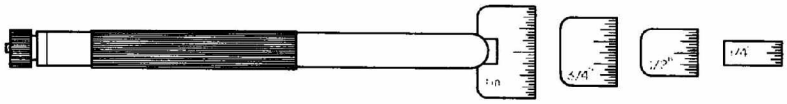


Fig. 4-2d. Narrow rules with holder. The five small rule sections are interchangeable in the holder, and can be set at various angles. Rules are graduated in 1/32 and 1/64.

Fig. 4-2e. Hook rule with a fixed hook.

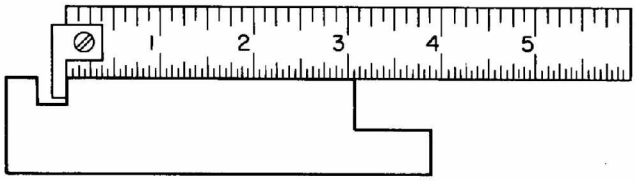


Fig. 4-2f. How the hooked rule is used.

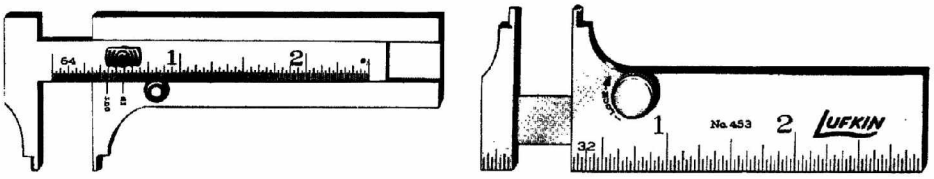


Fig. 4-2g. A slide caliper rule is fitted to the work and locked. Outside dimensions are read at the point marked "out." Inside dimensions at the point marked "in."

as they form on the machine will not only ruin the rule, but will prove extremely dangerous to the person attempting it.

3. Avoid laying other tools on the rule.
4. Frequent wiping with an oily cloth will prevent the forming of rust.
5. An occasional cleaning with fine steel wool will keep the graduations legible.
6. Make it a practice to take measurements and tool settings from the 1-in. line or other major graduation rather than from the end of the rule.
7. Store the rule separately. Do not throw it in a drawer with other tools.

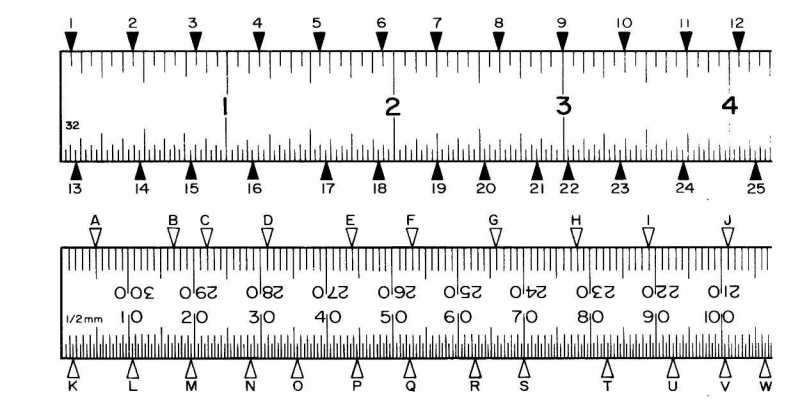


Fig. 4-3. How many measurements can YOU read?

8. Use the rule carefully so that the ends do not become nicked or worn.
9. Use the correct rule for the job at hand.
10. Coat the tool with wax or a rust preventative if the rule is to be stored for a prolonged period.

The modern micrometer caliper, known as a "mike," is a precision measuring tool capable of measuring to 1/1000 (0.001) in. and when fitted with a Vernier scale to 1/10000 (0.0001) in. While manufactured in sizes up to 60 in., the movement of the spindle is limited to 1 in. Only the frame is enlarged.

The Micrometer Caliper

A Frenchman, Jean Palmer, devised and patented a measuring tool that made use of a screw thread to make it possible to read measurements quickly and accurately without calculations. It incorporated a series of engraved lines on the hub and around the thimble. The device, Fig. 4-4, called "Systeme Palmer," is the basis for the modern MICROMETER CALIPER.

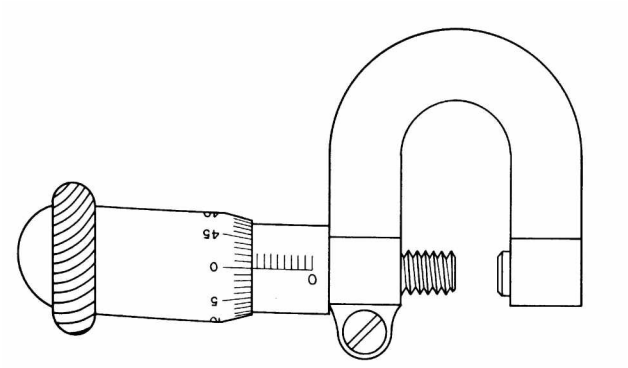


Fig. 4-4. A drawing of "Systeme Palmer." The modern micrometer caliper works on the same principle as this 1848 measuring tool.

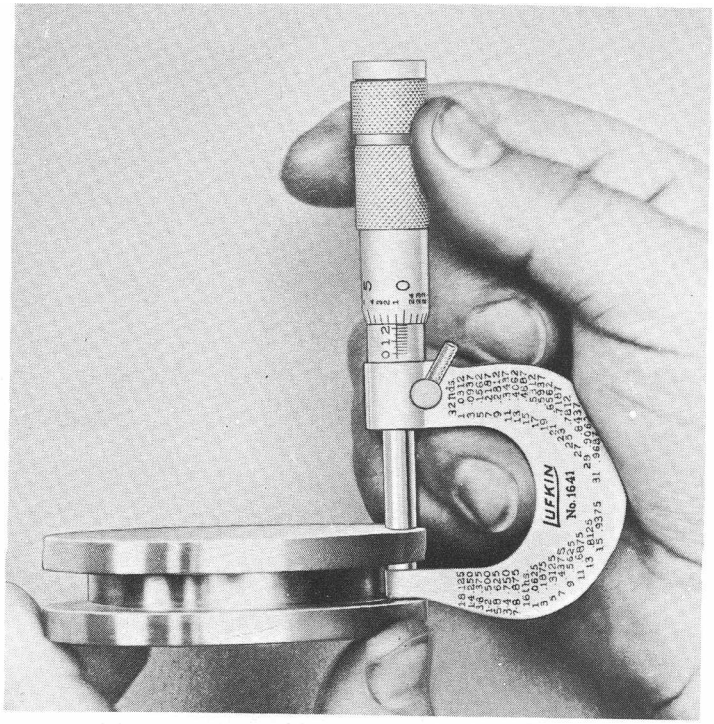


Fig. 4-5. The 0 to 1-in. outside micrometer caliper. Note how the machinist is holding it.

Types of Micrometers

Micrometers are made in a large variety of models. A few of the more commonly used are:

OUTSIDE MICROMETER, Fig 4-5. Measures outside diameters and material thickness.

INSIDE MICROMETER. Excellent for measuring inside cylinders and rings, measuring parallel slots, and for setting calipers, gages, etc. There are two generally used styles: the CONVENTIONAL INSIDE CALIPER, Fig 4-6, whose range is extended by fitting longer rods to the micrometer head, and the JAW-TYPE INSIDE MICROMETER, Fig. 4-7. It is used in much the same manner, however, its range is limited to 1 in. Note that the scale on the hub of the jaw type is graduated from RIGHT TO LEFT.

DIRECT READING MICROMETER, Fig 4-8. Measurements are read directly from the numbers appearing in the opening in the frame.

MICROMETER DEPTH GAUGE, Fig 4-9. Depths of holes, slots, projections, etc. can be measured with this tool. The measuring range can be increased by changing to measuring rods of longer lengths.

SCREW THREAD MICROMETER CALIPER Fig. 4-10. This micrometer has a pointer spindle and a double "V" anvil, both correctly shaped to contact the screw thread. It measures the pitch diameter of the thread in thousandths of an inch, which equals the outside diameter of the screw minus the depth of one thread.

SPECIAL MICROMETERS, Fig. 4-11. Many cutting tools have cutting edges that are uneven in number. This makes it impossible to measure their diameter with the conventional "mike." Special micrometers have been devised to handle this and other situations.

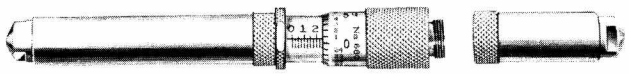


Fig. 4-6. Conventional inside micrometer.

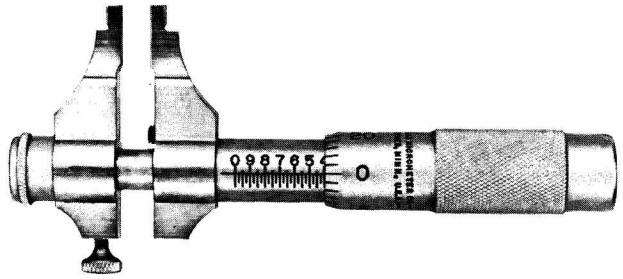


Fig. 4-7. Jaw-type inside micrometer. (Scherr-Tumico)

How to Read a Micrometer

The principle of the micrometer, a sectional view is show in Fig 4-12, is based on a very accurately made screw thread that rotates in a fixed nut. The screw thread is ground on the SPINDLE (C) and is attached to the THIMBLE (J). The spindle advances or recedes from the

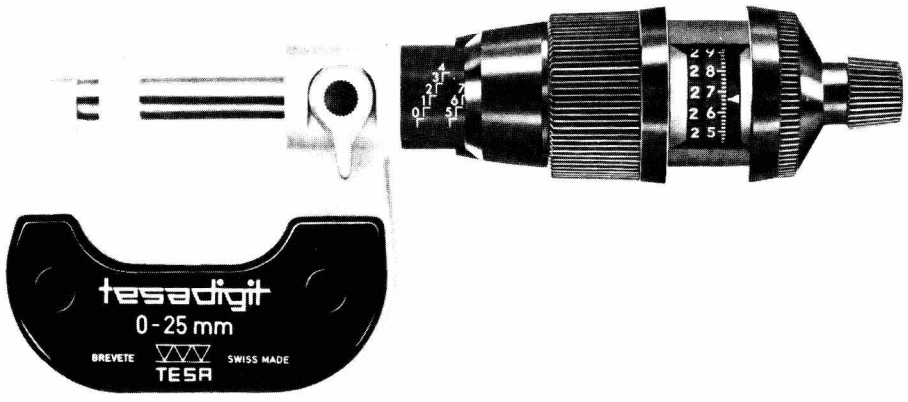


Fig. 4-8. To read a metric micrometer, add the total reading in millimetres visible on the sleeve to the reading in hundredths of a millimetre indicated by the graduation on the thimble which coincides with the longitudinal line on the sleeve. The reading here is 7.266 mm. (Brown and Sharpe Mfg. Co.)

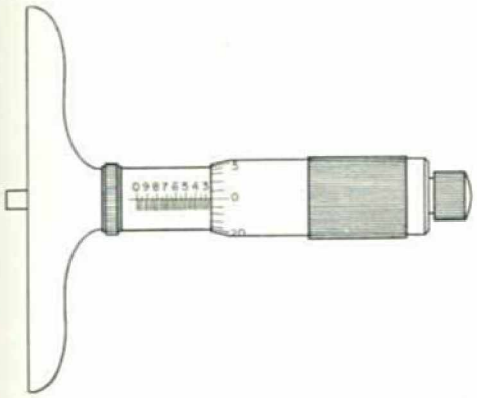


Fig. 4-9. Micrometer depth gauge.

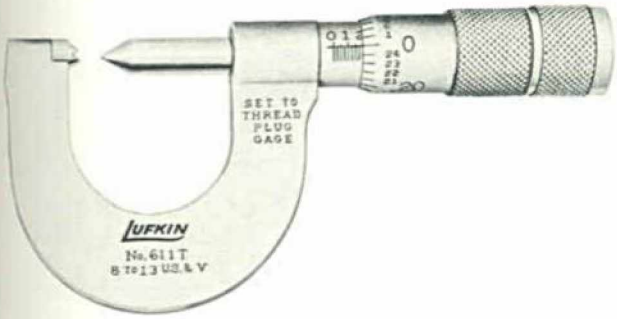


Fig. 4-10. The screw thread micrometer caliper.

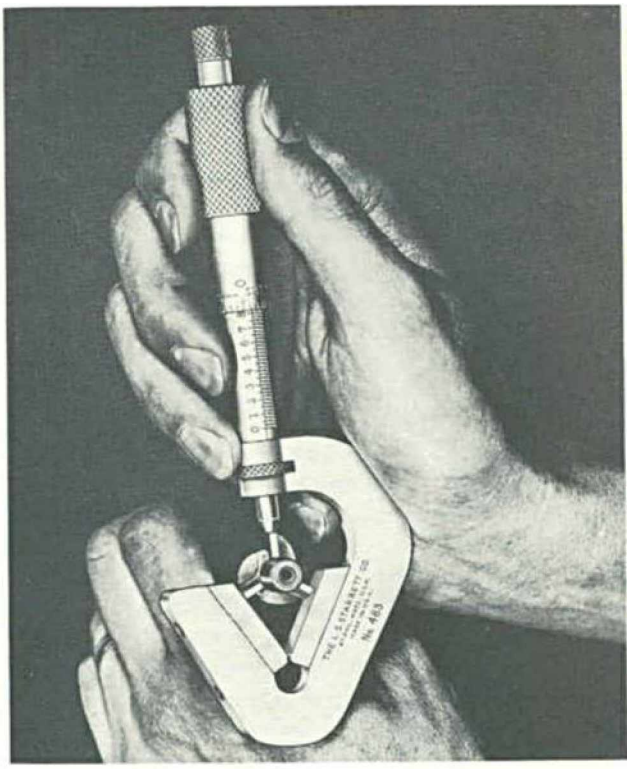


Fig. 4-11. One of many specially designed micrometer-type measuring tools.

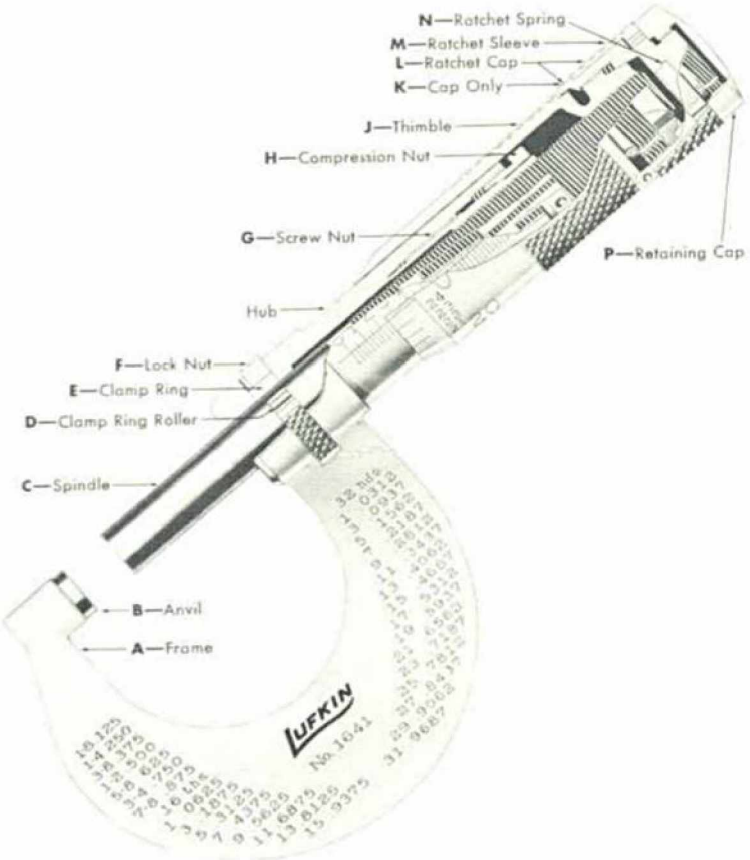


Fig. 4-12. A sectional view of a micrometer caliper.

ANVIL (B) by rotating the thimble. The threaded section has 40 threads per inch; therefore, each revolution of the thimble moves the spindle 1/40 in. (0.025).

The line engraved lengthwise on the HUB is divided into 40 equal parts per inch that correspond to the number of threads on the spindle. Each vertical line represents 1/40 or 0.025 in. Every fourth division is numbered 1, 2, 3 etc., representing 0.100 in., 0.200 in. etc.

The beveled edge of the THIMBLE (J) is divided into 25 equal parts, each representing 1/1000 (0.001) in. Each division is numbered on many micrometers, while every fifth division is numbered on others.

The micrometer caliper is read by recording the highest figure visible on the HUB, 1 = 0.100, 2 = 0.200, etc. To this number is added the number of vertical lines visible between the number and thimble edge, 1 = 0.025, 2 = 0.050, etc. To this total is added the number of thousandths indicated by the line on the thimble that coincides with the horizontal line on the hub. See Fig. 4-13.

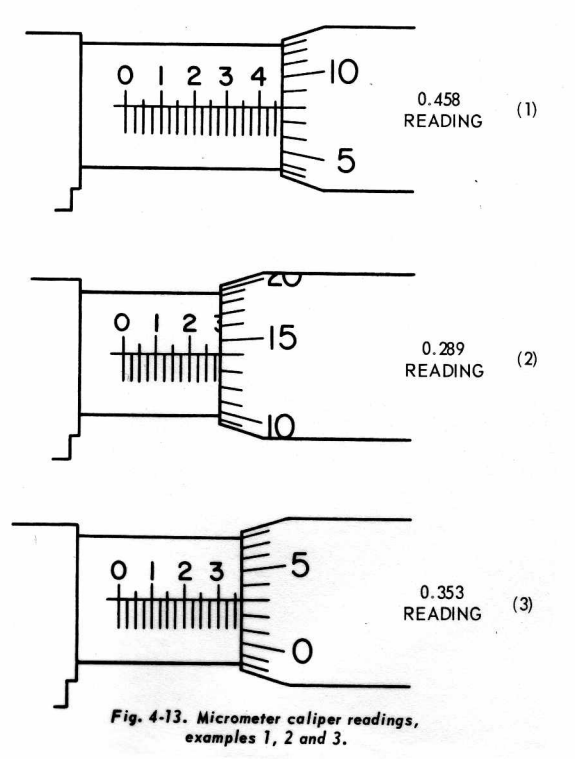


Fig. 4-13. Micrometer caliper readings, examples 1, 2 and 3.

EXAMPLE 1:

The reading is composed of:
4 large graduations or 4 x 0.100 = 0.400
2 small graduations or 2 x 0.025 = 0.050
and 8 graduations on the
thimble or 8 x 0.001 = 0.008
Total reading = 0.458 in.

EXAMPLE 2:

The reading is composed of:
2 large graduations or 2 x 0.100 = 0.200
3 small graduations or 3 x 0.025 = 0.075
and 14 graduations on the
thimble or 14 x 0.001 = 0.003
Total reading = 0.289 in.

EXAMPLE 3:

The reading is composed of:
3 large graduations or 3 x 0.100 = 0.300
2 small graduations or 2 x 0.050 = 0.050
and graduations on the
thimble or 3 x 0.001 = 0.014
Total reading = 0.353 in.

How to Read a Vernier Micrometer Caliper

On occasion, it becomes necessary to measure finer than 1/1000 in. When this situation is encounter, the Vernier micrometer caliper is employed. This micrometer has a third scale AROUND THE HUB, Fig 4-14, that furnished the 1/1000 reading without estimating or guessing. The Vernier has 11 parallel lines occupying the same space as 10 lines on the thimble. The lines around the hub are numbered 1 to 10. The difference between the space on

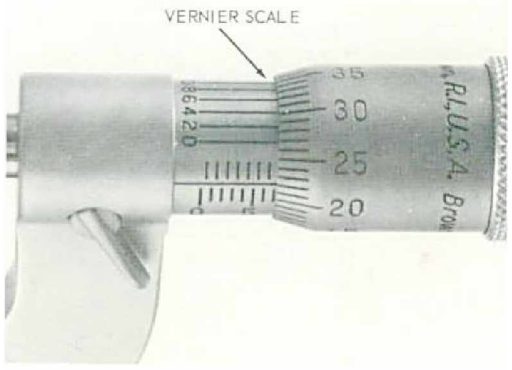


Fig. 4-14. Vernier scale on some micrometers.

the hub are those on the thimble is one-tenth of a space on the thimble or 1/10 of a thousandth (0.001) of an inch. To read, first obtain the thousandths reading, then observe which of the lines on the Vernier scale coincide with a line on the thimble. Only one of them can. If it is line 1, add 0.0001 to the reading; if line 2, add 0.0002 to the reading, etc.

EXAMPLE: (See Fig. 4-15.)

The reading is composed of:
2 large graduations or 2 x 0.100 = 0.200
3 small graduations or 3 x 0.025 = 0.075
11 graduations on the thimble or 11 x 0.001 = 0.011
and the additional distance the thimble has advanced beyond the 0.011 inch mark.
In this case it has advanced 0.0002
Total reading = 0.2862 in.

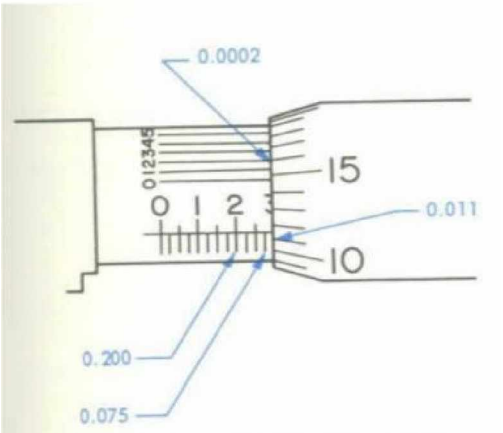


Fig. 4-15. Vernier micrometer caliper reading.

How to Read a Metric Based Micrometer

The metric based micrometer, Fig. 4-16, is read as shown in Fig. 4-17. If you are able to read the conventional inch based micrometer the change over to reading the metric based tool will offer no difficulties.

How to Use the Micrometer

Fig. 4-18 shows the proper way to hold the micrometer when making measurements. The work is placed into position, and the

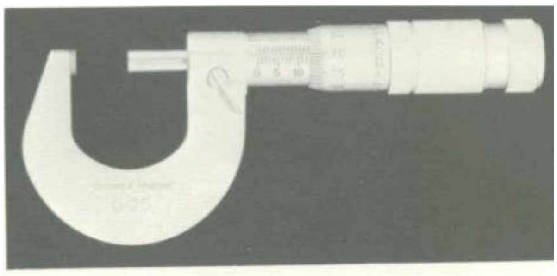


Fig. 4-16. Metric based micrometer.

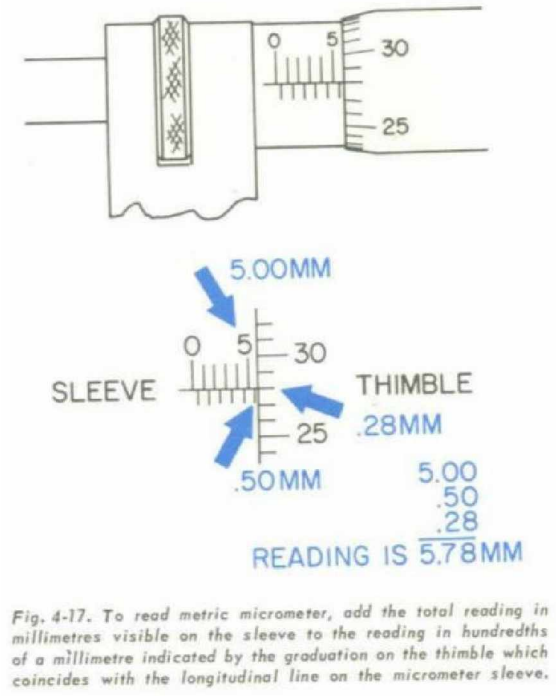


Fig. 4-17. To read metric micrometer, add the total reading in millimetres visible on the sleeve to the reading in hundredths of a millimetre indicated by the graduation on the thimble which coincides with the longitudinal line on the micrometer sleeve.

thimble rotated until the part is clamped lightly between the anvil and spindle. Guard against excessive pressure as it will cause an erroneous reading.

The correct contact pressure will be applied if a mike with a RATCHET STOP is employed, Fig. 4-19. This device is used to rotate the spindle and insures consistent, accurate measurement by limiting the spindle pressure on the work to a definite amount, even when different machinists use the same micrometer. When pressure reaches a predetermined amount, the ratchet slips and prevents further tightening.

Some micrometers are fitted with a FRICTION CLUTCH, Fig. 4-5. The attachment will slip the moment the correct pressure is applied and provide an accurate measurement. Whene several identical parts are to be gauged,

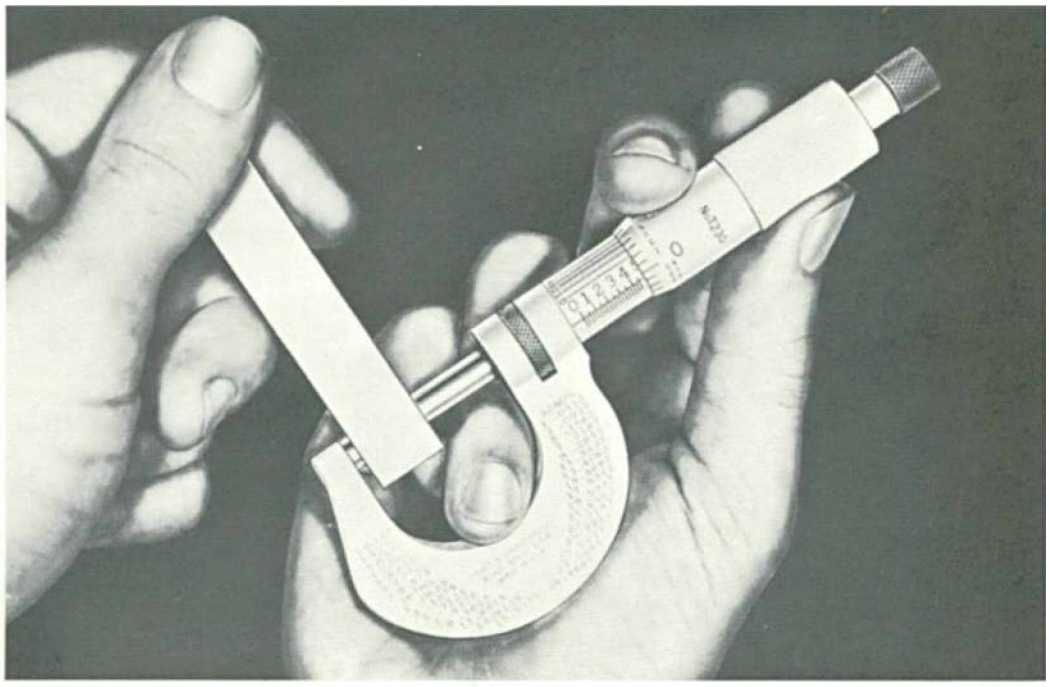


Fig. 4-18. The correct way to hold 0-1 in. micrometer caliper for making measurements. (L. S. Starrett Co.)

Fig. 4-19. Micrometer with a ratchet stop.

lock the spindle in place with the LOCK NUT, Fig. 4-12 (F). When a part is gauged with the micrometer locked at the proper setting, it is quite easy to identify the piece as being oversize, correct size or undersize.

How to Read an Inside Micrometer

To get a correct reading with and INDISE MICROMETER, it is important that the instrument be held square across the diameter and positioned so it will measure the diameter on exact center. Large diameters are measured, Fig. 4-20, by holding one end of the tool in place and then "feeling" for the maximum possible setting by moving the loose end from left to right, and in and out of the hole with your free hand. The measurement is taken when no left or right movement is felt, and a slight

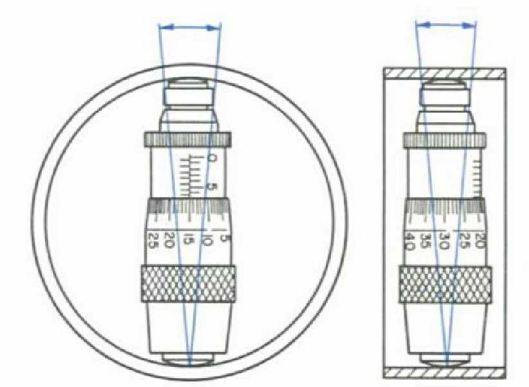


Fig. 4-20. Inside micrometer and how it is used. Extension rods can be added for measuring larger holes.

drag is noticeable on the in-and-out swing. It may be necessary to make several readings and average them.

How to Read the Micrometer Depth Gauge

Be sure to read the micrometer depth gauge, Fig. 4-9, correctly. Unlike the outside micrometer, the graduations on this tool are in REVERSE ORDER. That is, they read 0, 9, 8, 7, 6, etc. The graduations UNDER the thimble must be read rather than those that are exposed.

USING CALIPERS

CALIPERS

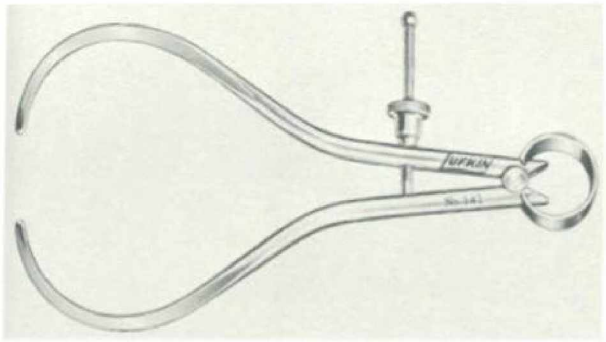


Fig. 5-1. The spring-joint outside caliper.

The OUTSIDE CALIPER, Fig. 5-1, is used to make external measurements where a 1/64 in. tolerance is permitted. A caliper does not have a dial or gauge which shows a measurement, and must be used with a steel rule.

Round stock is measured by setting the caliper to the approximate diameter of the material.

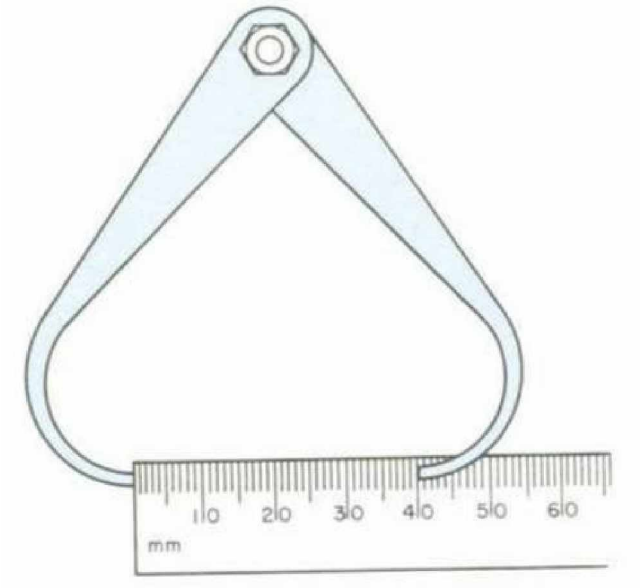


Fig. 5-2. Setting outside calipers.

Then, hold the caliper square with the work and move the caliper legs down on the stock. Adjust the tool until the caliper points bear lightly on the centerline of the stock. The weight of the caliper should cause the tool to pass over the diameter. Hold the caliper to the rule, Fig. 5-2, to read the size.

The INSIDE CALIPER, Fig. 5-3, is used for making internal measurements where 1/64 in. accuracy is acceptable.

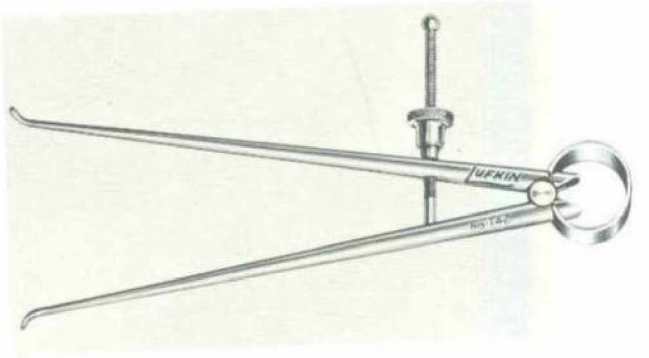


Fig. 5-3. The spring-joint inside caliper.

A hole diameter can be measured, Fig. 5-4, by setting the caliper to the approximate size of the hole, and inserting the legs into the opening. Hold one leg firmly against the hole wall, and adjust the thumbscrew until the other leg lightly touches the wall exactly opposite the first leg. The legs should "drag" slightly when moved in and out, or from side to side. Read the hole size by holding the caliper to a steel rule, Fig. 5-5.

There are times when a shaft must be turned to fit a hole, and it becomes necessary to transfer the measurement from one caliper to another. This can be accomplished quickly by setting the inside caliper to fit the hole diameter. Place one leg of the inside caliper against one leg of the outside

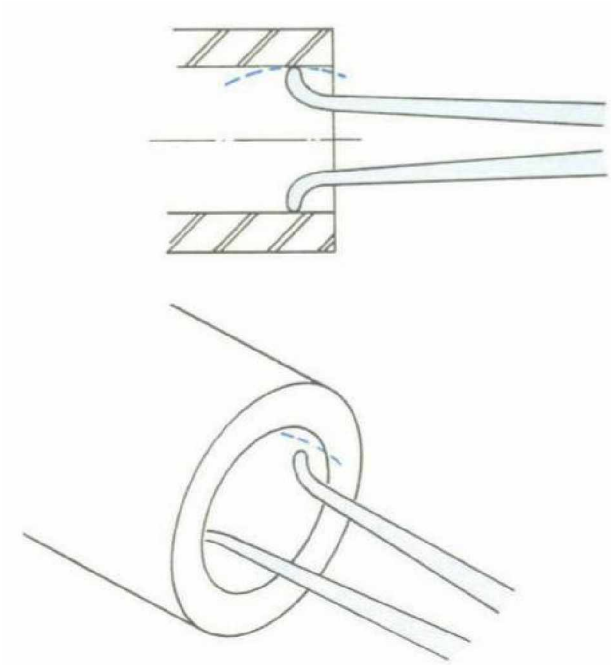


Fig. 5-4. Measuring with the inside caliper.

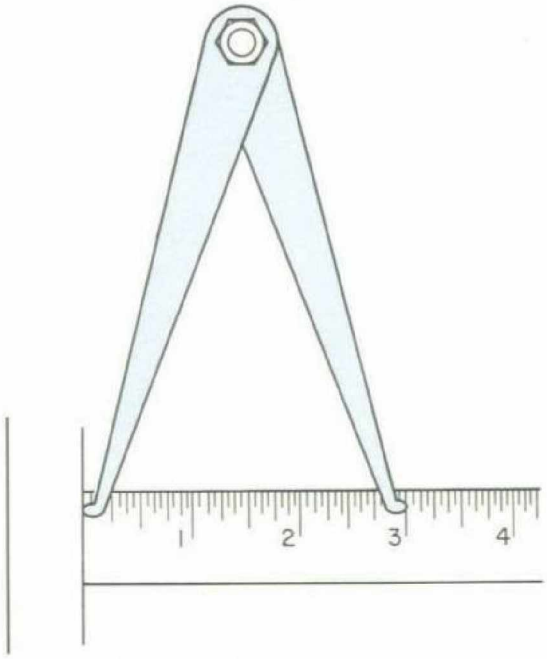


Fig. 5-5. Reading the inside caliper.

caliper, and adjust the outside caliper until the second leg lightly touches the other leg of the inside caliper.

Considerable skill is required to make accurate measurements with calipers. Much depends upon the machinist's sense of touch. With practice, measurements to within 0.003 to 0.005 in. can be made. A micrometer or Vernier caliper should be used if greater accuracy is required.

TEST YOUR KNOWLEDGE

1. The _____ caliper is used to make external measurements.
2. The _____ caliper is used to make internal measurements.
3. Calipers are used where _____ in. accuracy is acceptable.
4. A _____ or _____ caliper should be used when accuracy closer than 0.003 to 0.005 is required.

LAYOUT

LAYOUT WORK

LAYING OUT is the term used to describe the locating and marking out of lines, circles, arcs and points for drilling holes. These lines and reference points on the metal show the machinist where to machine.

The tools used for this work are known as LAYOUT TOOLS. Many common hand tools fall into this category. The accuracy of the job will depend upon the proper and careful used of these tools.

Making Lines on Metal

The shiny finish of metal makes it difficult to distinguish the layout lines from the metal. LAYOUT DYE, Fig. 6-1, is probably the easiest to use of the many coating devised to make the lines stand out better. This blue colored fluid, when applied to the metal, offers an excellent contrast between the metal and the layout lines. All grease and oil must be removed before applying the dye, otherwise it will not adhere properly.

Fig. 6-1. Applying layout fluid preparatory to making the layout.

In a pinch, layout fluid can be made by dissolving the coating on spirit duplicator carbons in alcohol. Chalk can be used on hot rolled metal as a layout background.

A layout, to be accurate, requires fine lines that must be scribed or scratched in the metal. A SCRIBER, Fig. 6-2, is used to produce these lines.

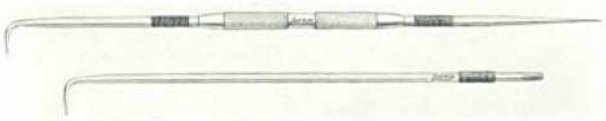


Fig. 6-2a. Scriber.

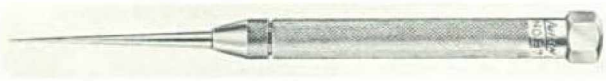


Fig. 6-2b. Pocket scriber. The point is reversed and stored in the handle when the tool is not being used.

The point is made of hardened steel, and is kept needle sharp by frequent honing on a fine oilstone. Many styles of scribers are available. CAUTION: NEVER CARRY AN OPEN SCRIBER IN YOUR POCKET.

The scriber is used to draw straight and gradually curved lines, circles and arcs are made with the DIVIDER, Fig. 6-3a.

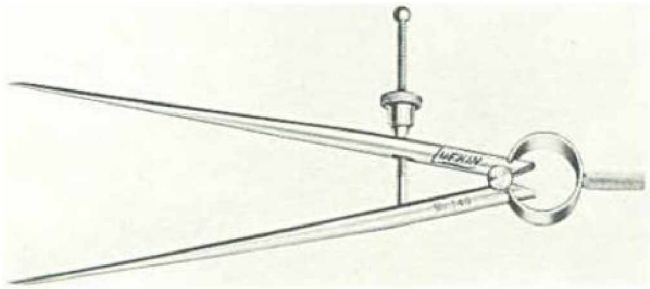


Fig. 6-3a. The divider.

It is essential that both legs of the tool be equal in length and kept pointed. The divider can be used to lay out and measure distances, Fig. 6-3b. To set the tool to the correct dimension, place one point on an

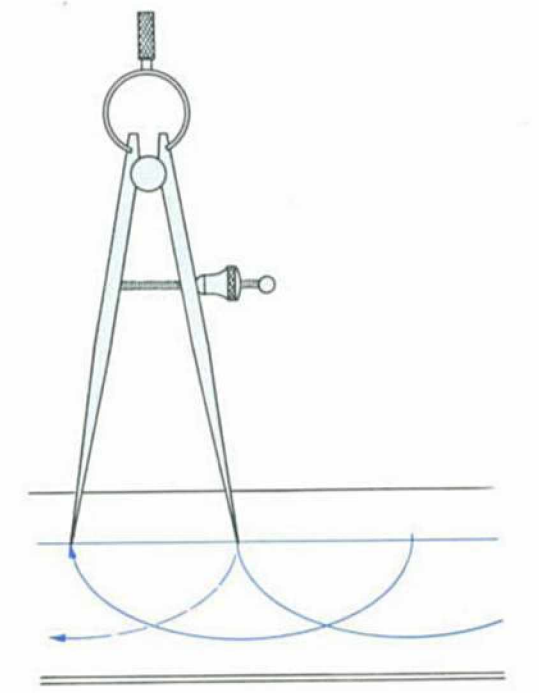


Fig. 6-3b. Laying out equal spaces with a divider.

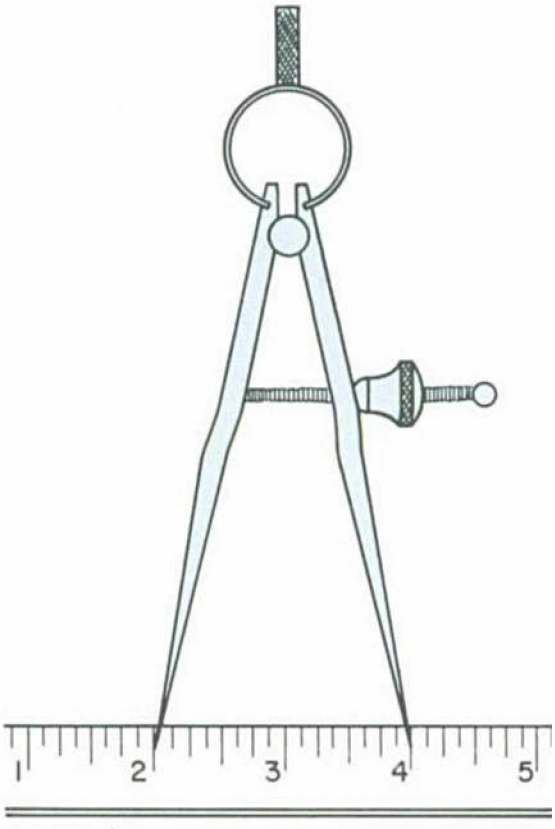


Fig. 6-3c. Setting a divider to the correct dimension.

inch mark of steel rule, and open the divider until the other leg is set to the proper distance, Fig. 6-3c.

Circles and arcs that are too large to be made with the divider are drawn with a trammel, Fig. 6-4. This consists of a long thin rod, called a BEAM, on which two SLIDING HEADS with scriber points are mounted. One head is fitted with an ADJUSTING SCREW. EXTENSION RODS can be added to the beam to increase the capacity of the tool.

The HERMAPHRODITE CALIPER, Fig. 6-5a, is a layout tool which has one leg shaped like a caliper, and the other pointed like a divider. The tool is used to lay out lines parallel to the edge of the material, Fig. 6-5b, and to located the center of irregularly shaped stock.

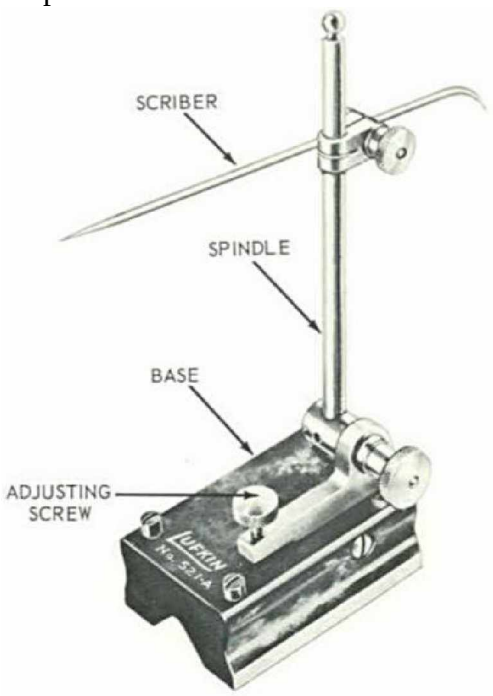


Fig. 6-6a. Surface gauge.

A SURFACE GAUGE, Fig. 6-6a, is used for many purposes, but is most frequently used for layout work. It consists of a BASE, SPINDLE and SCRIBER.
An ADJUSTING SCREW is fitted for making fine adjustments. The scriber is mounted in such a manner that it can be pivoted into any position. The surface gauge can be used for scribing lines, at a given height and parallel to the surface, Fig. 6-6b. A V-slot in the base permits the tool to be used on a curved surface.

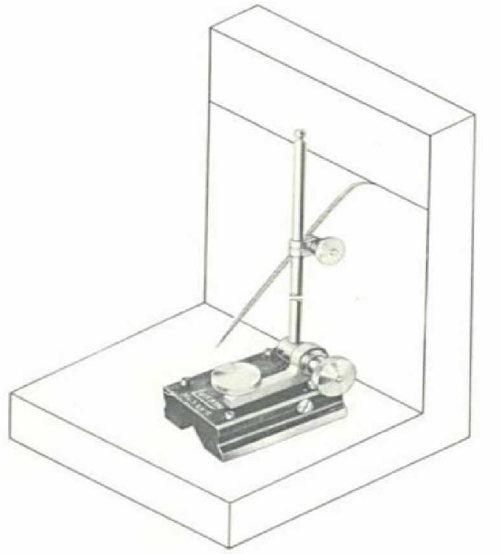


Fig. 6-6b. Using surface gauge to scribe lines parallel to base.

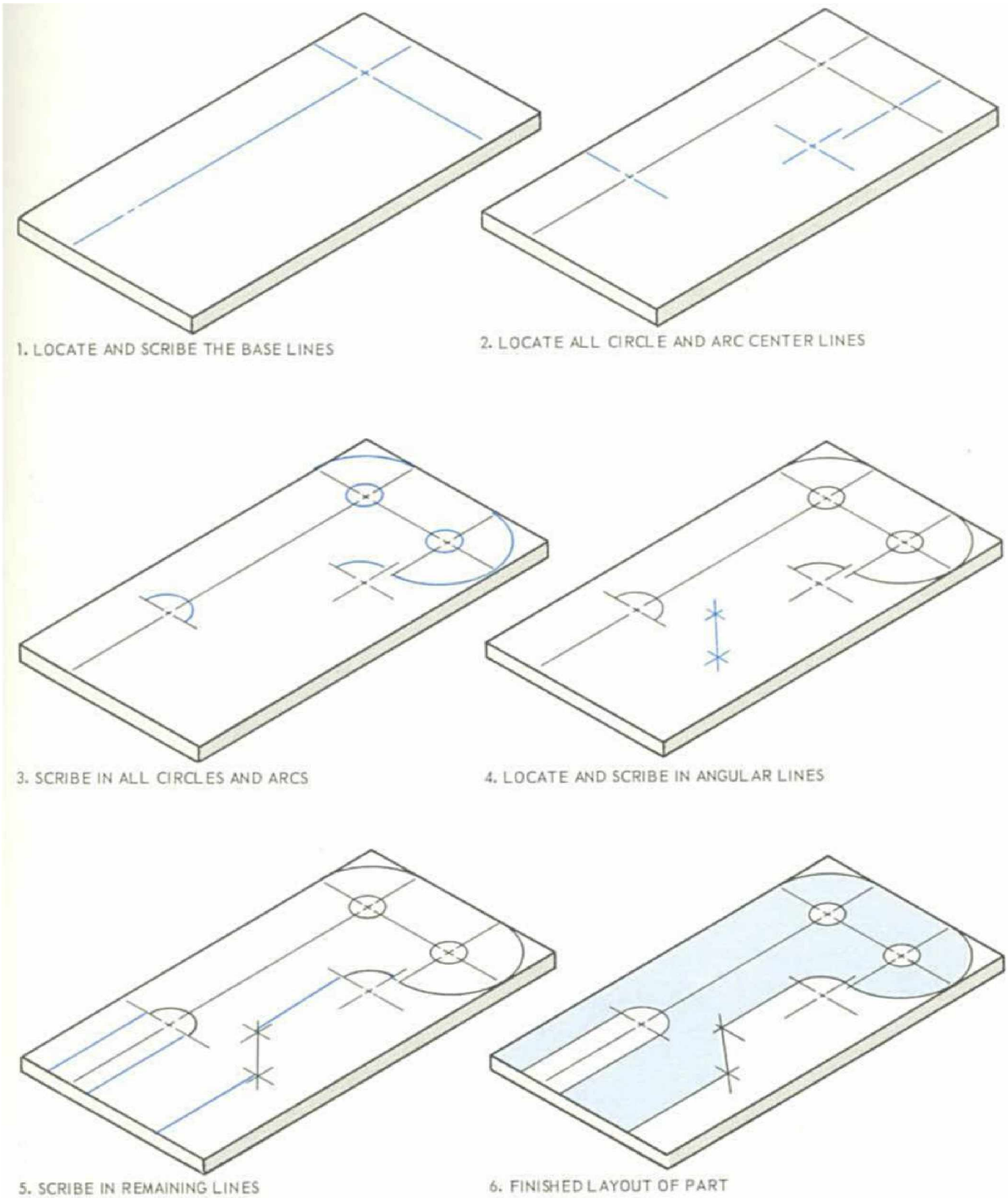


Fig. 6-19. Steps in laying out a job.

Steps in Making a Layout

Each layout job has its peculiarities and requires some planning before the operation can be started. Fig. 6-19 shows a typical job.

1. Study the drawings carefully.
2. Cut the stock to size and remove all burrs and sharp edges.
3. Clean the work surface of all oil and grease and apply layout dye.
4. Locate and scribe a REFERENCE or BASE LINE. Make all of your measurements from this line. If the material has one true edge, it can be used in place of the reference line.
5. Locate the center points of all circles and arcs.
6. Use the PRICK PUNCH, Fig. 6-20, to mark the point where the center lines intersect. The sharp point (30 to 60 deg.) of this punch makes it easy to locate this position. After the prick punch mark has been checked and found on center, it is enlarged with the CENTER PUNCH, Fig. 6-20.
7. Using the divider or trammel, scribe in all circles and arcs.
8. If angular lines are necessary, use the proper protractor type tool, or locate the correct points by measuring, and connect them by using a rule or straightedge.
9. Scribe in all other internal openings.
10. Use only clean sharp lines.

Modern Metalworking

S A F E T Y

1. Never carry an open scriber, divider, trammel or hermaphrodite caliper in your pocket.
2. Always cover all sharp points with a cork when the tool is not being used.
3. Wear goggles when grinding the points of scriber type tools.
4. Get help when you must move heavy angle plates, large V-blocks, etc.
5. Remove all burrs and sharp edges from stock before starting to work on it.

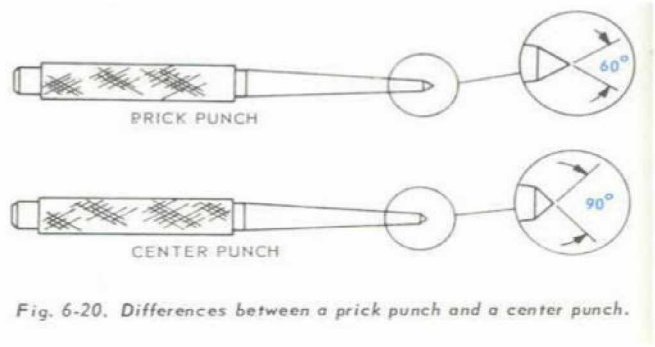


Fig. 6-20. Differences between a prick punch and a center punch.

TAPS AND DIES

HOW TO USE TAPS AND DIES

ABOUT TAPS AND DIES:

American Standard Taps and Dies are designated according to the Metal Cutting Institute Standard System of Marking as follows:

1) Nominal size such as a fraction or number representing the major diameter of the thread.
2) Number of threads per inch
3) Symbol to identify the thread types

Metric Taps and Dies are designated as follows:

1) A number representing the major diameter of the thread
2) The symbol MM indicating metric
3) A number which is the pitch (or distance from the crest of one thread to the crest of the next thread) of the thread in millimeters

TAPS

WHAT A TAP IS – WHAT A TAP DOES

A tap is a precision tool used in the cutting of an internal thread such as in a nut. Just a drill removes material to make a hole, a tap cuts material away to form a thread.

There are three basic types of hard taps: i.e., "taper", "plug", and "bottom" taps. The difference in these is the length of the chamfer on the starting end of the tap. "Taper" taps are chamfered for the first 6-8 threads. This makes staring easier but prevents threading close to the bottom of a hole. "Plug" taps are camfered 3-5 threads from the end. This is the optimum for starting and being able to tap close to the bottom of a hole. "Bottoming" taps have a very short camfer, 1 1/2-3 threads, and will tap as close to the bottom of a hole as practical; however, to do this requires starting the thread with a "plug" or "taper" tap first.

TOOLS REQUIRED TO MAKE A THREADED HOLE

1) A Tap of the correct size and thread form
2) A Tap wrench
3) Proper drill size or hole size
4) Lubrication or cutting oil

The correct drill or hole size is of great importance in producing satisfactory threads. The Tap Drill Chart (see later pages) provides a ready reference table of the correct drill sizes. Use of a smaller drill than specified does not provide a stronger or tighter thread. It only serves to overload the tap and cause undue breakage. Lubrication of the tap while cutting threads is important in producing smooth threads and maintaining long tap life. Refer to the lubrication section for recommendations.

RENEWING THREADS

Damaged, mutilated, or rusty threads are easily repaired. First check the part for correct thread

size and select the proper tap. Next carefully start the tap into the pre-threaded hole and proceed in the same manner as when cutting new threads. Some materials are case hardened and if a tap is forced into work in this type, damage to the tap will result. A simple file test will determine whether or not to proceed. If material can not be easily filed, do not attempt to rethread it.

CUTTING INTERNAL THREADS

The tap is held by the square in tap wrench and is started into the hole by turning clockwise for right hand threads. Care must be taken to start the tap straight in line with the hole. As the tap is turned it cuts into the metal and starts to lead into the hole. The metal chips flow into the flute spaces and will cause the tap to turn hard unless the chips are broken. The chips are broken and pressure on the tap is released by reversing the tap direction every ¼ or ½ a revolution depending on the material being tapped. This action is continued until the tap passes through the part or the desired depth of the thread has been reached. In cases where it is necessary to tap a hole that does not pass through the part, or so called blind hole, be sure to provide clearance at the bottom to accommodate chips and the camfer section of the tap.

WHEN USING TAPS

DO drill correct size hole (see chart)
DO countersink hole before tapping
DO keep tap straight in line with the hole being tapped
DO reverse tap during use to break up chips
DO use correct lubrication
DO provide rigid holding of part being tapped

The operation of any cutting tool can result in foreign objects being thrown into the eyes, which can result in severe eye damage. Always wear safety glasses or eye shields before starting cutting tool operation.

DON'T use too small a tap drill
DON'T crowd tap – Tap should be turned backwards slightly every ¼ to ½ turn to clear chips from tap flutes.
DON'T fail to clean tap before storage

MAINTENANCE

The importance of using a sharp tap cannot be over emphasized. As taps require precision sharpening equipment, it is recommended that dull or damaged tools be replaced.

DIES

WHAT IS A DIE? – WHAT DOES IT DO?

A die is a precision tool used in cutting external or outside threads. Dies cut external threads such as on a bolt.

TOOLS REQUIRED TO CUT AN EXTERNAL THREAD

1) A die of the correct size and thread form
2) A die stock to hole the die
3) Lubricating or cutting oil

HOW TO USE A DIE

After selecting the proper die, position and hold in the die stock, with the starting side next to the guide, by means of a set screw which tightens against the edge of the die. Next place the adjustable guide side of the die stock on the rod or bolt to be threaded.

With the rod or bolt in position, adjust the guides by turning the chuck plate counter clockwise until guides touch the rod of bolt. Clamp plate is then held in place by tightening the two knurled screws. The adjustable guides properly set assure cutting straight threads.

CUTTING EXTERNAL THREADS

Rigidly secure the correct size rod or bolt, preferably 0.005 to 0.010 undersize and beveled for ease in starting and turn the die clockwise. As the die starts to cut, chips will flow and should be broken by reversing every ¼ to ½ turn. Periodic application of cutting oil will help in cutting smooth threads and in prolonged die life. Continue the forward and reversing action until the desired length of thread has been cut.

RENEWING THREADS

Damaged threads are readily repaired by proceeding as for cutting new threads. Care should be taken to start the die in the previously formed thread.

WHEN USING DIES

DO select the right size die
DO keep die at right angle to work piece
DO use correct lubrication
DO chamfer or bevel end of work before threading
DO clean and store dies in proper spaces after use

The operation of any cutting tool can result in foreign objects being thrown into the eyes, which can result in severe eye damage. Always wear safety glasses or eye shields before commencing cutting tool operation.

DON'T crowd die – die should be turned backwards slightly every ¼ to ½ turn to clear chips from die

DON'T jam the die against the head or shoulder when threading close.

1) Steel	Lard oil, cutting oil, or Crisco
2) Cast Iron	Dry or air blast
3) Aluminum	Kerosene or Kerosene lightly mixed with lard oi
4) Brass	Kerosene

5) Magnesium	Kerosene
6) Zinc	Kerosene
7) Bakelite	Dry
8) Hard Rubber	Dry
9) Bronze	Kerosene or Kerosene mixed with lard oil
10) Stainless steel	Kerosene mixed with lard oil

Additional lubricants for production or industrial uses may be obtained by consulting commercial distributors of oils and greases.

TAP SIZE	DEC EQUIV.	FRAC DRILL SIZE	TAP SIZE	DEC. EQUIV	FRAC. DRILL SIZE	TAP SIZE	DEC EQUIV	FRAC DRILL SIZE
4 – 40	0.0890	3/32	5/8 – 11	0.5312	37/64	7mm -1	0.234	15/64
6 – 32	0.1065	7/64	5/8 – 18	0.5781	19/32	8mm – 1	0.277	9/32
8 – 32	0.1360	9/64	11/16-11	0.5937	5/8	8mm-1.25	0.265	17/64
10-32	0.1590	5/32	11/16-16	0.6250	21/32	¼-19BSP	0.453	29/64
10-24	0.1495	5/32	¾-10	0.6562	11/16	9mm-1	0.3125	5/16
12-24	0.1770	11/64	¾-16	0.6875	49/64	9mm-1	0.3125	5/16
¼-20	0.2010	13/64	7/8-9	0.7656	13/16	10mm-1	0.359	23/64
¼-28	0.2130	7/32	7/8-14	0.8125	7/8	10mm-1.25	0.3437	11/32
5/16-18	0.2656	17/64	1 in. -12	0.9219	59/64	10mm-1.5	0.339	11/32
5/16-24	0.2656	17/64	1 in. -14	0.9375	15/16	11mm-1.5	0.375	3/8
3/8-24	0.3281	21/64	3mm-0.5	0.0995	3/32	12mm-1.5	0.406	13/32
3/8-16	0.3125	5/16	3mm-0.6	0.0937	3/32	12mm-1.75	0.406	13/32
1/8 PIPE	0.3125	5/16	3.5mm-0.6	0.116	1/8	14mm-1.25	0.515	33/64
¼ PIPE	0.437	25/64	4mm-0.7	0.1285	1/8	14mm-2	0.469	15/32
7/16-20	0.3906	3/8	4mm-0.75	0.125	1/8	16mm-1.5	0.578	37/64
7/16-14	0.3750	27/64	4.5mm-0.75	0.141	9/64	16mm-2	0.656	35/64
½-13	0.4219	29/64	5mm-0.8	0.166	11/64	18mm-1.5	0.6614	21/32
½-20	0.4531	31/64	5mm-.09	0.161	5/32	18mm-2.5	0.609	39/64
9/16-12	0.4844	33/64	6mm-1	0.196	13/64	1/8-28BSP	0.3281	21/64
9/16-18	0.5156	17/32	6.3mm-1	0.213	7/32	1 in.-8	0.8750	7/8

MAINTENANCE

The importance of using sharp dies cannot be overemphasized. As dies require precision sharpening equipment, it is recommended that dull or damaged tools be replaced.

EXTRA INFORMATION

EFFECT OF HOLE OR BOLT SIZE ON HEIGHT OF THREAD

When cutting threads, if the tap or die cuts awat metal the full form or depth of the thread, the result is 100% height of thread on the work. Therefore, the height of thread is determined by the size of the drilled hole for tapping, or the size of bolt or rod when using a die. If the size of the hole is the same size as the minor diameter of the tap, the thread produced would be 100% height.

When the hole is larger than the minor diameter of the tap, or the size of the bolt or rod is less than the major diameter of the die, the height of the thread cut will be less than 100%. Thus to vary the height of the thread, one must vary the size of the drilled hole or size of the bolt or rod.

A 100% thread is only 5% stronger than a 75% thread height, but requires 3 times the power to turn the tap. A 100% thread height does not give a tighter fit. It only serves to overload the tools and possibly cause premature tool failure.

The recommended thread height is 75% for average use and the Tap Drill Reference Chart gives the correct drill size for each size tap. One should also remember in preparing bolts or rods for cutting of the external thread, the diameter of the bolt or rod should be from 0.005 to 0.010 under the nominal size.

The thread gauge will help in determining the correct number of threads per inch on a bolt or nut, or pitch on metric sizes. The gauge is provided with blades each marked with a number corresponding to the threads per inch or pitch. For example: “16” on the blade means 16 threads per inch. The part is checked by placing the correct blade in such a manner that all teeth or notches align properly with the threads on the bold or nut. As a substitute for a thread gauge, a tap may be used in the same manner as described above.

The bolt diameter is established by measuring the outside diameter with micrometers. Normally bolts are manufactured with the diameter slightly under the nominal size. For example; a 5/16 inch bolt will probably measure 0.305, instead of 0.3125, when measure in this manner.

LUBRICATION

Selection and application of the proper lubricant has a very important bearing on the success of the thread cutting operation. Longer tap and die life plus smoother, cleaner, and more accurately formed threads will be the benefits. Once the proper lubricant has been selected it should be directed with an oil can, brush, or other convenient method to the cutting edges during threading operation. Recommended lubricants most readily available for the home work shop use are listed with the materials to be threaded.

BAND SAW

Safety Instructions

1. Read and understand the owner's manual before operating the machine
2. Always wear safety goggles when operating this machine
3. Be positive the saw blade is installed properly – teeth pointing downward toward the table – before operating this machine
4. Be sure blade tension, blade guides, and thrust bearings are properly adjusted before operation of the machine
5. Always adjust the upper guide to clear the work piece by a ¼ of an inch
6. Minimize potential injury from contact with the saw blade by keeping fingers at a safe distance away
7. Maintain control of the work piece at all times. Hold firmly against the table. Use a vice
8. Be attentive to thin cut off pieces hitting the end of the slot in the insert or jamming in the slot
9. Get help when cutting heavy material
10. Clean oil and grease from the floor around the work area
11. Stop the machine before making adjustments
12. Do not operate the machine unless all guards are in place

Band Saw

The advantage of using the Band Saw:

1. Faster Cutting – the long blade moves in only one direction, and being continuous, can be run at much higher speeds as the blade rapidly dissipates the heat generated in cutting. The horizontal band saw in the shop can be run at speeds between 80 and 200 feet per minute.

2. Precision – The blade can be guided more accurately than the blade on the reciprocating saw and can utilize a finer blade for a given piece of material. It is common practice to cut directly to the line when using a band saw. The vise on the horizontal saw will increase the accuracy of any cutting operation. The vise can be opened to five inches and can be tilted to cut at angles between 0 and 90 degrees.

3. Little Waste – The small cross section of the band saw blade make smaller and fewer chips for a given length or thickness of material. The blades are made from tungsten and molybdenum steel and with tungsten carbide teeth on alloy steel backs. The carbide tip blades are more expensive. You can buy three tungsten blades for the price of one carbide tipped blade.

How to Select a Blade –

Choosing the proper blade is important. Always use the three- tooth rule. There must be at least three teeth in contact with the work at all times, but no more than 18.

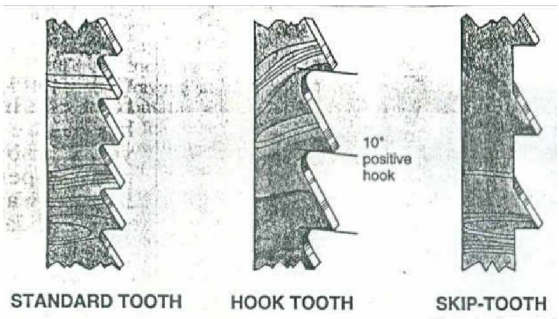
1. Large pieces and soft materials require coarse teeth.
2. Thin work and hard materials require a fine tooth blade.
3. For best cutting action, apply heavy feed pressure on soft materials and large work.
4. Light Pressure on hard materials work and small work.

The number of teeth per inch is also important, they can range from 3 to 18 teeth per inch.

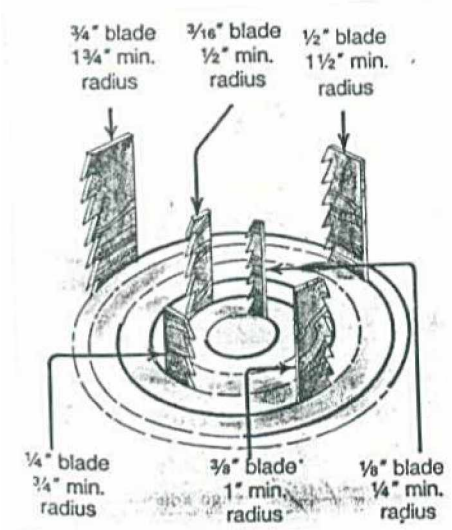
1. Use a 3 tooth blade when cutting 2” thick piece of wood
2. An 8 tooth blade for ¾” of stock
3. A 16 tooth blade for ¼” stock

These 3 examples leave 4-6 teeth on the work at all times. If there are too many teeth cutting the material, the saw blade can bind, or it will make wavy cuts in the material.

1. From figure 1, the Standard Tooth is best for cutting ferrous metals.
2. The Skip Tooth blade pattern is best suited for cutting aluminum, magnesium, copper and soft brass
3. The hook tooth is recommended for most non ferrous metallic materials



4. The width of the blade can range from 1/8" to ¾". As shown in the figure below, narrower blades can turn with a tighter radius. But for accuracy, smoothness, and blade life, use the widest blade possible.



The Horizontal Band Saw

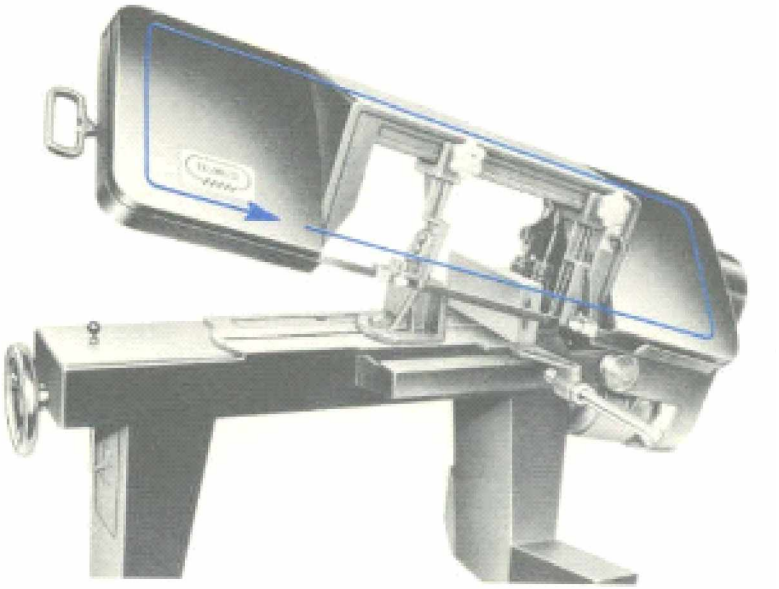
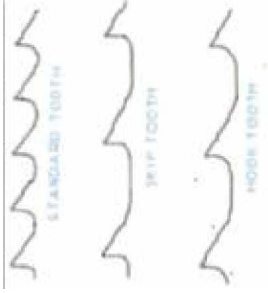


Fig. 35-2. Metal cutting band saw.
(Kalamazoo Tank & Silo Co.)

The Horizontal Band Saw uses a blade that has the size of ½" x 0.025" x 641/2".

Use the following procedure to change the blade.

1. Make sure the machine is unplugged
2. Raise the cutting head to the vertical position
3. Remove the guard
4. Loosen the blade guide , until the blade can be removed.. Remove the blade.
5. Install the new blade. The blade teeth should look like the following diagram.



6. Make sure the blade is not twisted, tighten the adjusting knob. The blade should be able to flex. Improper blade tension ruins blades and can cause early failure of the wheel bearings. Check with a shop assistant, if you are unsure.
7. Replace the guard
8. When starting the machine again, make sure that the band does not fall off.

Vertical Band Saw-

The finish and accuracy of the Vertical Band Saw can be held to within 0.010 to 0.0015 in. This accuracy eliminates or minimizes many secondary machining operations. Finishing operations can be performed with a file or the milling machine. Abrasive and brittle materials and the hardest steels can be cut rapidly and economically on the band saw by substituting a diamond edge blade for the conventional blade.
The blade for the vertical band saw is ¼" wide, 6 teeth per inch and 80 inches long.

Use the following procedure to change the blade.

1. Unplug the machine
2. Remove the front cover
3. Loosen the blade tension adjustment knob on the top of the machine. Keep turning the knob until the blade can be removed
4. Place the new blade with the teeth pointing downward. As in the diagram at the top of the page.
5. Make sure the blade is in the blade guide and that the blade is not twisted on the wheels
6. Tighten the blade adjustment knob. Again the proper blade tension is important, the blade should be able to flex. Improper blade tension can ruin the blade the blades and can cause early failure of the wheel bearings. Check with a shop assistant, if you are unsure
7. Replace the front cover
8. When starting the machine again, make sure that the band does not fall off

BENCH DRILL PRESS

Change in Spindle Speeds and Adjusting Belt Tension

14" Bench Drill Press ONLY

1) Disconnect the drill press from the power source.
2) Lift up the belt and pulley guard (A) Fig. 22.
3) Release belt tension by loosening tension lock knob (B) Fig. 22 and moving tension lever (C) forward.
4) Position the belt (D) on the desired steps of the motor and spindle pulleys, as shown in Fig. 22.
5) After the belt is positioned on the desired steps of the motor and spindle pulleys, move tension lever (C) Fig. 23. to the rear until the belt is properly tensioned and tighten tension lock knob (B). The belt should be just tight enough to prevent slipping. Excessive tension will reduce the life of the belt, pulleys and bearings. Correct tension is obtained when the belt (D) can be flexed about 1" out of line midway between the pulleys using light finger pressure.

16 ½" Drill Press Only

1) Disconnect the drill press from the power source.
2) Lift up the belt and pulley guard (A) Fig. 24.
3) Release belt tension by loosening tension lock knob (B) Fig. 24 and moving tension lever (C) forward
4) Position the two belts (D) on the desired steps of the motor, center and spindle pulleys, as shown in Fig. 24.
5) After the belt is positioned on the desired steps of the motor, center and spindle pulleys, move tension lever (C) Fig. 25 to the rear until the belts are properly tensioned and tighten tension lock knob (B). The belts should be just tight enough to prevent slipping. Excessive tension will reduce the life of the belt, pulleys and bearings. Correct tension is obtained when the belts (D) can be flexed about 1" out of line midway between the pulleys using light finger pressure.

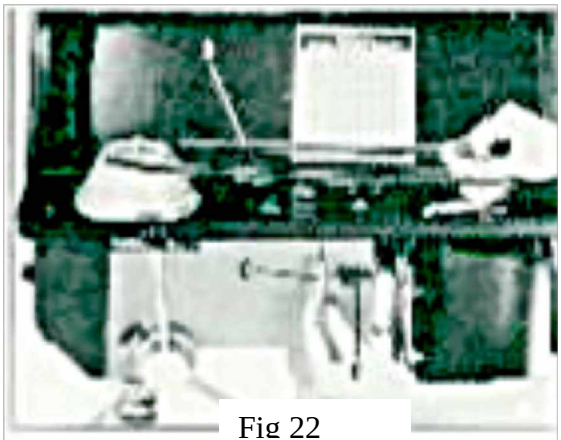


Fig 22

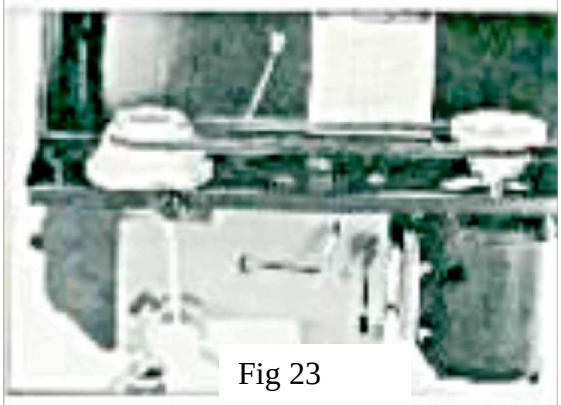


Fig 23

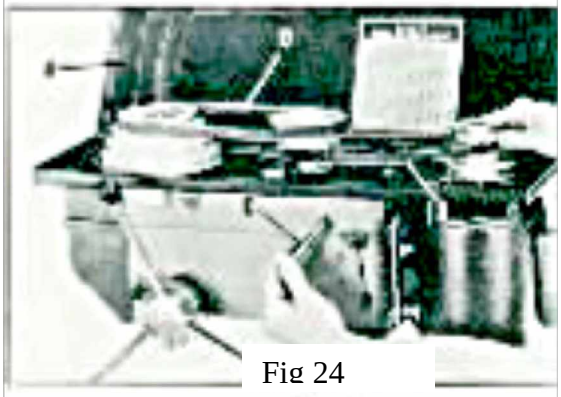


Fig 24

Fig 25

SPINDLE SPEEDS

Five spindle speeds of 460, 870, 1155, 1670 and 2500 RPM are available with the 14" Bench Drill Press and 12 spindle speeds of 250, 360, 410, 540, 590, 650, 1090, 1280, 1450, 1820m 2180 and 3000 RPM are available with the 16 ½" Drill Press. Fig 20 illustrates which steps of the pulleys the belt must be place to obtain the five speeds available for the 14' Bench Drill Press and Fig. 21 illustrates which steps of the pulleys the belt must be placed to obtain the 12 speeds available for the 16 ½" Drill Press.

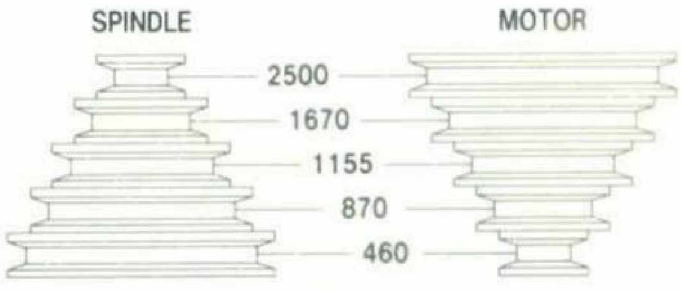


Fig 20

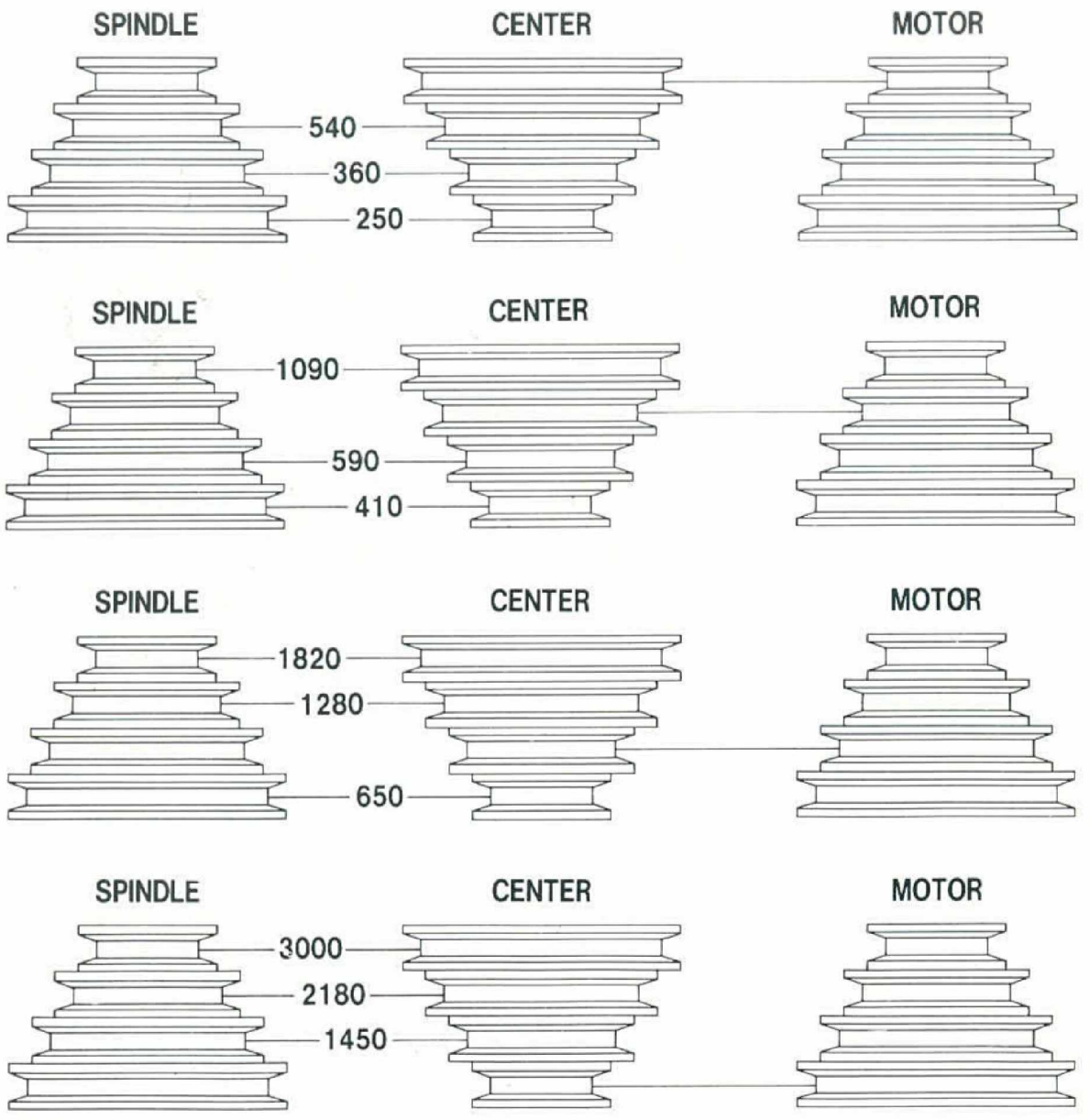


Fig 21

SWITCH

The switch (A) Fig. 26 is located on the front of the drill press head. To turn the drill press "ON" move the switch to the up position. To turn the drill press "OFF" move the switch to the down position.

Fig 26

We suggest that when the drill press is not in use the switch be locked in the "OFF" position. This can be done by grasping the switch toggle (B) and pulling it out of the switch, as shown in Fig. 27. With the switch toggle (B) Fig. 27, removed, the switch will not operate. However, should the switch toggle be removed while the drill press is operating, the switch can be turned "OFF" once, but cannot be restarted without inserting the switch toggle (B) Fig.. 27.

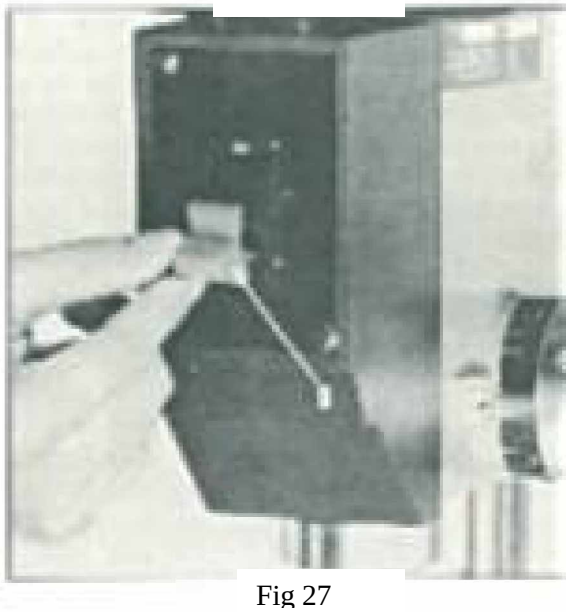


Fig 27

TABLE ADJUSTMENTS

1) The table (G) Fig. 28 can be raised or lowered on the drill press column by loosening the table clamp handle (K) and turning the table raising and lowering handle (J). After the table is at the desired height, tighten handle (K).
2) The table (G) Fig. 28, can be rotated 360 degrees on the table bracket by loosening lock handle (H)

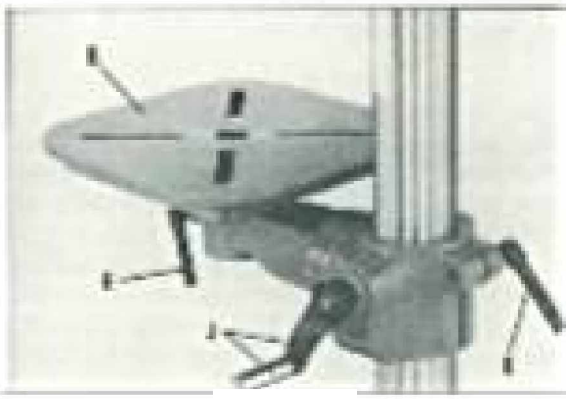


Fig 28

3) The table can be tilted right or left by pulling out and removing table alignment pin (B) Fig. 29. Note: If pin (B) is difficult to remove turn nut (C) clockwise to pull pin out of casting.

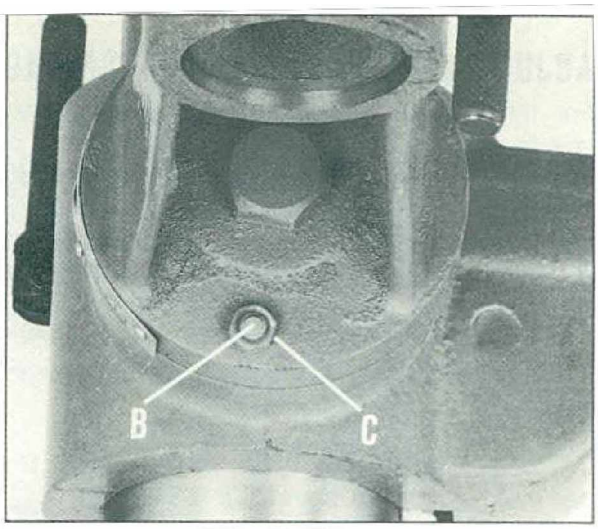


Fig 29

4) Fig. 30 illustrates the table alignment pin (B) removed. Loosen table locking bolt (D) Fig. 30, tilt table to the desired angle and tighten bolt (D) When returning table to the level position replace table alignment pin (B). This will automatically position the table surface at 90 degrees to the spindle.

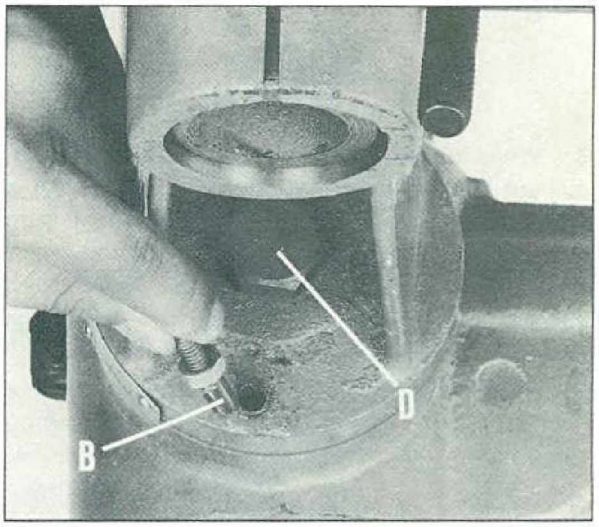


Fig 30

5) A tilt scale (E_ and pointer (F) Fig. 31 are provided on the table bracket casting to indicate the degree of tilt.

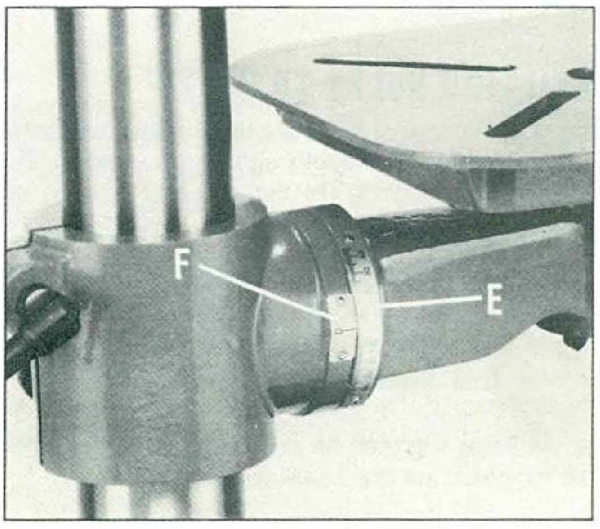


Fig 31

ADJUSTING SPINDLE RETURN SPRING

For the purpose of automatically returning the spindle upward after a hole has been drilled, a spindle return spring is provided in the spring housing (A) Fig. 32. This spring has been properly adjusted at the factory and should not be distributed unless absolutely necessary. To adjust the return spring, proceed as follows:

1) Disconnect the drill press from the power source.
2) Loosen the two nuts (B) approximately ¼" Do not remove nuts (B) from shaft (C) Fig. 32.

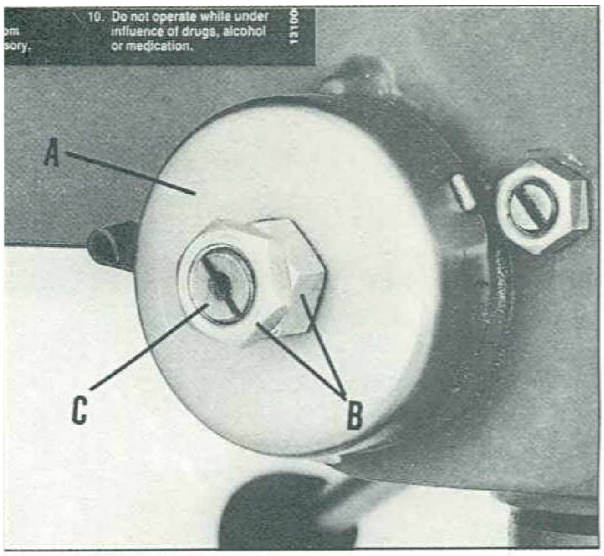


Fig 32

3) While firmly holding spring housing (A) Fig. 33, pull out housing and rotate it until the boss (D) is engaged with the next notch on the housing. Turn the housing counter-clockwise to increase and clockwise to decrease spring tension. Then tighten the two nuts (B) Fig. 33, to hold the housing in place. Important: Nuts (B) Fig. 33, should not contact spring housing (A) when tight.

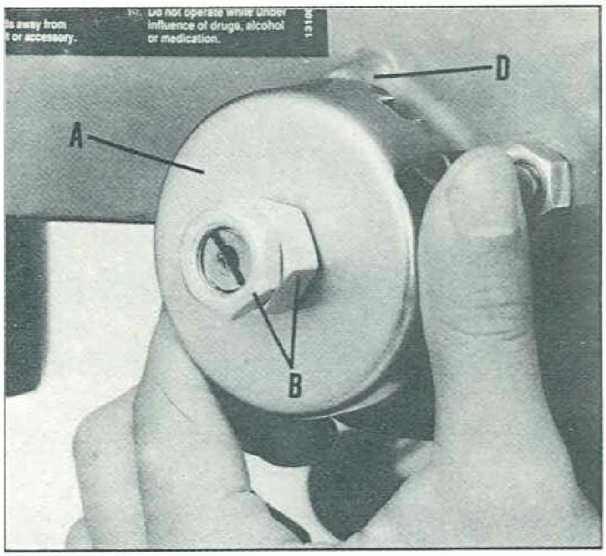


Fig 33

DRILLING HOLES TO DEPTH

Where a number of holes are to be drilled to exactly the same depth, a depth stop is provided in the pinion shaft housing (A) Fig. 34 and is used as follows:

1) Loosen lock handle (B) Fig. 34 and rotate housing (A) until the pointer (C) lines up with the depth you wish to drill on the scale (D). Then tighten lock handle (B).
2) All holes will then be drilled to the exact depth as indicated on the scale (D) Fig. 34.

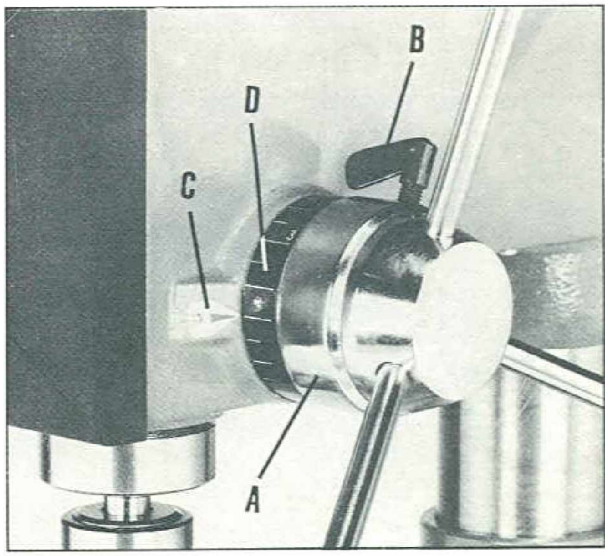


Fig 34

The following directions will give the inexperience operator a start on the common drill press operations. Use scrap material for practice to get the feel of the machine before attempting regular work.

CORRECT DRILLING SPEEDS

Factors which determine the best speed to use in any drill press operations are: kind of material being worked, size of hole, type of drill or other cutter and quality of cut desired. The smaller the drill, the greater the required RPM. In soft materials, the speed should be higher than for hard metals.

BORING IN WOOD

Twist drills, although intended for metal drilling, may also be used for boring holes in wood. However, machine spur bits are generally preferred for working in wood; they cut a square bottom hole and are designed for removal of wood chips. Do not use hand bits which have a screw tip; at drill press speeds they turn into the wood so rapidly as to lift the work off the table and whirl it.

For through boring, line up the table so that the bit will enter the center hole to avoid damage. Scribe a vertical line on the front of the column and a matchmark on the table bracket, so that the table can be clamped in the center position at any height.

Feed slowly when the bit is about to cut through the wood to prevent splintering the bottom face. Use a scrap piece of wood for a base block under the work; this helps to reduce splintering and protects the point of the bit.

DRILLING METAL

Use clamps to hold the work when drilling in metal. The work should never be held in the bare hand, the lips of the drill may seize the work at any time, especially when breaking through the stock. If the piece is whirled out of the operator's hand, he may be injured. In any case, the drill will be broken when the work strikes the column.

The work must be clamped firmly while drilling: any tilting, twisting or shifting results not only in a rough hole, but also increases drill breakage. For flat work, lay the piece on a wooden base and clamp it firmly down against the table to prevent it from turning. If the piece is of irregular shape and cannot be laid flat on the table, it should be securely block and clamped.

LATHE

SAFETY

1) Do not attempt to operate the lathe until you have been checked out on it and are thoroughly familiar with its operation.
2) Dress appropriately. Remove your necktie, sweater, wrist watch and rings. Wear an apron or a properly fitted shop coat. Safety goggles are a must.
3) Clamp all work solidly. Use the correct size tool or work holding device for the job. Get help if you must use heavy chucks or attachments.
4) Check your work frequently when it is being machined between centers. The work expands as it heats up and could damage the tail center if it overheats.
5) Replace all guards before starting to work. The guards should only be removed to make adjustments, and then with the power turned off at the main electrical panel to prevent the machine from being turned on accidentally. Replace the guards immediately after the adjustments have been made.
6) Return all unnecessary tools to the proper storage area. Remove all other tools from the immediate work area.
7) Turn the chuck or faceplate by hand to be sure there is no binding or danger of the work striking any part of the lathe.
8) Stop the machine before making adjustments or measurements.
9) Remember that the chips are razor sharp. Do not attempt to remove chips with your fingers. Stop the machine and use pliers to remove them.
10) Support all work solidly. Do not permit small diameter work to project too far from the chuck without support from the tailstock center.
11) Be careful not to run the cutting tool into the chuck or dog. Check out any readjustment of work or tool to be sure there is ample clearance between the tool and the chuck or dog, when the tool has been moved left to the farthest point that will be machined.
12) Do not use cotton waste or rags to wipe grease or oil from the work surface unless the machine is stopped. Keep brushes used for cleaning and to apply coolant, clear of work when knurling.
13) If work must be removed from the lathe, or repositioned in the chuck, always move the cutting tool clear of the work or reverse it in the tool post to prevent it from cutting you accidentally.
14) Do not talk to anyone, nor permit anyone to fool around the machine while you are operating it. You are the only one who should turn the machine on or off, or make adjustments to the lathe while you are operating it.
15) Never attempt to run the chuck on or off the spindle by using power. It is also a dangerous practice to stop the lathe by reversing its direction of rotation.
16) You should always be aware of the direction and speed of the carriage or cross-feed before engaging automatic feed.
17) Never leave the key in the chuck. Make it a habit never to let go of the key until it is out of the chuck and clear of the work area.
18) Tools must not be placed on the lathe ways. Use a tool board or place them on the lathe tray.
19) Do not wrap the cord around your hands when cleaning the lead screw. Grip it lightly between the fingers so if it catches on the screw it will slip safely out of your hand.
20) Never use a file without a handle.

21) Stop the machine immediately if some odd noise or vibration develops while you are operating it. If you cannot find what is causing the trouble, get your instructor. Under no condition should the machine be operated until the trouble has been found and corrected.

22) Remove all burrs and sharp edges from the piece before removing it from the lathe.

23) Plan your work thoroughly before starting. Have all of the tools that will be needed at hand before commencing work

24) Be careful when you clean the machine. As stated before, chips and shaving are sharp and will cause serious cuts if you attempt to remove them with your hands. Use a cleaning brush, NOT A DUST BRUSH, for the job. NEVER USE THE AIR HOSE. The flying chips may injure someone.

PREPARING THE LATHE FOR OPERATION

1) Clean and lubricate the lathe. Use the lubricants specified by the manufacturer.
2) Turn the spindle by hand to make sure it is not locked in back gear. Set the drive mechanism to the desired speed and feed.
3) Place all guards in position.
4) Move the carriage along the ways; there should be no binding.
5) Inspect the cross-feed and compound rest slides. Adjust the gibs if there is too much play. Do not permit excessive overhang of the compound rest.
6) Inspect the tailstock if it is to be used for any portion of the operation. Check it for alignment and use a smooth dead center.
7) Place the proper work holding attachment on the headstock spindle. Clean the threads and apply a drop of oil.
8) Sharpen the cutter bit. Clamp it in the appropriate tool holder and mount it in the tool post.

HOW TO CLEAN THE LATHE

A lathe should be cleaned after each work period. Remove chips with a paint brush – NOT YOUR HAND. Wipe all painted surfaces with a sodt cloth. To complete the job, move the tailstock to the extreme right and use a soft cloth to wipe the remaining oil, chips and dirt from the machined surfaces. DO NOT USE COMPRESSED AIR TO REMOVE THE CHIPS. The flying chips are dangerous.

The lead screw needs an occasional cleaning too. This may be done by adjusting the lathe to rotate at a slow speed and using a piece of cord. Permit the cord to feed along the threads. DO NOT WRAP THE CORD AROUND YOUR HAND because THE CORD MIGHT CATCH ON THE LEAD SCREW AD CAUSE SERIOUS INJURY!

METAL LATHE

A lathe is a machine tool in which the work is held and rotated, while being shaped by a cutting tool that is fed against the work.

LATHE SIZE

Lathe size is determined by the SWING and BED LENGTH. The swing indicates the largest diameter of work which can be turned. The bed length is the entire length of the ways, and should not be mistaken for the maximum length of metal piece that can be turned.

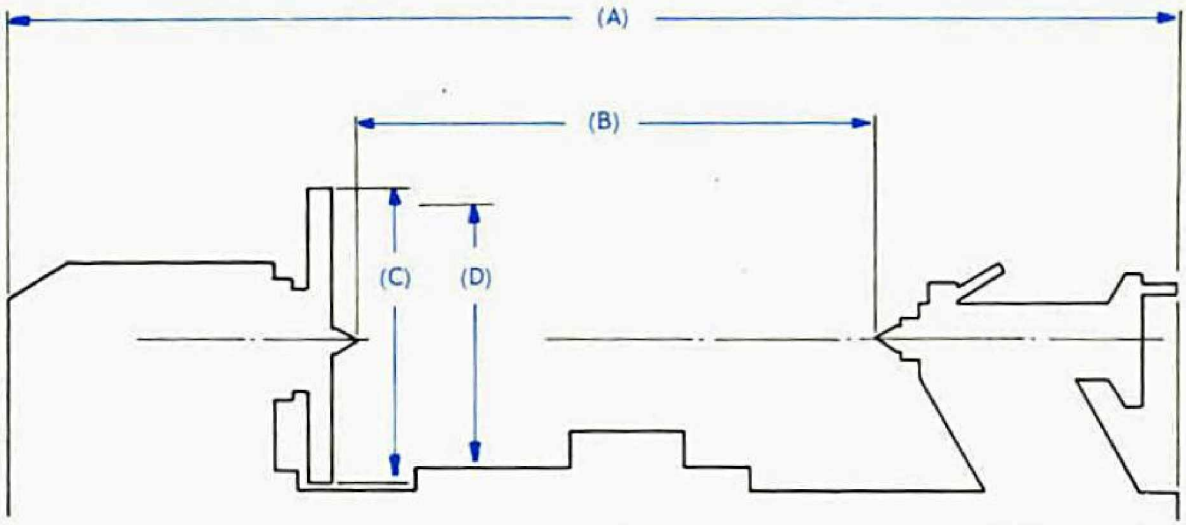


Fig. 36-3. How a lathe is measured. (A) Length of the bed. (B) Distance between centers. (C) Diameter of work that can be turned over the ways. (D) Diameter of work that can be turned over the cross slide.

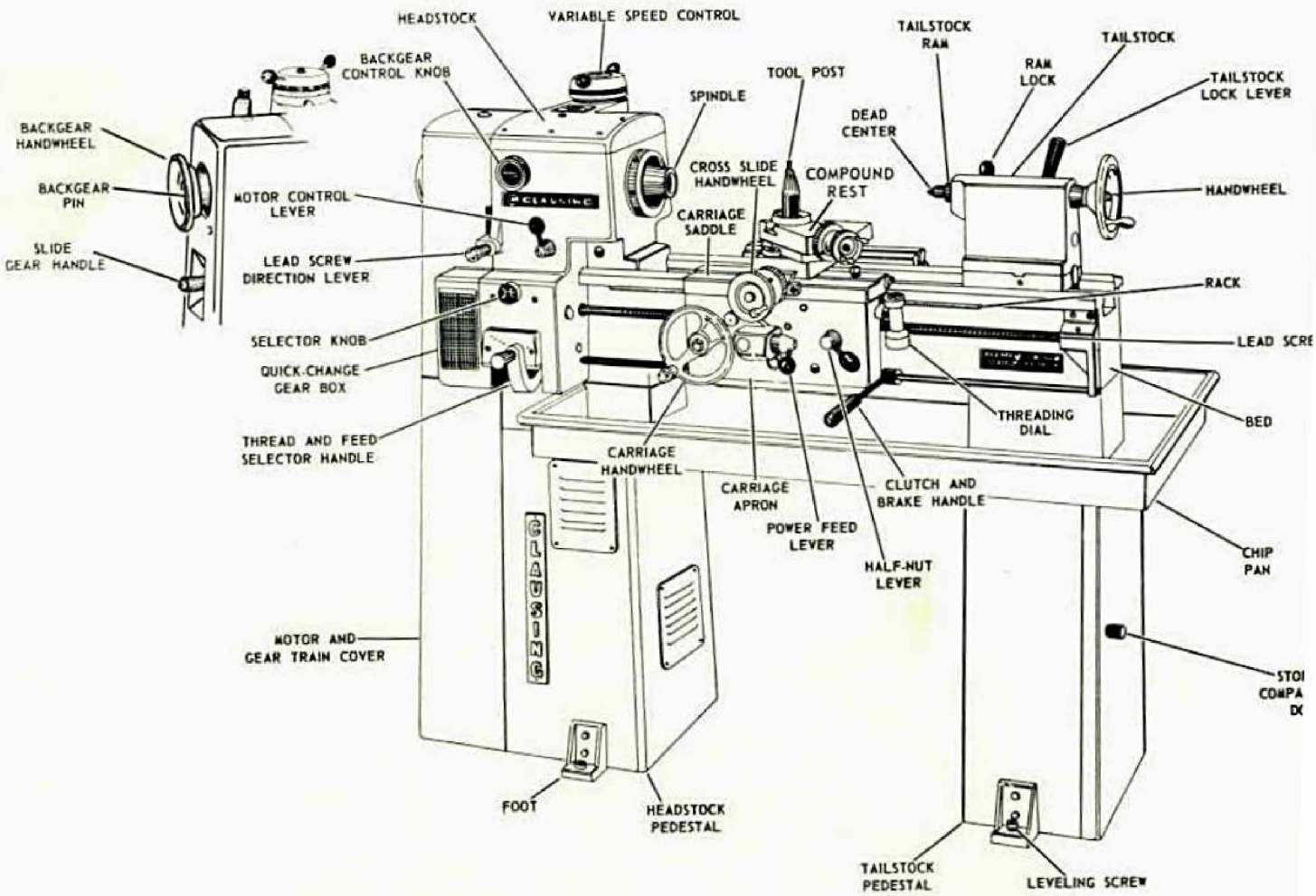


Fig. 36-4. The engine lathe and its major parts. (The Sheldon Machine Co., Inc.)

MAJOR PARTS OF THE LATHE

Each of the lathe parts fall into one of three functional categories:

1. DRIVING THE LATHE
2. HOLDING AND ROTATING THE WORK
3. HOLDING AND MOVING THE CUTTING TOOL

LATHE BED

The lathe bed is the foundation or base to which the other parts of the lathe are fitted. Carefully machined ways on top of the lathe bed, support and provide for precise alignment of the headstock and tailstock.

HEADSTOCK

The headstock contains the SPINDLE to which the various work holding attachments are fitted. The spindle is hollow with the front end tapered internally to receive tools and attachments with taper shanks. The hole permits long stock to be turned and allows a KNOWCKOUT BAR to be used to remove taper shank tools.

The spindle is usually fitted with either a tapered nose or a threaded nose. Also found in the headstock is the SPEED CONTROL MECHANISM. Power supplied by an electric motor is transmitted to the spindle by moving the belts to positions on the pulleys or by changing the gear ratio.

Slower speeds on belt driven lathes are obtained by engaging the BACK GEARS. The large gear (BULL GEAR) is keyed to the spindle and is locked to the pulley with the BULL GEAR LOCK PIN. The back gears can be engaged by disconnecting the bull gear from the step pulley by releasing the bull gear lock pin. DO NOT ENGAGE THE BACK GEARS WHILE THE SPINDLE IS ROTATING.

TAILSTOCK

The tailstock can be adjusted along the lathe ways to accommodate different lengths of work. It mounts the “dead” center that supports the outer end of the work, and can be fitted with cutting tools for drilling, reaming and threading. The unit is clamped to the ways by tightening the CLAMP BOLT NUT. The spindle is positioned by rotating the HANDWHEEL and is locked in position with the BINDING LEVER.

CARRIAGE

The carriage includes the SADDLE, APRON, CROSS AND LONGITUDINAL FEED, SCREW CUTTING MECHANISM, COMPOUND REST and TOOL POST. The cutting tool is supported and its actions controlled by the carriage which is moved along the ways by hand or power feed. The power feed mechanism is located in the apron. A friction clutch controls longitudinal and cross power feeds. Half-nuts are engaged for thread cutting.

FEED MECHANISM

The feed mechanism transmits power through a train of gears to the QUICK CHANGE GEAR BOX, which regulates the amount of tool movement per revolution of the spindle . The feed mechanism also contains gears for reversing tool travel. Lettering on the INDEX PLATE tells how to position the levers for various thread cutting and feed combinations.

The LEAD SCREW transmits the power to the carriage through a gearing and clutch arrangement in the apron. The FEED CHANGE LEVERS on the apron control the operation of power feeds and, when placed in neutral, permit half-nuts to be engaged for threading operations.

MANUAL MILL

SAFETY RULES

1. Do not attempt to operate the machine until you are thoroughly familiar with it. When in doubt, secure additional instructions.

2. Wear appropriate clothing and goggles.

3. Get help to move any heavy attachment like the vise, dividing head, rotary table, etc.

4. Never handle a cutter with bare hands. Use a piece of heavy cloth for protection.

5. Use a small brush (or compressed air) to remove chips – NEVER BRUSH WITH YOUR HAND!

6. Stop the machine before attempting to remove chips.

7. Never reach over or near the rotating cutter.

8. Make sure the holding device is mounted solidly to the table and the work held firmly. Spring or vibration can cause thin cutters like the slitting saw to jam and shatter.

9. Do not talk to anyone while operating the machine, nor allow anyone to turn on your machine for you.

10. No adjustments should be made while the cutter is rotating. Stop it before making measurements, removing chips, etc.

11. Keep the floor around the machine clear of chips and wipe up spilled cutting fluid immediately.

12. Be thoroughly familiar with the STOP lever.

13. Treat any small cuts and skin punctures as potential infections. Clean them thoroughly, apply antiseptic and cover with a bandage. Report any injury, even though minor, to your instructor.

14. Do not permit your work clothes to become saturated with oil and cutting fluids. Greasy clothing is a fire hazard.

15. Put all oily rags used to wipe down the machine in a metal container that can be closed tightly.

16. Do not fool around while operating the mill. Keep your mind on your job and be ready for any emergency.

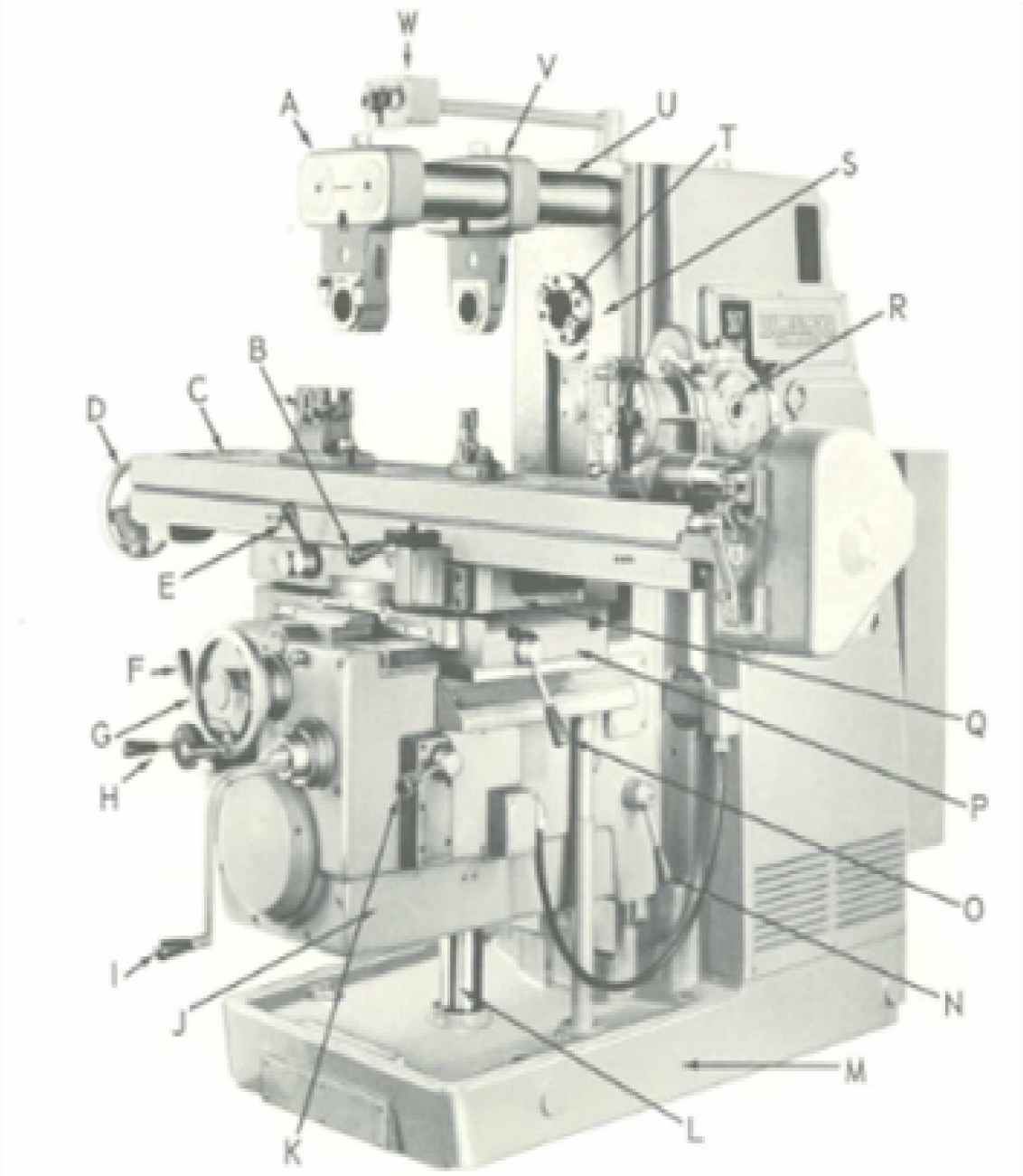


Fig. 30-3. Parts of the milling machine: A-Arbor support, B-Table feed lever, C-Table, D-Table handwheel, E-Table clamp lever, F-Saddle power feed lever, G-Saddle handwheel, H-Knee power feed lever, I-Knee handcrank, J-Knee, K-Rapid traverse lever, L-Telescopic coolant return and elevating screw, M-Base, N-Knee clamp lever, O-Saddle clamp lever, P-Saddle, Q-Saddle plate, R-Universal dividing head, S-Column, T-Spindle, U-Overarm, V-Inner arbor support, W-Spindle start-stop and master switch (the arm engages the clutch).
(Kearney & Trecker Corp.)

COLUMN AND KNEE TYPE MILLING MACHINE

The column knee type milling machine is so named because the components that provide movement to the work consists of a COLUMN that supports and guides the KNEE in vertical movement. The knee supports the mechanism for obtaining cross traverse and longitudinal table movements: VERTICAL, CROSS, & LONGITUDINAL, all of which are controlled entirely by hand levers.

All milling operations fall into two main categories:

1. FACE MILLING – The surface machined is parallel with the face of the cutter. Large flat surfaces are machined by this method.
2. PERIPHERAL MILLING – The surface being machined is parallel with the periphery of the cutter.

Milling cutters come in a large number of stock shapes, sizes, and kinds to meet many requirements. There are two general types:

1. SOLID CUTTER – The shank and body are made in one piece.
2. INSERTED TOOTH CUTTER – The teeth are made of special cutting material and are brazed or clamped into place. Teeth can be replaced.

Consult your instructor for the type of cutter needed.

There are two distinct cutting methods in milling operations:

1. CONVENTIONAL or UP-MILLING – The work is fed into the rotation of the cutter. The chip is at minimum thickness at the start of the cut and is so slight that the cutter has a tendency to slide until sufficient pressure is built up to make it bite into the work.
2. CLIMB or DOWN-MILLING – The work moves in the same direction as the rotation of the cutter. Full engagement of the tooth is instantaneous. The sliding action of conventional milling is eliminated resulting in a better finish and a longer life.

Climb milling is not recommended on light milling machines because lack of rigidity and light support offsets any advantages of the technique.

<u>Care of Milling Cutters and Cutter Holding & Driving Devices</u>

1. Support the cutter properly and hold the work rigid
2. Use the correct cutting speed and feed
3. An ample supply of cutting fluid is essential
4. Use the correct cutter for the job
5. Store cutters in individual compartments or on wooden pegs
6. Clean cutters before storing
7. Never hammer a cutter on the arbor. Examine the arbor for burrs or nicks if the cutter does not slip on easily
8. Use sharp cutters

To maintain accuracy during the machining operation it is necessary to prevent damage to the cutter holding and driving devices:

1. Keep the taper of the arbor free of nicks
2. Clean and lubricate the bearing sleeve and arbor support bearing before use
3. Clean the spacing collars before placing them on the arbor, otherwise cutter run-out will occur
4. Store arbors separately and in a vertical position
5. Never loosen or tighten the arbor nut unless the arbor support is locked in place
6. Use a wrench of the correct type and size
7. Do not tighten the arbor nut by striking the wrench with a hammer or mallet. This may crack the nut or distort the threats
8. To remove an arbor or adapter from the machine:
    a. Loosen the nut on the draw-in bar a few turns. DO NOT remove it from the arbor completely
    b. Tap the draw-in bar head with a lead hammer to loosen the arbor from the spindle
    c. Hold the loosened arbor with one hand and unscrew the draw-bar with the other
    d. Remove the arbor from the spindle, clean and store it

Cutting Speeds and Feeds, Fluids

The time required to complete a milling operation and the quality of the finish of the machined surface is almost completely governed by the CUTTING SPEED and FEED of the cutter.

Cutting Speed refers to the distance, measure in feet, a point (tooth) on the circumference moves in one minute. It is expressed in terms of FEET PER MINUTE (FPM) and is directly dependent on the REVOLUTIONS PER MINUTE (RPM) of the cutter.

Feed is the rate the work moves into the cutter and is given as FEED PER TOOTH PER REVOLUTION (FTR). The selection of the proper feed is probably the most difficult thing for the machinist to determine. In view of the many variables; width of cut, depth of cut, condition of the machine and cutter, etc., feed should be as coarse as possible and consistent with the desired finish.

Consult the mill manual or wall chart for the speeds and feeds required for various materials.

Cutting Fluids serve several purposes. They carry away the heat generated during the machining operation, act as a lubricant and prevent the chips from sticking or fusing to the cutter teeth, and flush away chips. The lubricating qualities also influence the quality of the finish of the machined surface.

UNTIL YOU BECOME PROFICIENT IN THE USE OF THE MILL, CONSULT YOUR INSTRUCTOR OR SHOP PERSONNEL BEFORE STARTING ANY MACHINING!

More information can be found in the reference book “Modern Metalworking”

SURFACE GRINDER

Bench Grinder Safety Instructions

1. Always use goggles.
2. Never grind aluminum on the grinder.
3. Use the face of the wheel, not the sides.
4. Move the work back and forth across the face of the wheel. Even wear will result and prevent the wheel from becoming grooved.
5. Keep the wheel dressed and the tool rests properly adjusted.
6. Never put a wheel on the grinder before checking it for soundness. Destroy wheels that are not sound.
7. Never stand in front of the grinder when it is turned on. Stand on the side of the grinder until it reaches full speed. This will keep you clear of flying pieces if the wheel shatters.
8. Do not attempt to use the grinder unless the guards are in place.
9. Keep your hands clear of the rotating grinding wheel. It is a cutting tool and can cause serious injuries.
10. Never force the work into the grinding wheel.
11. Always stop the machine before making adjustments or measurements.

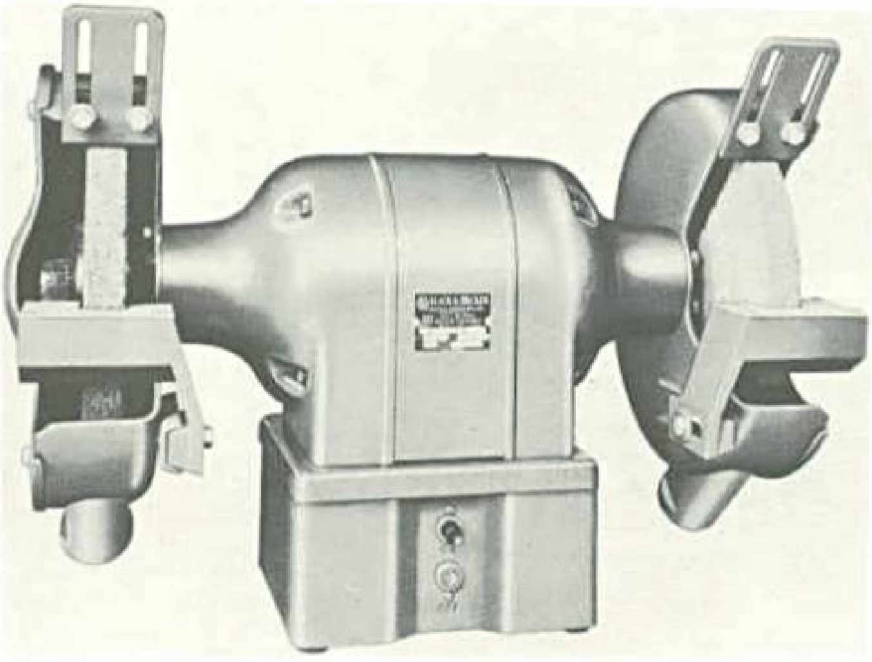


Fig. 33-2. The bench grinder. Eye shields have not been mounted. (Black & Decker Mfg. Co.)

Grinding

Grinding is the operation that removes material by rotating an abrasive wheel against the work. It is often used for sharpening tools, removing material that is too hard to be machined by any other method, or when fine surface finishes and close tolerances are required.

Bench Grinder

The familiar bench grinders are the simplest and most widely used grinding machines. The type of grinding which they perform is called OFFHAND GRINDING; that is, work that does not require great accuracy of size or shape is held in the hands and manipulated until ground to the desired shape.

The bench grinder can be seen in the photo on the previous page, it is fitted to a bench or table. The grinding wheels mount directly onto the motor shaft; one is for coarse, or rough grinding and the other is fine for finishing grinding.

The bench grinder can be dangerous if not used properly.

1. It must never be used unless fitted with guards and safety glass eye shields. **Even then, it is advisable to wear goggles.**
2. A TOOL REST is provided to support the work while grinding. It is recommended that the rests be adjusted to within 1/16 in. of the wheels. This will prevent the work from being wedged between the rest and the wheel. Turn the wheel by hand after adjusting the rest to be sure there is sufficient clearance.
3. The grinding wheel can be another source of danger and should be examined frequently for eccentricity and soundness. A new wheel can be tested by suspending it on a string or wire and tapping the side of the wheel with a light metal rod. A solid wheel will give off clear ringing sound. **A wheel which does not give off such a sound must be assumed to be cracked and should be destroyed. Under no condition should it be used**.
4. Because it is not possible to check the wheels by this manner each time the grinder is used, it is considered safe practice never to stand in front of a grinder when it is first turned on.
5. To keep the grinding wheel true and balanced, we use a WHEEL DRESSER. The wheel dresser should be used to bring abrasive wheels back to round and remove the glaze. The dresser is supported on the tool rest and is held firmly against the wheel with both hands. It is moved back and forth across the surface.

Surface Grinding

The planar type surface grinding machine makes use of a reciprocating motion by the table. The table motion can be controlled manually. See the photo below.

Much of the work done on a surface grinder is held in position by a MAGNETIC CHUCK. This holds the work by exerting a magnetic force. Nonmagnetic material can be ground by bracing it with steel blocks or parallels to prevent them from sliding.

As the wheel cuts, the chips dull the abrasive grains and wear and cut away the bonding material. The ideal grinding wheel, of course, would be one in which the bonding medium wears away slowly enough to achieve maximum use from the individual abrasive grains, yet rapidly enough to permit the dulled particles to drop off and expose sharp new particles.

HOW TO MOUNT THE GRINDING WHEEL

Select a grinding wheel recommended for the material to be ground. Check it for soundness and mount it on the spindle. It is essential that it be mounted properly or excessive strains will develop causing it to shatter during the grinding operation.

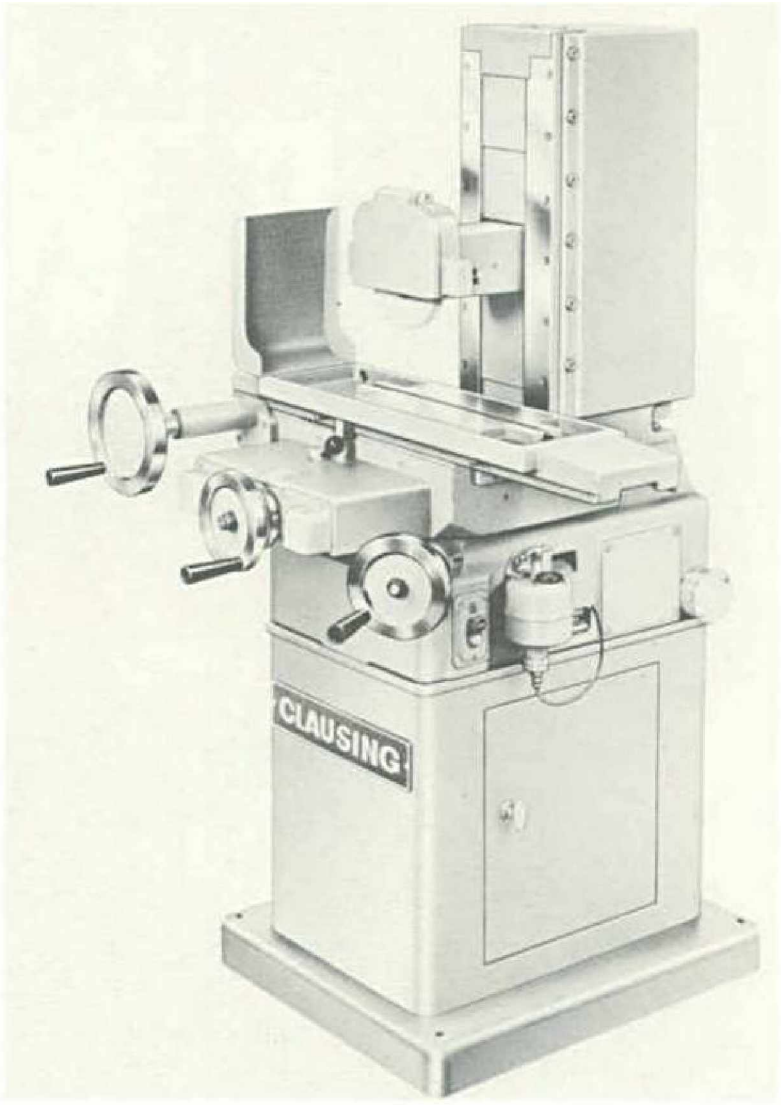


Fig. 33-25. A manually operated surface grinder. This is the type commonly found in the school shop. (Clausing)

TABLE SAW

“Safety Considerations”

1. Use all guards except when blade is covered by the work
2. Keep blades sharp and set for clean cuts
3. Cupped boards should rest on the table with the concave side down
4. Do not force saw to stall. A sharp blade running at full speed will do better work
5. Stand to one side when starting and using the saw
6. The blade should not project more than 1/8” above the work.
7. Let waste pieces fall off table or stop the saw to remove them. Never reach over or near the blade while it is running
8. Always use a guide to cut by; never saw freehand
9. Use a stand as an aid in handling long boards
10. Use stop blocks for clearance and never the rip fence when cutting to length
11. Always make adjustments with the machine stopped
12. Plan your work before starting the machine
13. Never talk to an operator when machine is running
14. Always use a push stick for ripping narrow pieces
15. The operator should have firm footing. There are nonskid preparations available.
16. No person should be in direct line with the saw blade
17. Never work alone! Always have at least one more person in the room

Operation of Circular Saw – Table Type

The circular saw is used to cut stock to length and width and cut rabbets, grooves, dadoes, and tenons.

Uses:

1. Dado heads are used to cut tenons, dadoes, grooves and rabbets.
2. Tenoning attachment is used to cut tenons without the use of dado heads.
3. Molding heads are used to cut moldings.
4. Length gauges are attached to the miter gauge and are used when cutting several pieces to the same length.
5. Stop block is attached to the rip fence and is used when several pieces are to be cut the same length.
6. A sanding disk is used to sand convex curves and edges of stock.

Principal Parts and Function of Each:

1. BASE, supports the table
2. TABLE, made of cast iron or pressed steel, supports the miter gauge, rip fence, attachments and stock to be cut
3. MITER GAUGE, made of cast iron or aluminum, used as a guide for crosscutting stock
4. RIP FENCE, made of cast iron or pressed steel, used as a guide for crosscutting stock
5. TILTING WHEEL, made of cast iron, used to tilt the saw blade or tilt the table, depending on the type of saw
6. HAND WHEEL, is turned to regulate height of saw
7. SAW BLADE, cuts the stock. Saw blade should be made of high grade steel
8. ARBOR, a round shaft to which the saw blade is fastened, is made of high grade steel
9. GUARDS, made of plastic, cast iron or aluminum, protect the operator from injury from the saw blade
10. SPLITTER, made of sheet steel, keeps stock from binding against the saw while cut is being made
11. MOTOR, provides the power.

Using the Circular Saw:

- Stock, with nails, grit, etc., should not be cut.

Crosscutting or squaring an end:

1. Use either a crosscut or combination blade and adjust the height of the saw blade so that it is about 1/8” above the stock to be cut.

2. Set the miter gauge at right angles with the saw blade. Usually a graduated scale will indicate this agree position or it may be checked with a framing square.
3. Use the saw guard and splitter. The rip fence must be moved clear of the work to prevent binding and "kick-backs."
4. One edge of the work to be cut must be straight. Keep the straight edge against the face of the miter gauge and move the stock to cutting position. Hold the stock firmly against the face of the miter gauge. Start the machine and allow it to reach full speed. Make a test cut by nicking the stock. Make any necessary minor adjustment of the stock; then holding the stock firmly against the miter gauge with both hands, feed steadily through the saw.
5. Remove the work before returning the guide to the starting position.

Cutting to length with stop block fastened to rip fence:

1. When many pieces of the same length are to be cut, a stop may be used for measuring. Location of the stop is determined by the length and width of work to be cut.
2. For short pieces, fasten a stop block to the rip fence near the front edge of the table with a clamp. The length of the piece to be cut is measured from this block to a tooth on the saw set toward the fence.
3. Secure the rip fence to the table at the correct cutting position
4. With the work to be cut held against the miter gauge, slide the work along the table until the square end strikes the block. Hold the stock firmly in place and feed into saw, thus cutting to length. Repeat this process for all pieces.

Cutting to length with stop block fastened to miter gauge:

1. Fasten a straight, flat piece of stock to the face of the miter gauge so that it just clears the saw on one end and extends slightly longer than the pieces to be cut on the other end
2. The length of the stock to be cut is measured from a tooth set to the left of the saw. The length is marked on the face of the wood fence piece. A stop block with a square edge is fastened at this point with nails, screws, or a lightweight clamp whichever is suitable.
3. The rip fence must be removed from the table.
4. One end of the work is squared; then this end is held against the stop block while the piece is cut to length.
5. Some miter gauge guides are equipped with a rod for measuring lengths, but when a wood fence piece is used for extending the working face of the guide, the rod is not convenient to use.

Cutting a miter or angle between 30 and 90 degrees:

1. The miter gauge may be set to cut angles between 30 and 90 degrees. The work to be cut is held against the miter gauge which is set at the required angle and the cut is made as in crosscutting.

2. A stop block fastened to the miter gauge may be used in cutting pieces to length as described above.
3. It is very important that the work be held securely against the miter gauge to insure a straight cut.
4. A smooth cut will be obtained if the angle points to the front so that the cut is made with the grain. The long edge of the work will also be against the gauge.
5. When cutting miter on wide stock, tilt the saw or table to the desired angle and proceed as in square crosscutting.
6. When cutting compound angles, set the miter gauge to the desired angle of the face of the stock and set the blade or table to the desired angle of the thickness of the stock. Feed the stock into the saw as described above.

Ripping or cutting to width:

1. A rip or combination saw is adjusted to 1/8" above the thickness of the stock to be cut
2. Use the saw guard and splitter.
3. One edge of the stock to be cut must be straight. This edge is held against the rip fence. A board with an uneven edge should not be cut.
4. Set the rip fence to the required distance to the right of the saw. This may be gauged by the scale on the saw table and check with a rule by measuring between a tooth set to the right and the rip fence.
5. Stand to one side of the saw. Start the saw running and with the straight edge of the board held against the fence, push the board with and even, firm motion to make the required cut.
6. If the cut is made close to the rip fence, us a "push stick" to move the board. Do not reach over the blade to remove the pieces. The section of board between the fence and the saw should always be pushed clear of the saw.
7. Long boards should be supported by a stand the same height as the saw table
8. A device used to keep the board firmly against the fence is called a "feather strip." The spring action of the fingers pushes the board against the fence but allows it to be moved in the cutting direction.

Resawing on the circular saw:

1. Set the saw blade 1/8" to ¼" higher than half the width of the stock to be cut. The saw should not be set to cut deeper than two inches for each cut. Boards wider than four inches should be cut in four steps.
2. Adjust the feather strip to hold the stock firmly against the rip fence.
3. Start the saw and make a cut along one edge.
4. Turn the stock end for end and make the second cut. Make sure the face side is always against the fence.
5. If the stock is more than twice as wide as the saw will cut, the remaining portion may be cut with a band saw or hand rip saw.

Cutting a taper:

1. An adjustable jig may be made as a handy attachment for cutting tapers on the circular saw.
2. The straight edge is held against the rip fence and the piece to be cut is held against the notch of the jig. The jig and the board are pushed past the saw as a unit, making the cut at the desired angle or taper.

Cutting a bevel or chamfer:

1. On most saws either the table or the saw may be tilted so that an angle cut between 45 and 90 degrees may be made.
2. The tilting arbor saw is the most convenient to use. The work may be cut with the fence on either side of the saw. With the tilting table it is easier to make the cut with the fence on the low side of the saw.
3. If the angle to be cut is less than 45 degrees the saw should be adjusted to the supplement of the angle. The trial cut should be check for the desired angle.

Cutting grooves, rabbets, or dadoes:

1. Grooves or rabbets may be cut by making a series of closely spaced cuts, but a dado head attachment will do the job much faster. A dado consists of two saws similar to combination saws. These saws may be set to cut grooves from 1/8" to 1" on most popular saws. The throat plate must be replaced either with one supplied with the machine or one made from hard wood.
2. The grooves are cut as in crosscutting or ripping. The guards and splitter cannot be used.
3. A rabbet may also be made by cuts made at right angles- on the adjacent edge and face of the stock.

Cutting stop grooves:

1. Cuts which do not run to the end of the board may be started by lowering the work over the saw.
2. This calls for two stop blocks on a board fastened to the rip fence to limit the travel or cutting length.
3. Hold the board in contact with the fence with one end down on the table and against the stop bloc nearest the operator. Slowly lower the board the length of the cut until it clears the saw, being careful to maintain contact with the rip fence until the board is clear of the blade.

Reference

Walker, John R. *Modern Metalworking.* South Holland, Illinois: The Goodheart-Wilcox Company, Inc, 1976.

APPENDIX N – Laser Safety

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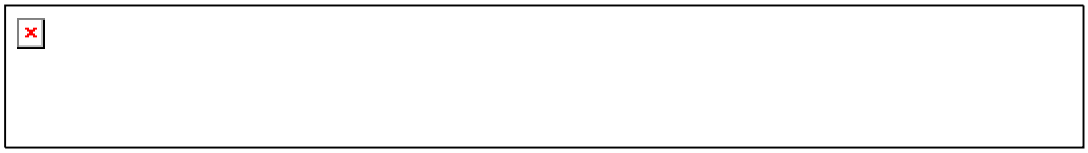
http://www.laserinstitute.org

This brief bulletin has been prepared by LIA's Laser Safety Committee to educate
new laser users on the concerns and issues related to laser safety.

What is a Laser?

LASER is an acronym which stands for Light Amplification by Stimulated Emission of Radiation. The energy generated by the laser is in or near the optical portion of the electromagnetic spectrum (see Figure 1). Energy is amplified to extremely high intensity by an atomic process called stimulated emission. The term "radiation" is often misinterpreted because the term is also used to describe radioactive materials or ionizing radiation. The use of the word in this context, however, refers to an energy transfer. Energy moves from one location to another by conduction, convection, and radiation. The color of laser light is normally expressed in terms of the laser's wavelength. The most common unit used in expressing a laser's wavelength is a nanometer (nm). There are one billion nanometers in one meter.

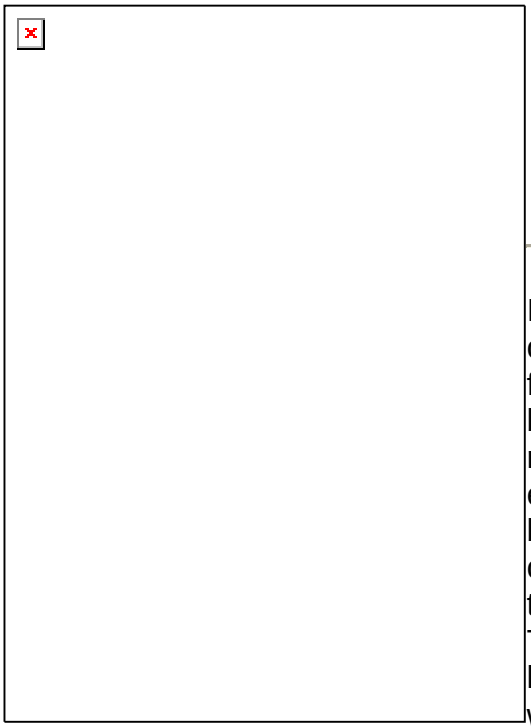


The optical spectrum. Laser light is nonionizing and ranges from the ultra-violet (100 - 400nm), visible (400 - 700nm), and infrared (700nm - 1mm).

Laser Hazards & Beam Hazards

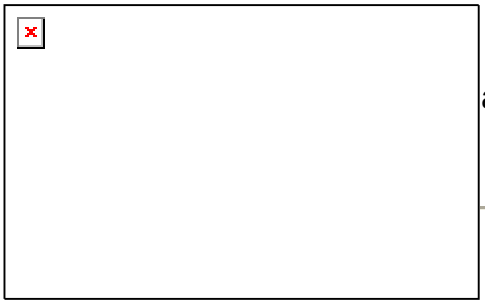
The laser produces an intense, highly directional beam of light. If directed, reflected, or focused upon an object, laser light will be partially absorbed, raising the temperature of the surface and/or the interior of the object, potentially causing an alteration or deformation of the material. These properties which have been applied to laser surgery and materials processing can also cause tissue damage. In addition to these obvious thermal effects upon tissue, there can also be photochemical effects when the wavelength of the laser radiation is sufficiently short, i.e., in the ultraviolet or blue region of the spectrum. Today, most high-power lasers are designed to minimize access to laser radiation during normal operation. Lower-power lasers may emit levels of laser light that are not a hazard.

The human body is vulnerable to the output of certain lasers, and under certain circumstances, exposure can result in damage to the eye and skin. Research relating to injury thresholds of the eye and skin has been carried out in order to understand the biological hazards of laser radiation. It is now widely accepted that the human eye is almost always more vulnerable to injury than human skin. The cornea (the clear, outer front surface of the eye's optics), unlike the skin, does not have an external layer of dead cells to protect it from the environment. In the far-ultraviolet and far-infrared regions of the optical spectrum, the cornea absorbs the laser energy and may be damaged. Figure 2 illustrates the absorption characteristics of the eye for different laser wavelength regions. At certain wavelengths in the near-ultraviolet region and in the near-infrared region, the lens of the eye may be vulnerable to injury. Of greatest concern, however, is laser exposure in the retinal hazard region of the optical spectrum, approximately 400 nm (violet light) to 1400 nm (near-infrared) and including the entire visible portion of the optical spectrum. Within this spectral region collimated laser rays are brought to focus on a very tiny spot on the retina. This is illustrated in Figure 3.



Absorption characteristics of the human eye (From Sliney & Wolbarsht, Safety with Lasers and Other Optical Sources, Plenum Press, 1980)

In order for the worst case exposure to occur, an individual's eye must be focussed at a distance and a direct beam or specular (mirror-like) reflection must enter the eye. The light entering the eye from a collimated beam in the retinal hazard region is concentrated by a factor of 100,000 times when it strikes the retina. Therefore, a visible, 10 milliwatt/cm2 laser beam would result in a 1000 watt/cm2 exposure to the retina, which is more than enough power density (irradiance) to cause damage. If the eye is not focussed at a distance or if the beam is reflected from a diffuse surface (not mirror-like), much higher levels of laser radiation would be necessary to cause injury. Likewise, since this ocular focussing effect does not apply to the skin, the skin is far less vulnerable to injury from these wavelengths.



Focussing effects of the human eye(From Sliney & Wolbarsht, Safety with Lasers and Other Optical Sources, Plenum Press, 1980)

If the eye is not focussed at a distance or if the beam is reflected from a diffuse surface (not mirror-like), much higher levels of laser radiation would be necessary to cause injury. Likewise, since this ocular focussing effect does not apply to the skin, the skin is far less vulnerable to injury from these wavelengths.

Non-Beam Hazards

In addition to the direct hazards to the eye and skin from the laser beam itself, it is also important to address other hazards associated with the use of lasers. These non-beam hazards, in some cases, can be life threatening, e.g. electrocution, fire, and asphyxiation. Table 1 indicates some of the potential non-beam hazards associated with laser usage. Because of the diversity of these hazards, the employment of safety and/or industrial hygiene personnel to effect the hazard evaluations may be necessary.

Safety Standards

There are a variety of laser safety standards including Federal and state regulations, and non-regulatory standards. The most important and most often quoted is the American National Standards Institute's Z136 series of laser safety standards. These standards are the foundation of laser safety programs in industry, medicine, research, and government. The ANSI Z136 series of laser safety standards are referenced by the Occupational Safety and Health Administration (OSHA) and many U.S. states as the basis of evaluating laser-related occupational safety issues.

ANSI Z136.1 Safe Use of Lasers, the parent document in the Z136 series, provides information on how to classify lasers for safety, laser safety calculations and measurements, laser hazard control measures, and recommendations for Laser Safety Officers and Laser Safety Committees in all types of laser facilities. It is designed to provide the laser user with the information needed to properly develop a comprehensive laser safety program.

For manufacturers of laser products, the standard of principal importance is the regulation of the Center for Devices and Radiological Health (CDRH),

Food and Drug Administration (FDA) which regulates product performance. All laser products sold in the USA since August 1976 must be certified by the manufacturer as meeting certain product performance (safety) standards, and each laser must bear a label indicating compliance with the standard and denoting the laser hazard classification.

Laser Hazard Classification

Research studies, along with an understanding of the hazards of sunlight and conventional, man-made light sources have permitted scientists to establish safe exposure limits for nearly all types of laser radiation. These limits are generally referred to as Maximum Permissible Exposures (MPE's) by laser safety professionals. In many cases it is unnecessary to make use of MPE's directly. The experience gained in millions of hours of laser use in the laboratory and industry has permitted the development of a system of laser hazard categories or classifications. The manufacturer of lasers and laser products is required to certify that the laser is designated as one of four general classes, or risk categories, and label it accordingly. This allows the use of standardized safety measures to reduce or eliminate accidents depending on the class of the laser or laser system being used. The following is a brief description of the four primary categories of lasers:

Class 1
A Class 1 laser is considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser product. There may be a more hazardous laser embedded in the enclosure of a Class 1 product, but no harmful radiation can escape the enclosure.

Class 2
A Class 2 laser or laser system must emit a visible laser beam. Because of its brightness, Class 2 laser light will be too dazzling to stare into for extended periods. Momentary viewing is not considered hazardous since the upper radiant power limit on this type of device is less than the MPE (Maximum Permissible Exposure) for momentary exposure of 0.25 second or less. Intentional extended viewing, however, is considered hazardous.

Class 3
A Class 3 laser or laser system can emit any wavelength, but it cannot produce a diffuse (not mirror-like) reflection hazard unless focused or viewed for extended periods at close range. It is also not considered a fire hazard or serious skin hazard. Any continuous wave (CW) laser that is not Class 1 or Class 2 is a Class 3 device if its output power is 0.5 W or less. Since the output beam of such a laser is definitely hazardous for intrabeam

viewing, control measures center on eliminating this possibility.

Class 4
A Class 4 laser or laser system is any that exceeds the output limits (Accessible Emission Limits, AEL's) of a Class 3 device. As would be expected, these lasers may be either a fire or skin hazard or a diffuse reflection hazard. Very stringent control measures are required for a Class 4 laser or laser system.

The Laser Safety Officer

ANSI Z136.1 specifies that any facility using Class 3b or Class 4 lasers or laser systems should designate a Laser Safety Officer to oversee safety for all operational, maintenance, and servicing situations.

This person should have the authority and responsibility to monitor and enforce the control of laser hazards. This person is also responsible for the evaluation of laser hazards and the establishment of appropriate control measures.

The Laser Safety Officer (LSO) may be a full or part-time position depending on the demands of the laser environment. This person may be someone from occupational health and safety, industrial hygiene, or similar safety related departments. The LSO may also be part of the engineering or production department. In any case, the LSO must be provided the appropriate training to properly establish and administer a laser safety program.

Some of the duties the LSO may perform include hazard evaluation and establishment of hazard zones, control measures and compliance issues, approval of Standard Operating Procedures and maintenance/service procedures, approval of equipment and installations, safety training for laser personnel, recommendation and approval of personal protective equipment, and other administrative responsibilities.

Controlling Laser Hazards

Like any other potentially hazardous operation, lasers can be used safely through the use of suitable facilities, equipment, and well trained personnel. The ANSI Z136 series of laser safety standards provide a detailed description of control measures which can be put into place to protect against potential accidents.

These control measures are divided into two distinctive categories, Engineering Controls and Administrative/Procedural Controls. Examples of

Engineering Controls include protective housings and interlocks, protective filter installations, key-controls, and system interlocks.
Administrative/Procedural Controls include standard operating procedures and personal protective equipment.

Engineering Controls are generally more costly to develop but are considered far more reliable by removing the dependence on humans to follow rigorous procedures and the possibility of personal protective equipment failure or misuse.

Administrative/Procedural Controls are designed to supplement Engineering Controls to assure that laser personnel are fully protected from potential laser hazards. The focus of these controls are to provide adequate education and training, provisions for protective equipment, and procedures related to the operation, maintenance and servicing of the laser.

Safety training is desired for those working with Class 3 lasers and systems. Operation within a marked, controlled area is also recommended. For Class 4 lasers or systems, eye protectors are almost always required and facility interlocks and further safeguards are used. Control measures for each laser classification are defined fully in the ANSI Z136.1 laser safety standard. This document is the single most important piece of information regarding the safe use of lasers and should be part of every laser safety program. For more information on laser safety, please refer to this standard. ANSI Z136 laser safety standards may be obtained by contacting Laser Institute of America at 407-380-1553.

Laser Institute of America • 13501 Ingenuity Drive • Suite 128 • Orlando, Florida 32826 •
Phone: 407.380.1553 • Fax: 407.380.5588
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APPENDIX O – HYDROGEN SAFETY STANDARDS

OSHA – 29CFR1910.103

[Code of Federal Regulations]
[Title 29, Volume 5]
[Revised as of July 1, 2003]
From the U.S. Government Printing Office via GPO Access
[CITE: 29CFR1910.103]
[Page 227-234]

TITLE 29—LABOR

CHAPTER XVII--OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1910--OCCUPATIONAL SAFETY AND HEALTH STANDARDS—

Table of Contents
Subpart H--Hazardous Materials

Sec. 1910.103 Hydrogen.

(a) General--(1) Definitions. As used in this section (i) Gaseous hydrogen system is one in which the hydrogen is delivered, stored and discharged in the gaseous form to consumer's piping. The system includes stationary or movable containers, pressure regulators, safety relief devices, manifolds, interconnecting piping and controls. The system terminates at the point where hydrogen at service pressure first enters the consumer's distribution piping.
(ii) Approved--Means, unless otherwise indicated, listed or approved by a nationally recognized testing laboratory. Refer to Sec. 1910.7 for definition of nationally recognized testing laboratory.
(iii) Listed--See ``approved".
(iv) ASME--American Society of Mechanical Engineers.
(v) DOT Specifications--Regulations of the Department of Transportation published in 49 CFR Chapter I.
(vi) DOT regulations--See Sec. 1910.103 (a)(1)(v).
(2) Scope--(i) Gaseous hydrogen systems. (a) Paragraph (b) of this section applies to the installation of gaseous hydrogen systems on consumer premises where the hydrogen supply to the consumer premises originates outside the consumer premises and is delivered by mobile equipment.
(b) Paragraph (b) of this section does not apply to gaseous hydrogen systems having a total hydrogen content of less than 400 cubic feet, nor

to hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his agent for the purpose of storing hydrogen and refilling portable containers, trailers, mobile supply trucks, or tank cars.
(ii) Liquefied hydrogen systems. (a) Paragraph (c) of this section applies to the installation of liquefied hydrogen systems on consumer premises.
(b) Paragraph (c) of this section does not apply to liquefied hydrogen portable containers of less than 150 liters (39.63 gallons) capacity; nor to liquefied hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his agent for the sole purpose of storing liquefied hydrogen and refilling portable containers, trailers, mobile supply trucks, or tank cars.
(b) Gaseous hydrogen systems--(1) Design--(i) Containers. (a) Hydrogen containers shall comply with one of the following:
(1) Designed, constructed, and tested in accordance with appropriate requirements of ASME Boiler and Pressure Vessel Code, Section VIII--Unfired Pressure Vessels--1968, which is incorporated by reference as specified in Sec. 1910.6.
(2) Designed, constructed, tested and maintained in accordance with U.S. Department of Transportation Specifications and Regulations.
(b) Permanently installed containers shall be provided with substantial noncombustible supports on firm noncombustible foundations.
(c) Each portable container shall be legibly marked with the name ``Hydrogen'' in accordance with ``Marking Portable Compressed Gas Containers to Identify the Material Contained'' ANSI Z48.1--1954, which is incorporated by reference as specified in Sec. 1910.6. Each manifolded hydrogen supply unit shall be legibly marked with the name Hydrogen or a legend such as ``This unit contains hydrogen.''
(ii) Safety relief devices. (a) Hydrogen containers shall be equipped with safety relief devices as required by the ASME Boiler and Pressure Vessel Code, Section VIII Unfired Pressure Vessels, 1968 or the DOT Specifications and
[[Page 228]]
Regulations under which the container is fabricated.
(b) Safety relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structure or personnel. This requirement does not apply to DOT Specification containers having an internal volume of 2 cubic feet or less.
(c) Safety relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner which would interfere with proper operation of the device.
(iii) Piping, tubing, and fittings. (a) Piping, tubing, and fittings shall be suitable for hydrogen service and for the pressures and temperatures involved. Cast iron pipe and fittings shall not be used.

(b) Piping and tubing shall conform to Section 2--``Industrial Gas and Air Piping"--Code for Pressure Piping, ANSI B31.1-1967 with addenda B31.1-1969, which is incorporated by reference as specified in Sec. 1910.6.
(c) Joints in piping and tubing may be made by welding or brazing or by use of flanged, threaded, socket, or compression fittings. Gaskets and thread sealants shall be suitable for hydrogen service.
(iv) Equipment assembly. (a) Valves, gauges, regulators, and other accessories shall be suitable for hydrogen service.
(b) Installation of hydrogen systems shall be supervised by personnel familiar with proper practices with reference to their construction and use.
(c) Storage containers, piping, valves, regulating equipment, and other accessories shall be readily accessible, and shall be protected against physical damage and against tampering.
(d) Cabinets or housings containing hydrogen control or operating equipment shall be adequately ventilated.
(e) Each mobile hydrogen supply unit used as part of a hydrogen system shall be adequately secured to prevent movement.
(f) Mobile hydrogen supply units shall be electrically bonded to the system before discharging hydrogen.
(v) Marking. The hydrogen storage location shall be permanently placarded as follows: ``HYDROGEN--FLAMMABLE GAS--NO SMOKING--NO OPEN
FLAMES," or equivalent.
(vi) Testing. After installations, all piping, tubing, and fittings shall be tested and proved hydrogen gas tight at maximum operating pressure.
(2) Location--(i) General. (a) The system shall be located so that it is readily accessible to delivery equipment and to authorized personnel.
(b) Systems shall be located above ground.
(c) Systems shall not be located beneath electric power lines.
(d) Systems shall not be located close to flammable liquid piping or piping of other flammable gases.
(e) Systems near aboveground flammable liquid storage shall be located on ground higher than the flammable liquid storage except when dikes, diversion curbs, grading, or separating solid walls are used to prevent accumulation of flammable liquids under the system.
(ii) Specific requirements. (a) The location of a system, as determined by the maximum total contained volume of hydrogen, shall be in the order of preference as indicated by Roman numerals in Table H-1.
Table H-1

Size of
hydrogen system
Nature of location ----------

Less than 3,000 CF 3,000 CF to
15,000 CF In excess of 15,000 CF

Outdoors..... I.....
IDI.....
In a separate building..... II.....
II..... II.
In a special room..... III.....
III..... Not permitted.
Inside buildings not in a special IV..... Not
permitted..... Not permitted.
room and exposed to other
occupancies.

(b) The minimum distance in feet from a hydrogen system of indicated capacity located outdoors, in separate buildings or in special rooms to any specified outdoor exposure shall be in accordance with Table H-2.
(c) The distances in Table H-2 Items 1, 14, and 3 to 10 inclusive do not apply where protective structures such as adequate fire walls are located between the system and the exposure.
[[Page 229]]
Table H-2

Type of outdoor exposure
Size of hydrogen system ---

3,000 CF In excess
Less than to 15,000 of 15,000
3,000 CF CF CF

---
1. Building or structure..... Wood frame construction \1\.....
10 25 50
Heavy timber, noncombustible or
0 10 \2\ 25
ordinary construction \1\.
Fire-resistive construction \1\..
0 0 0
2. Wall openings..... Not above any part of a system...
10 10 10
Above any part of a system.....

25 25 25
3. Flammable liquids above ground..... 0 to 1,000 gallons.....
10 25 25
In excess of 1,000 gallons.....
25 50 50
4. Flammable liquids below ground--0 to Tank.....
10 10 10
1,000 gallons. Vent or fill opening of tank.....
25 25 25
5. Flammable liquids below ground--in Tank.....
20 20 20
excess of 1,000 gallons.. Vent or fill opening of tank.....
25 25 25
6. Flammable gas storage, either high 0 to 15,000 CF capacity.....
10 25 25
pressure or low pressure.. In excess of 15,000 CF capacity..
25 50 50
7. Oxygen storage..... 12,000 CF or less \4\.....
....
More than 12,000 CF \5\.....
....
8. Fast burning solids such as ordinary lumber, excelsior or paper.....
50 50 50
9. Slow burning solids such as heavy timber or coal.....
25 25 25
10. Open flames and other sources of ignition.....
25 25 25
11. Air compressor intakes or inlets to ventilating or air-conditioning
50 50 50
equipment.
12. Concentration of people \3\.....
25 50 50

\1\ Refer to NFPA No. 220 Standard Types of Building Construction for definitions of various types of
construction. (1969 Ed.) \2\ But not less than one-half the height of adjacent side wall of the
structure.
\3\ In congested areas such as offices, lunchrooms, locker rooms, time-clock areas.
\4\ Refer to NFPA No. 51, gas systems for welding and cutting (1969).
\5\ Refer to NFPA No. 566, bulk oxygen systems at consumer sites (1969).
(d) Hydrogen systems of less than 3,000 CF when located inside buildings and exposed to other occupancies shall be situated in the building so that the system will be as follows:

(1) In an adequately ventilated area as in paragraph (b)(3)(ii)(b) of this section.
(2) Twenty feet from stored flammable materials or oxidizing gases.
(3) Twenty-five feet from open flames, ordinary electrical equipment or other sources of ignition.
(4) Twenty-five feet from concentrations of people.
(5) Fifty feet from intakes of ventilation or air-conditioning equipment and air compressors.
(6) Fifty feet from other flammable gas storage.
(7) Protected against damage or injury due to falling objects or working activity in the area.
(8) More than one system of 3,000 CF or less may be installed in the same room, provided the systems are separated by at least 50 feet. Each such system shall meet all of the requirements of this paragraph.
(3) Design consideration at specific locations--(i) Outdoor locations. (a) Where protective walls or roofs are provided, they shall be constructed of noncombustible materials.
(b) Where the enclosing sides adjoin each other, the area shall be properly ventilated.
(c) Electrical equipment within 15 feet shall be in accordance with subpart S of this part.
(ii) Separate buildings. (a) Separate buildings shall be built of at least noncombustible construction. Windows and doors shall be located so as to be readily accessible in case of emergency. Windows shall be of glass or plastic in metal frames.
(b) Adequate ventilation to the outdoors shall be provided. Inlet openings shall be located near the floor in exterior walls only. Outlet openings shall be located at the high point of the room in exterior walls or roof. Inlet and outlet openings shall each have minimum total area of one (1) square foot per 1,000 cubic feet of room volume. Discharge from outlet openings shall be directed or conducted to a safe location.
(c) Explosion venting shall be provided in exterior walls or roof only. The venting area shall be equal to not
[[Page 230]]
less than 1 square foot per 30 cubic feet of room volume and may consist of any one or any combination of the following: Walls of light, noncombustible material, preferably single thickness, single strength glass; lightly fastened hatch covers; lightly fastened swinging doors in exterior walls opening outward; lightly fastened walls or roof designed to relieve at a maximum pressure of 25 pounds per square foot.
(d) There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.
(e) Electrical equipment shall be in accordance with subpart S of this part for Class I, Division 2 locations. (f) Heating, if provided, shall be by steam, hot water, or other

indirect means.
(iii) Special rooms. (a) Floor, walls, and ceiling shall have a fire-resistance rating of at least 2 hours. Walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall shall be an exterior wall. Openings to other parts of the building shall not be permitted. Windows and doors shall be in exterior walls and shall be located so as to be readily accessible in case of emergency. Windows shall be of glass or plastic in metal frames.
(b) Ventilation shall be as provided in paragraph (b)(3)(ii)(b) of this section.
(c) Explosion venting shall be as provided in paragraph (b)(3)(ii)(c) of this section.
(d) There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.
(e) Electric equipment shall be in accordance with the requirements of subpart S of this part for Class I, Division 2 locations.
(f) Heating, if provided, shall be by steam, hot water, or indirect means.
(4) Operating instructions. For installations which require any operation of equipment by the user, legible instructions shall be maintained at operating locations.
(5) Maintenance. The equipment and functioning of each charged gaseous hydrogen system shall be maintained in a safe operating condition in accordance with the requirements of this section. The area within 15 feet of any hydrogen container shall be kept free of dry vegetation and combustible material.
(c) Liquefied hydrogen systems--(1) Design--(i) Containers. (a) Hydrogen containers shall comply with the following: Storage containers shall be designed, constructed, and tested in accordance with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII--Unfired Pressure Vessels (1968) or applicable provisions of API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, Second Edition (June 1963) and appendix R (April 1965), which is incorporated by reference as specified in Sec. 1910.6.
(b) Portable containers shall be designed, constructed and tested in accordance with DOT Specifications and Regulations.
(ii) Supports. Permanently installed containers shall be provided with substantial noncombustible supports securely anchored on firm noncombustible foundations. Steel supports in excess of 18 inches in height shall be protected with a protective coating having a 2-hour fire-resistance rating.
(iii) Marking. Each container shall be legibly marked to indicate ``LIQUEFIED HYDROGEN--FLAMMABLE GAS."
(iv) Safety relief devices. (a)(1) Stationary liquefied hydrogen containers shall be equipped with safety relief devices sized in

accordance with CGA Pamphlet S-1, Part 3, Safety Relief Device Standards for Compressed Gas Storage Containers, which is incorporated by reference as specified in Sec. 1910.6.
(2) Portable liquefied hydrogen containers complying with the U.S. Department of Transportation Regulations shall be equipped with safety relief devices as required in the U.S. Department of Transportation Specifications and Regulations. Safety relief devices shall be sized in accordance with the requirements of CGA Pamphlet S-1, Safety Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers. (b) Safety relief devices shall be arranged to discharge unobstructed to the outdoors and in such a manner as to prevent impingement of escaping
[[Page 231]]
liquid or gas upon the container, adjacent structures or personnel. See paragraph (c)(2)(i)(f) of this section for venting of safety relief devices in special locations.
(c) Safety relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner which would interfere with proper operation of the device.
(d) Safety relief devices shall be provided in piping wherever liquefied hydrogen could be trapped between closures.
(v) Piping, tubing, and fittings. (a) Piping, tubing, and fittings and gasket and thread sealants shall be suitable for hydrogen service at the pressures and temperatures involved. Consideration shall be given to the thermal expansion and contraction of piping systems when exposed to temperature fluctuations of ambient to liquefied hydrogen temperatures.
(b) Gaseous hydrogen piping and tubing (above -20 <deg>F.) shall conform to the applicable sections of Pressure Piping Section 2--Industrial Gas and Air Piping, ANSI B31.1-1967 with addenda B31.1-1969. Design of liquefied hydrogen or cold (-20 <deg>F. or below) gas piping shall use Petroleum Refinery Piping ANSI B31.3-1966 or Refrigeration Piping ANSI B31.5-1966 with addenda B31.5a-1968 as a guide, which are incorporated by reference as specified in Sec. 1910.6.
(c) Joints in piping and tubing shall preferably be made by welding or brazing; flanged, threaded, socket, or suitable compression fittings may be used.
(d) Means shall be provided to minimize exposure of personnel to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members, and surfaces not suitable for cryogenic temperatures. Only those insulating materials which are rated nonburning in accordance with ASTM Procedures D1692-68, which is incorporated by reference as specified in Sec. 1910.6, may be used. Other protective means may be used to protect personnel. The insulation shall be designed to have a vapor-tight seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation. The insulation material and outside shield shall also be of

adequate design to prevent attrition of the insulation due to normal operating conditions.
(e) Uninsulated piping and equipment which operate at liquefied-hydrogen temperature shall not be installed above asphalt surfaces or other combustible materials in order to prevent contact of liquid air with such materials. Drip pans may be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.
(vi) Equipment assembly. (a) Valves, gauges, regulators, and other accessories shall be suitable for liquefied hydrogen service and for the pressures and temperatures involved.
(b) Installation of liquefied hydrogen systems shall be supervised by personnel familiar with proper practices and with reference to their construction and use.
(c) Storage containers, piping, valves, regulating equipment, and other accessories shall be readily accessible and shall be protected against physical damage and against tampering. A shutoff valve shall be located in liquid product withdrawal lines as close to the container as practical. On containers of over 2,000 gallons capacity, this shutoff valve shall be of the remote control type with no connections, flanges, or other appurtenances (other than a welded manual shutoff valve) allowed in the piping between the shutoff valve and its connection to the inner container.
(d) Cabinets or housings containing hydrogen control equipment shall be ventilated to prevent any accumulation of hydrogen gas.
(vii) Testing. (a) After installation, all field-erected piping shall be tested and proved hydrogen gas-tight at operating pressure and temperature.
(b) Containers if out of service in excess of 1 year shall be inspected and tested as outlined in (a) of this subdivision. The safety relief devices shall be checked to determine if they are operable and properly set.
(viii) Liquefied hydrogen vaporizers. (a) The vaporizer shall be anchored and its connecting piping shall be sufficiently flexible to provide for the effect of expansion and contraction due to temperature changes.
[[Page 232]]
(b) The vaporizer and its piping shall be adequately protected on the hydrogen and heating media sections with safety relief devices.
(c) Heat used in a liquefied hydrogen vaporizer shall be indirectly supplied utilizing media such as air, steam, water, or water solutions.
(d) A low temperature shutoff switch shall be provided in the vaporizer discharge piping to prevent flow of liquefied hydrogen in the event of the loss of the heat source.
(ix) Electrical systems. (a) Electrical wiring and equipment located within 3 feet of a point where connections are regularly made and disconnected, shall be in accordance with subpart S of this part, for

Class I, Group B, Division 1 locations.
(b) Except as provided in (a) of this subdivision, electrical wiring, and equipment located within 25 feet of a point where connections are regularly made and disconnected or within 25 feet of a liquid hydrogen storage container, shall be in accordance with subpart S of this part, for Class I, Group B, Division 2 locations. When equipment approved for class I, group B atmospheres is not commercially available, the equipment may be--
(1) Purged or ventilated in accordance with NFPA No. 496-1967, Standard for Purged Enclosures for Electrical Equipment in Hazardous Locations,
(2) Intrinsically safe, or
(3) Approved for Class I, Group C atmospheres. This requirement does not apply to electrical equipment which is installed on mobile supply trucks or tank cars from which the storage container is filled.
(x) Bonding and grounding. The liquefied hydrogen container and associated piping shall be electrically bonded and grounded.
(2) Location of liquefied hydrogen storage--(i) General requirements. (a) The storage containers shall be located so that they are readily accessible to mobile supply equipment at ground level and to authorized personnel.
(b) The containers shall not be exposed by electric power lines, flammable liquid lines, flammable gas lines, or lines carrying oxidizing materials.
(c) When locating liquified hydrogen storage containers near above-ground flammable liquid storage or liquid oxygen storage, it is advisable to locate the liquefied hydrogen container on ground higher than flammable liquid storage or liquid oxygen storage.
(d) Where it is necessary to locate the liquefied hydrogen container on ground that is level with or lower than adjacent flammable liquid storage or liquid oxygen storage, suitable protective means shall be taken (such as by diking, diversion curbs, grading), with respect to the adjacent flammable liquid storage or liquid oxygen storage, to prevent accumulation of liquids within 50 feet of the liquefied hydrogen container.
(e) Storage sites shall be fenced and posted to prevent entrance by unauthorized personnel. Sites shall also be placarded as follows: ``Liquefied Hydrogen--Flammable Gas--No Smoking--No Open Flames."
(f) If liquified hydrogen is located in (as specified in Table H-3) a separate building, in a special room, or inside buildings when not in a special room and exposed to other occupancies, containers shall have the safety relief devices vented unobstructed to the outdoors at a minimum elevation of 25 feet above grade to a safe location as required in paragraph (c)(1)(iv)(b) of this section.
(ii) Specific requirements. (a) The location of liquefied hydrogen storage, as determined by the maximum total quantity of liquified

hydrogen, shall be in the order of preference as indicated by Roman numerals in the following Table H-3.

Table H-3--Maximum Total Quantity of Liquefied Hydrogen Storage Permitted

Size of hydrogen storage (capacity in gallons)				
Nature of location	39.63 (150 liters) to 50	51 to 300	301 to 600	In excess of 600
Outdoors	I	I	I	I
In a separate building	II	II	II	II
In a special room	III	III	III	Not permitted
Inside buildings not in a special room and exposed to other occupancies.	IV	Not permitted	....do	....do

Note: This table does not apply to the storage in dewars of the type generally used in laboratories for experimental purposes.

(b) The minimum distance in feet from liquefied hydrogen systems of indicated storage capacity located outdoors, in a separate building, or in a special room to any specified exposure shall be in accordance with Table H-4.

Table H-4--Minimum Distance (Feet) From Liquefied Hydrogen Systems to Exposure \1\ \2\

Liquefied hydrogen storage (capacity in gallons)			
Type of exposure	39.63 (150 liters) to 3,500	3,501 to 15,001	15,001 to 30,000

1. Fire-resistive building and fire walls 5 5 5
\3\.....
2. Noncombustible building \3\..... 25 50 75
3. Other buildings \3\..... 50 75 100
4. Wall openings, air-compressor intakes, 75 75 75
inlets for air-conditioning or
ventilating equipment.....
5. Flammable liquids (above ground and 50 75 100
vent or fill openings if below ground)
(see 513 and 514).....
6. Between stationary liquefied hydrogen 5 5 5
containers.....
7. Flammable gas storage..... 50 75 100
8. Liquid oxygen storage and other 100 100 100
oxidizers (see 513 and 514).....
9. Combustible solids..... 50 75 100
10. Open flames, smoking and welding..... 50 50 50
11. Concentrations of people..... 75 75 75

\1\ The distance in Nos. 2, 3, 5, 7, 9, and 12 in Table H-4 may be reduced where protective structures, such as firewalls equal to height of top of the container, to safeguard the liquefied hydrogen storage system, are located between the liquefied hydrogen storage installation and the exposure.

\2\ Where protective structures are provided, ventilation and confinement of product should be considered. The 5-foot distance in Nos. 1 and 6 facilitates maintenance and enhances ventilation.

\3\ Refer to Standard Types of Building Construction, NFPA No. 220-1969 for definitions of various types of construction.

In congested areas such as offices, lunchrooms, locker rooms, time-clock areas.

(iii) Handling of liquefied hydrogen inside buildings other than separate buildings and special rooms. Portable liquefied hydrogen containers of 50 gallons or less capacity as permitted in Table H-3 and in compliance with subdivision (i)(f) of this subparagraph when housed inside buildings not located in a special room and exposed to other occupancies shall comply with the following minimum requirements:

(a) Be located 20 feet from flammable liquids and readily combustible materials such as excelsior or paper.

(b) Be located 25 feet from ordinary electrical equipment and other sources of ignition including process or analytical equipment.

(c) Be located 25 feet from concentrations of people. (d) Be located 50 feet from intakes of ventilation and air-conditioning equipment or intakes of compressors.

(e) Be located 50 feet from storage of other flammable-gases or storage of oxidizing gases.

(f) Containers shall be protected against damage or injury due to falling objects or work activity in the area.
(g) Containers shall be firmly secured and stored in an upright position.
(h) Welding or cutting operations, and smoking shall be prohibited while hydrogen is in the room.
(i) The area shall be adequately ventilated. Safety relief devices on the containers shall be vented directly outdoors or to a suitable hood. See paragraphs (c)(1)(iv)(b) and (c)(2)(i)(f) of this section.
(3) Design considerations at specific locations--(i) Outdoor locations. (a) Outdoor location shall mean outside of any building or structure, and includes locations under a weather shelter or canopy provided such locations are not enclosed by more than two walls set at right angles and are provided with vent-space between the walls and vented roof or canopy.
(b) Roadways and yard surfaces located below liquefied hydrogen piping,
[[Page 234]]
from which liquid air may drip, shall be constructed of noncombustible materials.
(c) If protective walls are provided, they shall be constructed of noncombustible materials and in accordance with the provisions of paragraph (c)(3)(i)(a) of this section.
(d) Electrical wiring and equipment shall comply with paragraph (c)(1)(ix) (a) and (b) of this section.
(e) Adequate lighting shall be provided for nighttime transfer operation.
(ii) Separate buildings. (a) Separate buildings shall be of light noncombustible construction on a substantial frame. Walls and roofs shall be lightly fastened and designed to relieve at a maximum internal pressure of 25 pounds per square foot. Windows shall be of shatterproof glass or plastic in metal frames. Doors shall be located in such a manner that they will be readily accessible to personnel in an emergency.
(b) Adequate ventilation to the outdoors shall be provided. Inlet openings shall be located near the floor level in exterior walls only. Outlet openings shall be located at the high point of the room in exterior walls or roof. Both the inlet and outlet vent openings shall have a minimum total area of 1 square foot per 1,000 cubic feet of room volume. Discharge from outlet openings shall be directed or conducted to a safe location.
(c) There shall be no sources of ignition.
(d) Electrical wiring and equipment shall comply with paragraphs (c)(1)(ix) (a) and (b) of this section except that the provisions of paragraph (c)(1)(ix)(b) of this section shall apply to all electrical wiring and equipment in the separate building.

(e) Heating, if provided, shall be by steam, hot water, or other indirect means.
(iii) Special rooms. (a) Floors, walls, and ceilings shall have a fire resistance rating of at least 2 hours. Walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall shall be an exterior wall. Openings to other parts of the building shall not be permitted. Windows and doors shall be in exterior walls and doors shall be located in such a manner that they will be accessible in an emergency. Windows shall be of shatterproof glass or plastic in metal frames.
(b) Ventilation shall be as provided in paragraph (c)(3)(ii)(b) of this section.
(c) Explosion venting shall be provided in exterior walls or roof only. The venting area shall be equal to not less than 1 square foot per 30 cubic feet of room volume and may consist of any one or any combination of the following: Walls of light noncombustible material; lightly fastened hatch covers; lightly fastened swinging doors opening outward in exterior walls; lightly fastened walls or roofs designed to relieve at a maximum pressure of 25 pounds per square foot.
(d) There shall be no sources of ignition.
(e) Electrical wiring and equipment shall comply with paragraph (c)(1)(ix) (a) and (b) of this section except that the provision of paragraph (c)(1)(ix)(b) of this section shall apply to all electrical wiring and equipment in the special room.
(f) Heating, if provided, shall be steam, hot water, or by other indirect means.
(4) Operating instructions--(i) Written instructions. For installation which require any operation of equipment by the user, legible instructions shall be maintained at operating locations.
(ii) Attendant. A qualified person shall be in attendance at all times while the mobile hydrogen supply unit is being unloaded.
(iii) Security. Each mobile liquefied hydrogen supply unit used as part of a hydrogen system shall be adequately secured to prevent movement.
(iv) Grounding. The mobile liquefied hydrogen supply unit shall be grounded for static electricity.
(5) Maintenance. The equipment and functioning of each charged liquefied hydrogen system shall be maintained in a safe operating condition in accordance with the requirements of this section. Weeds or similar combustibles shall not be permitted within 25 feet of any liquefied hydrogen equipment.
[39 FR 23502, June 27, 1974, as amended at 43 FR 49746, Oct. 24, 1978; 53 FR 12121, Apr. 12, 1988; 55 FR 32015, Aug. 6, 1990; 58 FR 35309, June 30, 1993; 61 FR 9236, 9237, Mar. 7, 1996]
[[Page 235]]

Guide for Hydrogen Hazards Analysis on Components and Systems
NASMTM-2003-212059

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CONTENTS

Abstract

The physical and combustion properties of hydrogen give rise to hazards that must be considered when designing and operating a hydrogen system. One of the major concerns in the use of hydrogen is that of fire or detonation because of hydrogen's wide flammability range, low ignition energy, and flame speed. Other concerns include the contact and interaction of hydrogen with materials, such as the hydrogen embrittlement of materials and the formation of hydrogen hydrides. The low temperature of liquid and slush hydrogen bring other concerns related to material compatibility and pressure control; this is especially important when dissimilar, adjoining materials are involved. The potential hazards arising from these properties and design features necessitate a proper hydrogen hazards analysis before introducing a material, component, or system into hydrogen service.

The objective of this guide is to describe the NASA Johnson Space Center White Sands Test Facility hydrogen hazards analysis method that should be performed before hydrogen is used in components and/or systems. The method is consistent with standard practices for analyzing hazards. It is recommended that this analysis be made before implementing a hydrogen component qualification procedure. A hydrogen hazards analysis is a useful tool for hydrogen-system designers, system and safety engineers, and facility managers. A hydrogen hazards analysis can identify problem areas before hydrogen is introduced into a system-preventing damage to hardware, delay or loss of mission or objective, and possible injury or loss of life.

This guide is based on information from the NASA Safety Standard for Hydrogen and Hydrogen Systems (NSS 1740.16) and experience derived from the development of a similar protocol for oxygen system hazards analysis. It was previously published as TP-WSTF-937 (Woods 1998).

1 .O Introduction

Hydrogen shall be stored, handled, and used so that life and health are not jeopardized, the risk of property/equipment damage is minimized, and the mission of the system/equipment is sustained. This guide provides a method (Stoltzfus 1996, Woods 1998) by which contributing factors are reviewed and scenarios representative of hazards are considered.

The purpose of this guide is to describe the NASA Johnson Space Center White Sands Test Facility (NASA JSC WSTF) hydrogen hazards analysis method that should be performed before hydrogen is used in components and/or systems. This analysis is in accordance with the requirements and guidelines in NSS 1740.16, NASA Safety Standard for Hydrogen and Hydrogen Systems, and the method is consistent with standard practices for analyzing hazards. It is recommended that this analysis be made before implementing a hydrogen component qualification procedure. A hydrogen hazards analysis is a useful tool for hydrogen-system designers, system and safety engineers,

facility managers, and those tasked with accident analysis. A hydrogen hazards analysis can identify problem areas before hydrogen is introduced into a system-preventing damage to hardware, delay or loss of mission or objective, and possible injury or loss of life.

This guide addresses gaseous and liquid hydrogen but does not specifically address all the hazards associated with other forms of hydrogen, such as slush.

Recommendations, guidelines, standards, and mandatory requirements for the safe design, installation, operation, and maintenance of a hydrogen component, system, or facility are presented in other documents (NSS 1740.16, NSS 1740.12, NFPA 50A, NFPA 50B, 29 CFR 1910.103, ASME 2001, ASME 2002).

2.0 Objective

The objective of this guide is to describe a hydrogen hazards analysis method that should be performed before hydrogen is used in components and/or systems. The widespread uses of hydrogen in the future will benefit from applying a rigorous, comprehensive hazards analysis method such as the one described in this guide.

3.0 Hazards

Proper design and operation of hydrogen systems allow for control of the potentially hazardous environments and chemical properties associated with hydrogen. Any event involving hydrogen that creates a condition that could result in one or more of the following is considered a hazard: (1) injury
to people; (2) damage to property or equipment; and (3) delay or loss of a mission or objective. A hazard results from the occurrence of a particular set of contributing factors that make up a scenario. Hence, hazards arise from how hydrogen is used and are not intrinsic to hydrogen itself. Hydrogen's combustion and physical properties must be considered. When it is used in a system, further questions arise concerning potential pressure releases such as blast, overpressure, stored energy, and boiling liquid expanding vapor explosions. The phases present in the system lead to temperature considerations. At low temperatures, it is important to consider cold fluids handling, cryopumping, contaminant solidification, cold surfaces, oxygen enrichment of air, and cold embrittlement of containment and nearby materials. Hydrogen embrittlement of metals must be considered. Operations that involve personnel give rise to potential health issues, including burns (from direct contact with flame or hot surfaces, cryogens, or radiation exposure); asphyxiation (from hydrogen or purge gases such as nitrogen or helium); hypothermia; blast (overpressure) injury; or injury from fragments.

3.1 Combustion Hazard

Hydrogen is flammable. Therefore, fire is a primary hydrogen hazard if the consequences of the fire include: (1) injury of personnel; (2) damage to equipment/property; and (3) delay or loss of mission or objective. A fire can result from the following scenarios.

- Hydrogen is released, mixes with an oxidizer, and forms a combustible mixture. The mixture contacts an ignition source and ignition occurs.

- The hydrogen system is contaminated with an oxidizer as a result of improper purging and/or in leakage of an oxidizer, such as air. The hydrogen and the oxidizer form a combustible mixture, the combustible mixture contacts an ignition source, and ignition occurs.

- Hydrogen or an oxidizer leak from one part of a system into another part of the system where a combustible mixture is formed and ignited.

This guide will focus on the fire and explosion hazards as the basic hazards for assessment.

3.2 Pressure Hazard

Hydrogen has a significant expansion ratio in its conversion from a liquid at normal boiling point to a gas at normal temperature and pressure; therefore, overpressure is another hydrogen hazard to be considered. Overpressure can result in:

- Excessive deformation and subsequent release of hydrogen.

- Rupture of the pressure vessel, which would release hydrogen (this could provide the ignition source) and/or produce projectiles from vessel fragments.

Gaseous hydrogen is compressible, and a compressed gas can have a significant potential energy. Therefore, this is another pressure hazard to be considered.

3.3 Hydrogen-Related Injuries

Potential hydrogen-related accidents and injuries are described below.

Asphyxiation. Asphyxiation can result if hydrogen or inert gases used for purging a hydrogen system displace the oxygen in a breathing atmosphere.

Blast Overpressure. Blast overpressure can result from a detonation or from the unconfined expansion of a compressed gas.

Burn. A burn can result from direct contact with a hydrogen fire, thermal radiation from a

hydrogen fire, or contact with a surface that has been heated by a hydrogen fire.

Fragments. An explosion can produce fragments from the container of an explosive mixture or from structures or other items near the explosion. These fragments can result in injury or death to personnel, and damage or destruction of equipment.

Frostbite (Freezing, Cvyogenic Burn). Frostbite can result from contact with a cold fluid or a cold surface.

Hypothermia. Hypothermia can occur if the body temperature is lowered as a consequence of a cold environment, such as from a liquid hydrogen spill.

Most hydrogen systems isolate personnel from direct exposure to hydrogen. For example, we mitigate frostbite danger from liquid hydrogen by using personal protective equipment and with
proper equipment insulation and barriers.

4.0 Procedure

The procedure for conducting a hydrogen hazards analysis is described in this section. Figure 1 provides an outline of this procedure. The procedure examines in detail all components exposed to hydrogen, analyzes likely failure modes, determines the consequence(s) of a particular change to the system, and qualitatively assesses the risk for the system owners. At present, the procedure is primarily designed to address hydrogen combustion hazards. Preliminary activities are to adequately define the application and the scope of the investigation. Once defined, an analysis team with expertise in mechanical design, materials, ignition and combustion, safety, and component testing as it pertains to hydrogen, is assembled. Before convening analysis activities, detailed information on the components and the system to be analyzed is compiled as a report draft. Thoroughness at this point cannot be overemphasized; ease of the analysis process depends heavily on rigorous preparation.

4.1 General

A typical hazards analysis procedure begins with the system owners identifying the authorities that have jurisdiction over the system and what requirements and regulations must be met for its safe operation. A hazards analysis can be performed at any stage in the development of a system, but is preferably accomplished early on, particularly during the design phase. It can also be an effective tool for understanding hazards in an existing system.

The analysis identifies possible hazards related to a component, system, or facility based on relevant hydrogen properties, materials of construction, operating conditions, and siting. The possible source(s) for each hazard and the possible cause(s) for each source are examined. For each hazard, the analysis identifies possible consequences and risks for employees and the public, property, and the overall operation. The analysis does not

determine whether consequences are acceptable or not; what constitutes an acceptable risk is commonly determined at a higher management level in an organization. The analysis may recommend that the probability or severity of a particular hazard be minimized and may suggest a means to do so.

Input to the hazards analysis is very important. One strength of the procedure is how it drives examination of all materials wetted with hydrogen in a systematic, component-by-component fashion. The usual approach is top-down, with the analyst(s) first considering what types of components and 3 materials might generally contribute to a hazard. One limitation of this approach is that it examines from the top-down perspective only, which can lead to unintended omissions when specific hazards are missed. The typical analysis begins by identifying possible component failures in much the same way that a failure modes and effects analysis (FMEA) does, except that the modes identified are limited to those that would create or be implicated in a hydrogen hazard. Therefore, an FMEA or similar document, along with an exact materials list and system and component drawings, are needed before the actual analysis can commence. Team members responsible for design and system function must have at their fingertips complete information regarding which materials (body, bellows, diaphragm, and soft goods) the component manufacturer uses, and how they are used within the component. Again, good record keeping and advance preparation are key to a successful analysis.

To illustrate the level of detail needed, consider the following example of what happens when the analysis preparation is insufficient. Component parts such as electrical solenoids or electronics are sealed from hydrogen-wetted areas and from the outside environment. The probability of identifying a hazard increases in hydrogen systems if a single failure can lead to hydrogen accumulating in a component housing that also contains air and electrical ignition sources. When the information needed to evaluate such a scenario is not readily available, design teams are forced to call their support staffs to obtain this information, usually from vendors, and the analysis can come to a standstill. Typically, every design team encounters this situation during the analysis, and the downtime can be costly. However, the value accrued by the detailed analysis offsets the delay, and design teams have all remarked on the usefulness of a thorough analysis.

For more complex systems, the hazards analysis procedure is evolving. The initial goal for the hydrogen hazards analysis team was to capture analysis rationale in the draft report as work progresses so that the team members would have a completed report in their hands at the close of work. The more complex a system is, however, the more time is required for preparation. Analysis and system design are often not fixed at the time the team is convened, and the analysis must continue even after the team is adjourned.

Depending on the complexity of the hydrogen system to be analyzed, it is suggested to convene an advance party to familiarize key team members with the hazards analysis procedure, the hydrogen system function, pertinent data requirements, and to work out an analysis strategy to present to the full team. Components subject to potential design modifications should be identified. The process is greatly expedited if a detailed database

of materials, components, and combustion data are available at this time for use in the hazards analysis.

Another aspect of the system complexity challenge is the record keeping necessary to document system states, failures modes, dual-fault requirements, identified hazards, recommendations, equipment or component descriptions, and explanatory notes in a format that can be followed by the team and subsequently read by other analysts. The implications of a component failure vary with the system state, so a given component may require a separate analysis for each possible operational state. Dual-fault tolerance requirements introduce yet greater complexity. Currently, the report draft used by WSTF teams involves component data tables that rely on hyperlinks to relate the tabular data with explanatory endnotes. Recommendations made in the endnotes are also called out in a list conveniently located at the front of the document. The team recorder edits this document as the analysis proceeds. Team members constantly look for commonality in failure modes and effects across different components to streamline the analysis. The analysis worksheets list hydrogen hazard considerations and ignition sources that are used as needed. The resulting document can be large and complex. How to handle this complexity from the applied perspective will continue to evolve as improvements are sought.

The relationships among hazards analysis team members are important, as their functions are not identical and sometimes conflict. Design or system advocates may perceive an adversarial environment when design faults are uncovered or new requirements are created. System owners may feel ambivalent toward the analysis process when they realize the cost and schedule. There are sometimes hidden agendas between the designers and system owners, especially when designs may be perceived as flawed or where the analysis is being conducted to determine how a system failed. The effort proceeds by consensus, without which the hazards analysis cannot be completed. It is important to have an experienced, diplomatic team leader who keeps the focus on technical issues.

Technical communication within a group can challenge the process. Current presentation and communications techniques, such as those encountered with the use of overheads and computer projectors, can be restrictive. The technical backgrounds of team members may be sufficiently different that misunderstandings can arise. Large groups can dissemble into separate discussions. Although these facts need to be recognized as necessary elements to the consensus process, those unfamiliar with the pace and apparent “confusion” may be somewhat frustrated. These are not insurmountable problems, but they are a factor in the success of the hazards analysis. An experienced team leader is an essential and vital force that keeps the team focused and moving forward.

4.2 Define the Application

Define the hydrogen application to be analyzed.

4.3 Define Investigation Scope

Define the scope of the investigation.

4.4 Assemble Hydrogen Hazards Analysis Team

When assembling a hydrogen hazards analysis team, consider the particular application to be analyzed and the scope of the investigation. The team shall include, at a minimum, personnel with expertise in mechanical design, materials, ignition and combustion, safety, and component testing (with emphasis on hydrogen systems). Depending on the system, personnel should also be included with expertise in electrical design, cryogenic fluids, and chemistry. The team members should represent the appropriate technologies involved in the analysis and should be familiar and experienced with hydrogen systems. A team leader should be appointed to direct team efforts, and a team member should record deliberations within the report format. Experts in materials and component design should participate as required to develop the information and data needed for the analysis.

4.5 Compile Component/System Information

Compile information on the system and the components in the system, including system configuration, technical specifications, materials involved, operational conditions, and operational procedures. Obtain information and data on each component in the system, such as materials of construction (including soft goods and lubricants), cross-sectional drawings of each component (particularly fluid flow paths and the location of soft goods), and a system fluid schematic. Component cross sections are used to locate and identify all the soft goods. If the cross-sectional view of a component is of poor quality or unclear, an actual disassembled component complete with soft goods is useful. All materials of construction should be identified. The flow path should also be identified, along with all hydrogen-wetted materials. The material data for each component should be tabulated in the Component/System Material Summary Worksheet (Figure 2).

Reasons for compliance or noncompliance with specific code requirements (Appendix A) must be assessed before conducting a hazards analysis on a hydrogen system.

4.6 Identify Operating and Worst-case Conditions

Determine realistic worst-case operating environments and conditions for each component. The data for operating and worst-case conditions should be tabulated in the Operating and Worst-case Environment Summary Worksheet (Figure 3). This information includes minimum and maximum use pressures, temperatures, and flow rates, and is used to evaluate the materials of construction for compatibility with hydrogen and operating conditions. The rate-of-change of operating conditions, such as temperature, shall also be determined. Temperature and pressure are important because a material's hydrogen compatibility is often a function of these two parameters. Also, many material properties are temperature-sensitive. Flow rate is important because it has an affect on such concerns as particle impact and adiabatic compression.

4.7 Assess Hydrogen Hazards

The analysis team begins by reviewing the hazards analysis objectives and methodology. An overview of system design and operation is then presented. The inputs to this are system and component drawings, materials lists, and an FMEA. Operating and worst-case conditions are identified. Component design and function are examined to see if grouping them by failure type, failure effect, or subsystem, can streamline the analysis. The analysis proceeds for each component or subsystem in a given operational mode by identifying the nature of the failure, type of combustible mixture formed, potential ignition mechanisms, and whether fire, deflagration, or detonation can occur. Also considered are design features and administrative controls that may be used. Occurrence probabilities are assessed for each of these categories. The scenario posed by a given failure and the potential resulting combustion processes are evaluated to see what secondary effects may result. Assessing the overall risk to the system or its purpose completes the analysis at this level. The results are summarized and documented in the Hydrogen Hazards Analysis Chart (Figure 4). When necessary, supporting rationale is noted.

To summarize, perform a hydrogen hazard assessment in accordance with the seven basic steps listed below, described in detail in the following sections, and outlined in Figure 1. Tabulate the results of the assessment in the Hydrogen Hazards Analysis Chart.

Step 1 List all system components.
Step 2 Determine if failure of each component is possible.
Step 3 Determine if a combustible mixture can form if the component fails.
Step 4 Determine if an ignition source is present.
Step 5 Determine the probability of consequences such as fire, deflagration, and detonation.
Step 6 Analyze secondary effects.
Step 7 Assess the reaction effects.

Analysis scores are determined by team consensus and are tallied through a qualitative rating scheme. This rating may be based in part on quantitative analysis, but it also relies on experience and intuition. Published sources used in the analysis include: Safety Standard for Hydrogen and Hydrogen Systems (NSS 1740.16); Safety in the Handling of Cvyogenic Fluids (Edeskuty 1996); the Sourcebook for Hydrogen Application (TISEC 1998); Ignition and Thermal Hazards of Selected Aerospace Fluids (Benz 1988); and current combustion literature. The rating scheme, used in the assessment of the first four steps, is based on a qualitative probability rating of 0 through 4. The score, negotiated among team members, is based on their experience. The following probability ratings shall be used in Steps 2 through 5 of the procedure:

0 = Almost Impossible
1 = Remote (tested and shown to be compatible with hydrogen and operating conditions)
2 = Possible
3 = Probable

4 = Highly Probable

The estimates made by assigning one of these probability ratings are quite imprecise and generally subjective, but they do create a basis for evaluating applications by helping to focus on the most important issues.

The results tabulated in each step are read as independent assessments of probability rather than as interrelated. Analysis places the failure of the individual component not only in the context of its function in the subsystem or system but also in its functional environment. This is important for hydrogen, which may leak from one component, accumulate elsewhere, and be subjected to ignition sources and confinement criteria that vary throughout the entire system. When necessary, the interaction among components may be evaluated in a matrix fashion. Analysis may also be driven by fault-level requirements. The final risk assessment given for the reaction effect, Step 7, is not read as a result derived by "multiplying" the probabilities assessed in Steps 2 through 5 of the procedure, but is an assessment of the overall effect on personnel, the system, or its mission, caused by the particular failure mode of the component under consideration.

The analysis proceeds through all the system components. Recommendations are recorded as they become apparent from analysis. During team deliberations the analysis, supporting rationale, and recommendations are recorded into the draft report by the team member acting as recorder. The objective is to have a draft report when the team is finished. After review, a final report is prepared for the system owners. Where needed, the report provides recommendations for testing, component redesign, materials replacement, and the identification of procedural controls. The risks identified in the hazards analysis are then available for review by appropriate upper management review teams.

4.7.1 Step 1

List all components of the hydrogen system being analyzed in column 1 of the Hydrogen Hazards Analysis Chart (Figure 4). The components may be sorted by subsystem.

4.7.2 Step 2

Use the Causes Evaluated Worksheet (Figure 5) to examine each component for the characteristics listed below and consider the complete range of operating environments to which the component will be exposed.

(1) Examine catastrophic and noncatastrophic failure modes.
(2) Ensure suitable materials are used in each component such that they safely perform as expected. The physical and chemical interaction of hydrogen with the materials in each component, the possible operating conditions for each component, and the interaction of hydrogen with the system configuration should be considered.

(3) Evaluate component/system operating conditions. Some conditions are not conducive to an unplanned release of hydrogen or contamination of the hydrogen system/equipment with an oxidizer (air, for example).
(4) Confirm that design features of the component/system are adequate to prevent an unplanned release of hydrogen or contamination of the hydrogen systedequipment with an oxidizer (air, for example).
(5) Determine if control features/functions are adequate such that the system will safely operate.

Determine at the start if any of the causes given in Figure 5 can be eliminated, or if there are other causes that should be added.

Appendix B contains a discussion of relevant failure modes, applicable material properties, component/system operating considerations, design features, and control functions applicable for the Causes Evaluated Worksheet (Figure 5).

Transfer a summary of the results from the Causes Evaluated Worksheet to columns 2 through 4 of the Hazards Analysis Chart. If needed, replace "Other" in column 4 with a specific failure mode and add additional columns as needed to identify specific failure modes that are considered essential to the hazards analysis.

4.7.3 Step 3

Evaluate each component to determine if a failure (as determined in Step 2) will allow a combustible mixture to form, and enter the results in columns 5 through 8 of the Hazards Analysis Chart. The complete range of operating environments to which the component will be exposed must be considered.

In hydrogen systems, combustible mixtures are typically formed as a result of hydrogen leaking into an air environment (external leakage); air leaking into a hydrogenenvironment (in leakage); or hydrogen (or oxidizer) leaking from one part of a hydrogen system into another part. Material failures are a predominant source of external or internal leakage, but all failure modes described in Step 2 should be considered.

If needed, replace "Other" in column 8 with a specific event that could lead to the formation of a combustible mixture. Add additional columns as needed to identify specific events that could lead to the formation of a combustible mixture. This is essential in the hazards analysis.

4.7.4 Step 4

Next, use the Ignition Sources Worksheet (Figure 6) to do an ignition mechanism survey. Possible ignition sources must be evaluated for each component for which a failure mode is identified and for which a combustible mixture is possible. The objective of this assessment is to determine if there is an ignition source present within the extent of a combustible mixture and if that ignition source could ignite the mixture that was

produced by the failure of a component. A discussion of potential ignition sources applicable for using the Ignition Sources Worksheet is given in Appendix C.

Enter the ignition sources survey results into columns 9 through 12 of the Hazards Analysis Chart. The amount of energy involved in an ignition source should be considered because this is an important factor in determining if a detonation is possible.

If needed, replace "Other" in column 12 with an ignition source specific to the system being assessed that could ignite a combustible mixture. Insert additional columns as needed to identify specific ignition sources that are essential to the hazards analysis.

4.7.5 Step 5

The probability of consequences such as fire, deflagration, and detonation must be assessed and the results entered into columns 13 through 16 of the Hazards Analysis Chart.

System characteristics such as volume and turbulence shall be considered in this step. Some specific concerns include:

- Can a combustible mixture accumulate in a confined space?
- If so, how large is the confined area?
- Is the area sufficiently large that a detonation could occur (that is, is there sufficient volume for the cells)?
- Are there obstacles within the volume such that a flame would experience turbulence?

If needed, replace "Other" in column 16 with a specific consequence that could occur, and add additional columns as needed to identify other specific consequences that could occur that are essential to the hazards analysis.

4.7.6 Step 6

After the failure modes and their consequences have been surveyed, secondary effects are assessed. This assessment addresses the effects of failures that may create a hazard in a nearby component. For example, liquid air could drip from an uninsulated cold surface onto a brittle surface material at low temperature. Or liquid air could drip onto a material, such as asphalt, and create an explosive mixture.

Use the Secondary Effects Worksheet (Figure 7) to evaluate the probability of the failure of one component having an effect on another component, subsystem, or region, and enter the results in column 17 of the Hazards Analysis Chart.

Use the following ratings for the secondary effects analysis:

R = further analysis of affected components required
N = no further analysis needed.

4.7.7 Step 7

Next, a reaction effects assessment is performed and documented. This is an assessment of the effects if a component fails (that is, consider that the component does fail and assess what the results would be, regardless of the probability of it failing). This is useful for making a judgment on the safe use of a component. The reaction effects assessment would then help determine if the component may be safely used. The results of the reaction effects assessment should be entered into column 18 of the Hazards Analysis Chart.

The ratings given in Table 1 are used for the reaction effects assessment.

4.8 Hydrogen Hazard Assessment Report

The most benefit from a hydrogen hazards analysis is realized if the effort is properly documented from the beginning of the process. The report should include the following information:

- Description of the system/equipment analyzed.
- List of the team members and others who participated in the effort.
- List of any assumptions that were made.
- List of the standards and sources of information used.
- Discussion of each step in the analysis procedure.
- Description of the results of the analysis process.
- Cross-sectional view of each component.
- System fluid schematic.
- Statement of any uncertainties, unknowns, concerns, limitations, stipulations of use, and any additional safety precautions.
- The recommendations and suggestions from the analysis, including any recommendations for further testing.
- The completed Hazards Analysis Chart and all of the worksheets used in the analysis.

5.0 Closing

This procedure can be applied to the design and operation of hydrogen systems, and much can be learned from this process that could ultimately improve the public perception of hydrogen safety. Lessons to be learned include: how to better conduct the analysis, how to apply engineering judgment with limited combustion data, how to

handle the effects of system complexity, and how to recognize and diffuse potentially divisive team roles.

A hazards analysis, as described herein, provides design teams with a better understanding of their systems and gives system owners better knowledge of the risks and improved confidence in the system. System owners and design teams are much better prepared for higher-level reviews; in fact, analysis results may be directly transferred as preparation for subsequent reviews. Higher-level review teams appreciate and respect the rigor of this procedure.

Resource requirements to conduct a hazards analysis using this procedure depend on system complexity. Current experience suggests that a single component requires approximately one day, but systems and facilities can take anywhere from a week to a month, depending on complexity. Complex systems require thorough advance preparation to keep the work group focused and working effectively.

This guide conveys a flexible approach that can be applied to a variety of hydrogen systems at different levels, such as those described below:

- Component level: valves, instrumentation, connectors, and tanks.
- System level: fuel cells, electrolyzers, thrusters, storage systems, and transfer systems.
- Facility level: test, storage, and dispensing facilities and remote or auxiliary power systems.

This approach can be directly applied by industry to aid in the development of commercial and transportation hydrogen technologies. Hazards analysis results can be used to help prove code compliance and to ensure that liability issues have been addressed. This hydrogen hazards analysis may eventually become accepted as state of the art in liability cases. Further, it is suggested that development of a general hydrogen hazards analysis protocol be managed through a voluntary standards organization for ultimate use in the evaluation and certification of commercial hydrogen systems.

The use of this guide to conduct hazards analyses of various hydrogen systems has shown the need for data that are not available, especially combustion and hydrogen embrittlement data. Specific inadequacies of basic combustion data have been identified, and more detailed ignition energy data are needed. Flammability limits vary with mixture composition, diluent presence, total pressure, and ignition source energy. While basic data exist for ambient conditions, more information is needed for hydrogen-oxygen-water and hydrogen-air-water mixtures at low and elevated pressures. Information is needed to evaluate electrolyzers in which failure modes could lead to hydrogen-oxygen-water vapor mixtures entrained in a two-phase bubbly-flow at pressures 2 to 3 times ambient temperature and pressure. Corresponding data are also needed to evaluate detonation initiation. Finally, basic microgravity combustion data are needed for the aerospace community.

Strategy is involved in completing those hazards analyses where incomplete combustion data or system familiarity challenge team members. Some examples are described below.

- Attempt to bracket effects within regions or by thresholds discernible in the combustion data. Ignition sources may be considered in three energy regions: spurious static discharges (<1 J); those arising from an active device present in the system (10s to 100s of J); or explosive discharges (>l000 J). A sample consideration might be whether pressure limits preclude worry over spurious or spontaneous ignition. Our present understanding is that mixtures at sufficiently low pressure will not be ignited by weak ignition sources.

- Attempt to identify "work-around logic." Two simple examples are.

    - Specific ignition data are not available, but system design and operation at low pressure ensure there is no ignition source present.
    - If the mixture composition is unknown, be conservative and assume it to be stoichiometric.

- In general, be conservative. For hydrogen, always assume some ignition mechanism is present.

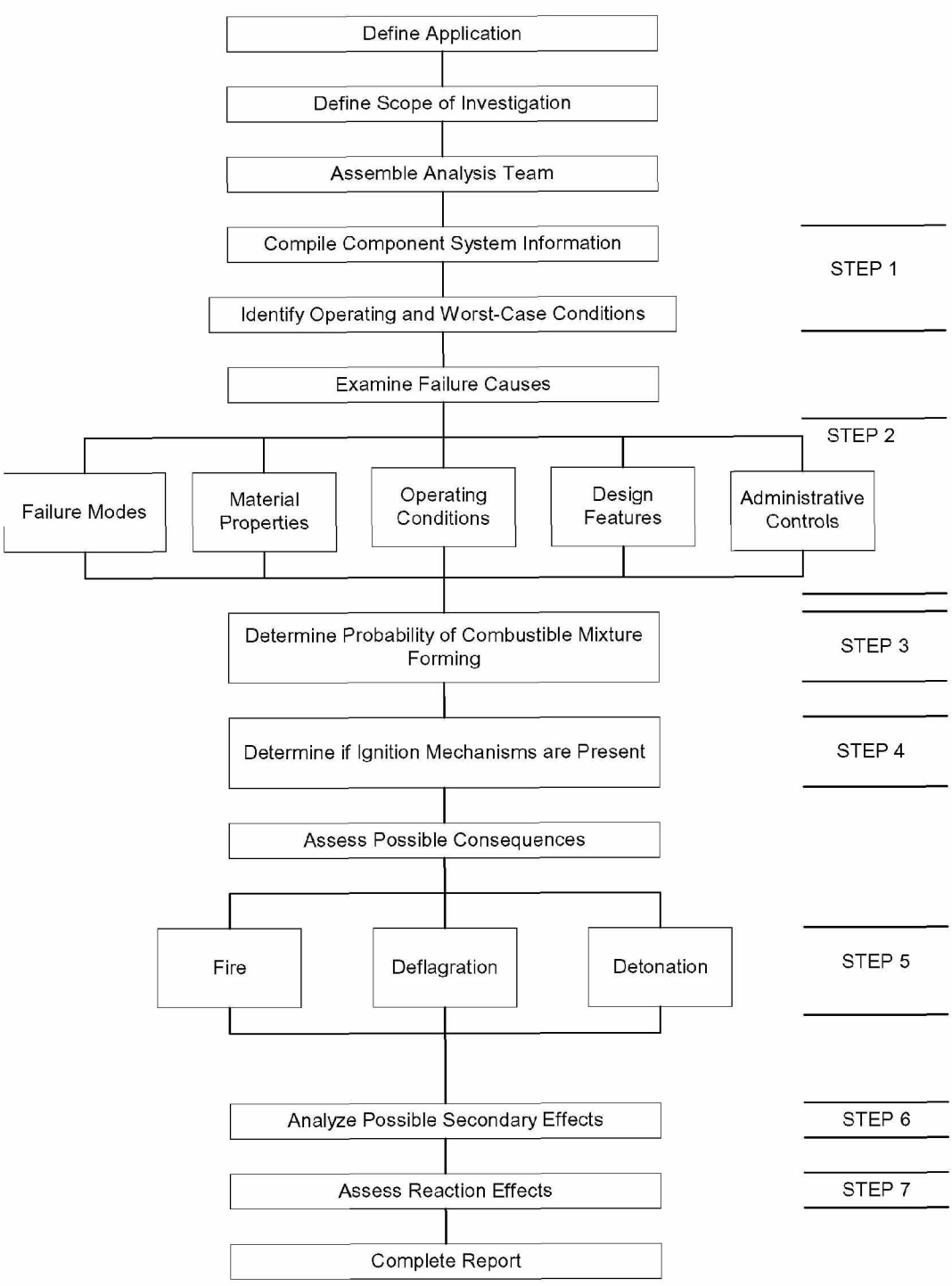

Figure 1
Procedure for Hydrogen Hazards Analysis

	Materials			
Component	Metals	Soft Goods	Lubricants	Other
Component A				
Component B				
Component C				
Component D				
⇓				
Component N				

Figure 2
Component/System Material Summary Worksheet

	Operating Environment					Worst-Case Conditions				
Component	Temperature Range	Pressure Range	Shock & Vibration	Flow Regime	Other	Temperature Range	Pressure Range	Shock & Vibration	Flow Regime	Other
Component A										
Component B										
Component C										
Component D										
⇓										
Component N										

Figure 3
Operating and Worst-Case Environment Summary Worksheet

STEP 1	STEP 2				STEP 3					STEP 4					STEP 5					STEP 6		STEP 7	
1	2	3	4		5	6	7	8		9	10	11	12		13	14	15	16		17		18	
	Probability of Failure in These Modes				Probability of Combustible Mixture From These Events					Probability of Ignition From These Sources					Probability of These Consequences								
Component	Noncatastrophic	Catastrophic	Other		External Leakage	In leakage	Contamination	Other		Electrical	Mechanical	Thermal	Other		Fire	Deflagration	Detonation	Other		Secondary Effect		Reaction Effect	
SUBSYSTEM 1																							
Component 1																							
Component 2																							
Component 3																							
SUBSYSTEM 2																							
Component 5																							
Component 6																							
Component 7																							
SUBSYSTEM 3																							
Component 8																							
Component 9																							

Probability Rating
0 = Almost Impossible
1 = Remote
2 = Possible
3 = Probable
4 = Highly Probable

Secondary Effect
R = Analysis of Affected Components Required
N = No Further Analysis Required

Reaction Effect
A = Negligible
B = Marginal
C = Critical
D = Catastrophic

Figure 4
Hydrogen Hazards Analysis Chart

Component: _____

Causes Considered		Probability That Cause Is Present	Probability of Noncatastrophic Event				Probability of Catastrophic Event				
			Leak Externally	In leakage	Contamination	Other	Rupture	BLEVE	Liquid Lockup	Overpressurization	Other
Material Properties	Hydrogen Embrittlement										
	Diffusion/Permeation										
	Chemical Reaction										
	Temperature Compatibility										
	Expansion/Contraction										
	Ortho-Para Conversion										
	Other										
Operating Conditions	Adiabatic Compression										
	Particle Impact										
	Mechanical Stress/Vibration										
	Flow Regime										
	Deformation										
	Resonance										
	Thermal Acoustic Oscillation										
	Other										
Design Features	Venting										
	Ventilation										
	Shock/Vibration										
	Dewar Ullage										
	Fail-Safe Design										
	Boiloff										
	Pressure Control										
	Condensation										
	Contamination Concentration										
	Purge										
	Quantity										
	Hydrogen Detection										
	Fire Detection										
	Instrumentation										
	Controls (hardware)										
	Controls (software)										
	Other										
Administrative Considerations	Operating Procedures										
	Checklists										
	Emergency Procedures										
	Training Plan										
	Maintenance Plan										
	Other										
Other											

Figure 5
Causes Evaluated Worksheet

Component N	⇓	Component D	Component C	Component B	Component A	Components	
						Static Discharge	Electrical
						Electrical Arc	
						Charge Accumulation	
						Electrical Short Circuits, Sparks, and Arcs	
						Static Electricity (two-phase flow)	
						Static Electricity (flow with solid particles)	
						Lightning	
						Electrical Charge Generated by Equipment	
						Other	
						Mechanical Impact	Mechanical
						Tensile Rupture	
						Friction and Galling	
						Mechanical Vibration	
						Metal Fracture	
						Other	
						Open Flames	Thermal
						Hot Surfaces	
						Personnel Smoking	
						Welding	
						Exhaust from Thermal Combustion Engine	
						Explosive Charges	
						Resonance Ignition	
						Heating by High-Velocity Jets	
						Shock Waves from Tank Rupture	
						Fragments from Bursting Vessels	
						Other	
							Other

Figure 6
Ignition Sources Worksheet

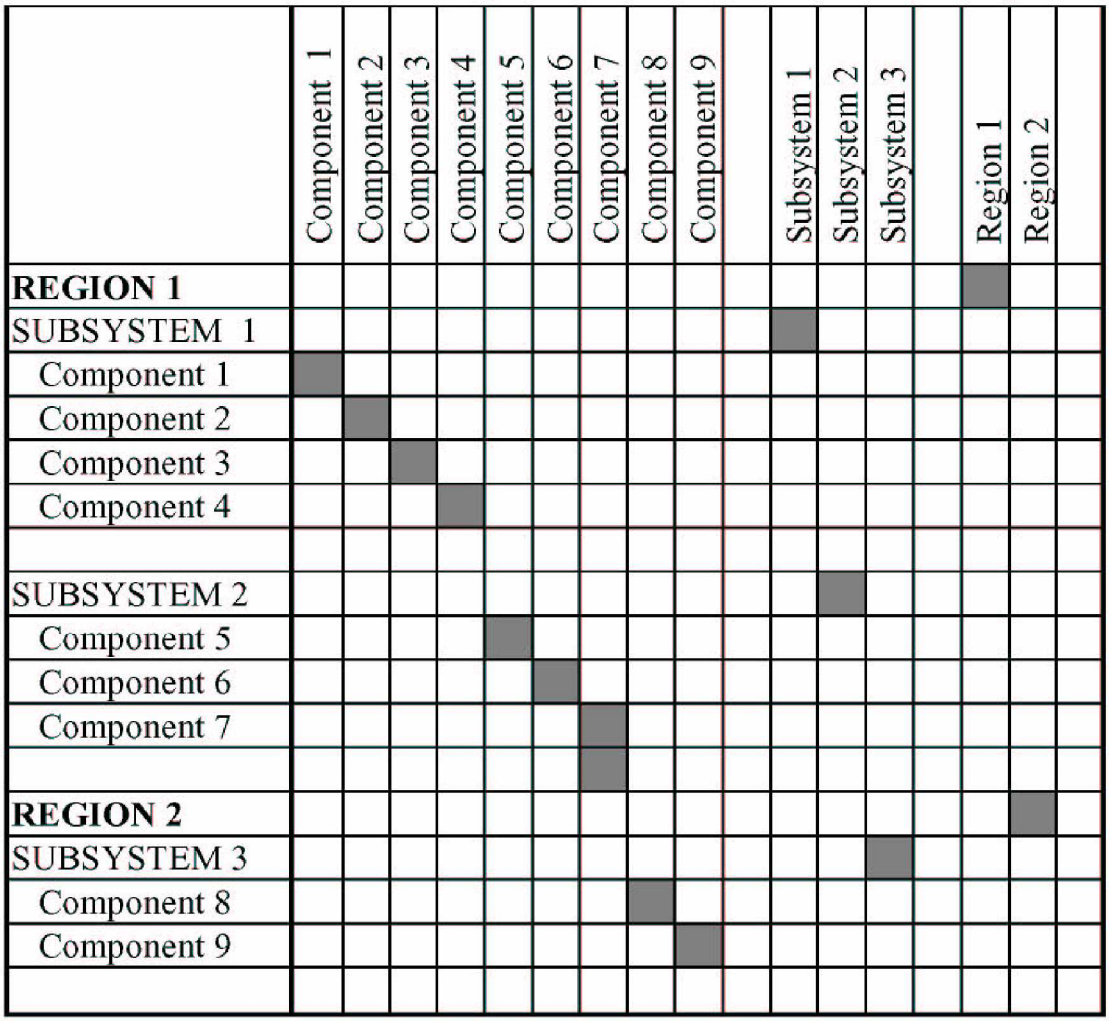

Figure 7
Secondary Effects Worksheet

Table 1
Reaction Effect Assessment Rating and Criteria

Rating		Element Affected		
Code	Severity Level	Equipment	Mission/Objective	Personnel
A	Negligible	No unacceptable damage.	No unacceptable effect.	No injury.
B	Marginal	No more than one component or subsystem damaged. This condition is either repairable or replaceable on- site within an acceptable time.	Mission/Objective can be accomplished by using available redundant operational options.	Personnel-injuring factors can be controlled by automatic devices, warning devices, or special operating procedures.
C	Critical	Two or more major subsystems damaged. Extensive repairs required.	Seriously impaired.	Personnel injured by: (1) operating the system; (2) maintaining the system; or, (3) being in the vicinity of the system.
D	Catastrophic	Total loss. No part of system can be salvaged.	Lost.	Multiple injuries or loss of life.

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Appendix A

Code Requirements for Hydrogen Systems

5 1910.103 Hydrogen (Source: Code of Federal Regulations, Title 29 - Labor, Parts 1900 to 1910, U.S. Government Printing Office, Washington, 1993)

ACTION	REQUIREMENT
	(a) General (1) Definitions (i) Gaseous hydrogen system (ii) Approved (iii) Listed (iv) ASME (v) DOT Specifications (vi) DOT regulations (2) Scope (i) Gaseous hydrogen systems (*a)* facilities applied to (*b*) facilities not applied to (ii) Liquefied hydrogen systems (*a*) facilities applied to (*b*) facilities not applied to
	(b) Gaseous hydrogen systems (1) Design (i) Containers (*a*) compliance requirements (*1)* ASME Boiler and Pressure Vessel Code (*2)* DOT Specifications and Regulations (*b)* supports for permanently installed containers (*c*) marking of portable container and manifolded supply unit (ii) Safety relief devices (*a*) as required by ASME BPVC or DOT Specifications and Regulations (*b*) arrangement of discharge (*c*) protection from frozen moisture) (iii) Piping, tubing, and fittings (*a*) suitable for hydrogen service, and temperature and pressure involved (*b*) conform to Section 2— "Industrial Gas and Air Piping" —Code for Pressure Piping, ANSI B31.1-1967 with addenda B31.1-1969 (*c*) acceptable joints, gaskets, and thread sealants (iv) Equipment assembly (*a*) components must be suitable for hydrogen service (*b*) supervision of installation (*c*) accessibility and protection of storage containers, piping, valves, regulating equipment and other accessories (*d*) ventilation of cabinets and housings containing hydrogen control or operating equipment (*e*) secure mobile unit to prevent movement (*f*) electrical bonding of mobile supply units (v) Marking of hydrogen storage location

ACTION	REQUIREMENT
	(vi) Testing for gas tight at maximum operating pressure (2) Location (i) General (*a*) accessible to delivery equipment and to authorized personnel (*b*) shall be located above ground (*c*) shall not be located beneath electrical power lines (*d*) shall not be located close to flammable gas or liquid piping (*e*) location and dikes for storage near flammable liquid storage (ii) Specific requirements (*a*) order of preference for location (*b*) minimum separation distance to specified outdoor exposure (*c*) effect of fire wall on separation distance (*d*) location of systems of less than 3,000 CF (3) Design considerations at specific locations (i) Outdoor locations (*a*) noncombustible materials of construction for protective walls or roofs (*b*) ventilation where enclosing sides adjoin (*c*) electrical equipment within 15 ft (ii) Separate buildings (*a*) construction (*b*) ventilation to outdoors (*c*) explosion venting (*d*) elimination of ignition sources (*e*) electrical equipment for Class I, Division 2 locations (*f*) heating (iii) Special rooms (*a*) construction (*b*) ventilation to outdoors (*c*) explosion venting (*d*) elimination of ignition sources (*e*) electrical equipment for Class I, Division 2 locations (*f*) heating (4) Operating instructions (5) Maintenance
	(c) Liquefied hydrogen systems (1) Design (i) Containers (*a*) comply with ASME BPVC or API 620 (*b*) portable containers in accordance with DOT Specifications and Regulations (ii) Supports for permanently installed containers (iii) Marking of containers (iv) Safety relief devices (*a*) stationary and portable containers (*1*) stationary containers

ACTION	REQUIREMENT
	(*2*) portable containers (*b*) arrangement of discharge (*c*) protection from frozen moisture (*d*) protection of trapped volume between closures (v) Piping, tubing, and fittings (*a*) suitable for hydrogen service, pressures and temperatures involved, and thermal expansion and contraction (*b*) for GH_2 above -20 °F: conform to Section 2— "Industrial Gas and Air Piping" — Code for Pressure Piping, ANSI B31.1-1967 with addenda B31.1-1969; for GH_2 below -20 °F and for LH_2: conform to Petroleum Refinery Piping ANSI B31.3-1966 or Refrigeration Piping ANSI B31.5-1966 with addenda B31.5a-1968 (*c*) preferable joints (*d*) insulation of cold surfaces (*e*) surfaces beneath uninsulated cold surfaces dripping liquid air (vi) Equipment assembly (*a*) components must be suitable for LH_2 service and for pressures and temperatures involved (*b*) supervision of installation (*c*) accessibility and protection of storage containers, piping, valves, regulating equipment and other accessories; shutoff valve located in liquid product withdrawal lines (*d*) ventilation of cabinets and housings containing hydrogen control equipment (vii) Testing (*a*) testing for gas-tight at operating pressure and temperature after installation (*b*) inspection and testing of containers out of service more than 1 year (viii) Liquefied hydrogen vaporizers (*a*) anchors and flexibility (*b*) relief valve protection (*c*) heat source (*d*) low temperature shutoff switch (ix) Electrical systems (*a*) Class I, Group B, Division 1 within 3 ft of point where connections regularly made and disconnected (*b*) Class I, Group B, Division 2 within 25 ft of point where connections regularly made and disconnected or within 25 ft of a LH_2 storage container; alternatives when equipment for Class I, Group B atmospheres not commercially available (x) Bonding and grounding (2) Location of LH_2 storage containers (i) General requirements (*a*) accessible to mobile supply equipment at ground level and to authorized personnel (*b*) exposure to electrical power lines, flammable gas and liquid lines, or

ACTION	REQUIREMENT
	lines carrying oxidizing materials (*c*) locate on ground higher than nearby above-ground flammable liquid storage or LOX storage (*d*) diking, diversion curbs, grading (*e*) fencing, posting, and placarding of storage sites (*f*) outdoor venting of safety relief devices for LH_2 located indoors (ii) Specific requirements (*a*) order of preference for location (*b*) minimum separation distance to specified exposure (iii) Handling of LH_2 inside buildings other than separate buildings and special rooms (3) Design considerations at specific locations (i) Outdoor locations (*a*) meaning; includes weather shelter or canopy (*b*) materials for surfaces beneath LH_2 lines from which liquid air can drip (*c*) construction of protective walls (*d*) electrical wiring and equipment compliance (*e*) lighting (ii) Separate buildings (*a*) construction (*b*) ventilation to outdoors (*c*) elimination of sources of ignition (*d*) electrical wiring and equipment compliance (*e*) heating (iii) Special rooms (*a*) construction (*b*) ventilation to outdoors (*c*) explosion venting (*d*) elimination of sources of ignition (*e*) electrical wiring and equipment compliance (*f*) heating (4) Operating instructions (i) Written instructions (ii) Attendant (iii) Security (iv) Grounding (5) Maintenance

Appendix B

Causes

A discussion of relevant failure modes, applicable material properties, component/system operating considerations, design features, and control functions applicable for using the Causes Evaluated Worksheet (Figure 5) is given in this Appendix.

Failure Modes

Catastrophic failure modes include events with an accompanying rapid release of hydrogen (perhaps a large quantity) and/or fragments from the system, such as:

- rupture
- boiling liquid expanding vapor explosion (BLEVE)
- liquid lockup
- overpressurization

Noncatastrophic failure modes include events that involve a slow release of hydrogen in which the quantity could be small. This could be the result of the use of unsuitable materials, or an incompatibility in material properties, for the operating environment.

Material Properties

Properties of the component materials to be considered include the following:

Hydrogen Embrittlement. Evaluate the materials of each component for hydrogen embrittlement for all possible operating conditions, such as temperature, pressure, exposure time, stress state, and hydrogen purity. Some materials are more susceptible to hydrogen embrittlement than others, and some operating conditions promote hydrogen embrittlement more than others.

Diffusion/Permeation. Hydrogen can diffuse through solid materials, especially some plastics. Hydrogen can diffuse through some metals at elevated temperatures, high pressure, or under an electrolytic driving force.

Chemical Reaction. Hydrogen can form hydrides with many materials. This process generates heat and can change material properties.

Temperature Compatibility. The low- and/or high-temperature compatibility/suitability of the materials for all components operating in an extreme temperature environment must be established.

Ductility. Verify whether a ductile-to-brittle transition occurs.

Thermal Expansion/Contraction. Establish that appropriate provisions for dimensional changes exist over the greatest temperature span that the material will experience.

Thermal Gradients. Dimensional changes vary from one material to another and this must not create a failure during cool-down and/or warm-up.

Expansion/Contraction. This may occur in a phase change (liquid to gas, for example).

Ortho-Para Conversion. This will add heat to the system, which could increase vent rate or pressure buildup.

Operating Conditions

Some operating conditions to be considered include the following:

Adiabatic Compression. A quantity of any gas can generate a considerable amount of heat if rapidly compressed. This heat can cause distortion, or even melting, of polymers; and ignition of oxidizing contaminants such as air. Example: a downstream valve or flexible hose with a polymer liner in a dead-ended high-pressure hydrogen system.

Particle Impact. Solid oxidizer particles such as sand, air, and oxygen in LH, impinging on materials may cause seat erosion or ignition in valves.

Mechanical Stress or Vibration Internal to System Flow. Materials that are poor heat conductors, such as plastics, can reach their ignition temperature, causing them to soften and leak, when stressed or vibrated. Example: unanchored joints that protrude inside piping.

Flow Regime. Stratified flow during cool-down; pressure and flow oscillations.

Deformation. Changes from ambient to operating temperature can result in significant material changes in dimension, tolerance, and shape. This effect will be greater for some materials than others (metals vs. plastics, for example). The effect of thermal expansion/contraction in all components must be evaluated to determine if this condition could result in leakage (internally through a component such as a valve, or externally). Compatibility of dissimilar materials must be established. Example: stainless steel valve body with a plastic seat.

Resonance. Acoustic oscillations within resonant cavities can cause a rapid gas temperature rise. The rise is more rapid and achieves higher values when particles are present. Ignition is not a concern in the absence of an oxidizer, but heat-distortion and/or melting of plastics is of concern.

Thermal Acoustic Oscillation.

Design and System Features

Design and system features that should be evaluated include the following:

- Evaluate the design features for venting hydrogen that reduce or eliminate the possibility of an unplanned ignition (sonic velocity at exit, backflow of air).

- Check ventilation (keep hydrogen-aidoxygen mixtures below LFL; keep hydrogen from
- accumulating in a confined space).

- Evaluate the design features for protection of the equipmenthystem from shock and vibration environments that could result in leakage. Stationary equipmenthystems could be subjected to loading from an earthquake, for example. Mobile equipmenthystems could be subjected to a variety of shock and vibration loads from roads (ground transportation), air turbulence (air transportation), and vibration from motors and engines.

- Protect component/system from external damage (wrench dropped onto a component, for
- example).

- Dewar ullage (prevent overfilling of dewar).

- Check that failure of 2 components must occur to produce a hazardous situation.

- Determine if there is adequate instrumentation for proper operatiodsafe conditions.

- Check joints of redundant components (especially safety components).

- Boiloff.

- Check pressure control (liquid-to-gas conversion; thermal expansion; regulator failure).

- Check condensation [internal, exterior (on cold surfaces)].

- Check contamination concentration (air particles in filter in LH, system, sand particles, iron filings, weld slag, and soft good particles).

- Purge hydrogen and air from system.

- Minimize quantity stored and handled to minimize consequences of a hazard.

- Hydrogen detection.

- Fire detection.

Administrative controls to mitigate or reduce hazards that should be evaluated include the following:

- Approved operating procedures/checklists/emergency procedures.
- Training plan.
- Maintenance plan.

Appendix C

Potential Ignition Sources

A discussion of relevant ignition mechanisms applicable for using the Ignition Sources Worksheet (Figure 6) is given in this Appendix. Such ignition sources should be eliminated wherever possible. It is generally assumed that an ignition source will be present.

Some potential ignition sources that should be evaluated are described below.

Electrical Sources

- Static discharge - Discharges of static electricity can produce high temperatures, often sufficient to cause a material to reach its ignition temperature. Example: the accumulation of electrostatic charges created by the friction of dry hydrogen flowing over, or through, nonmetals.

- Electrical arc - Electrical arcs can provide the energy to ignite a combustible mixture of hydrogen and air/oxygen.

- Charge accumulation - Electrical charge buildup is a function of electrical conductivity and dielectric strength parameters. Whether electrical charge buildup is a problem is a function of the relative rates of charge accumulation and charge dissipation within the flowing fluid. Electrical charge buildup is very small for flowing hydrogen, including liquid hydrogen, but solid particles in the flow could greatly increase its buildup. The type of particle (oxygen, nitrogen, hydrogen, sand, metal) could be important. Buildup of electrical charge could cause a spark that could result in an ignition of a combustible mixture of hydrogen and air/oxygen.

- Electrical short circuits, sparks, and arcs.

- Static electricity (two-phase flow).

- Static electricity (flow with solid particles).

- Lightning.

- Electrical charge generated by equipment operation.

Mechanical Sources

- Mechanical impact.

- Friction and galling.

- Metal fracture.

- Tensile rupture.
- Mechanical vibration.

Thermal Sources

- Open flames.
- Hot surfaces.
- Personnel smoking.
- Welding.
- Exhaust from thermal combustion engine.
- Explosive charges.
- Resonance ignition (repeated shock waves in a flow system).
- Heating by high-velocity jets.
- Shock waves from tank rupture.
- Fragments from bursting vessels.

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13. ABSTRACT *(Maximum 200 words)*

The physical and combustion properties of hydrogen give rise to hazards that one must consider when designing and operating a hydrogen system. One of the major concerns is fire or detonation because of hydrogen's wide flammability range, low ignition energy, and flame speed. Other concerns include contact and interaction with materials, such as the hydrogen embrittlement of materials and the formation of hydrogen hydrides. The low temperature of liquid and slush hydrogen bring other concerns related to material compatibility and pressure control; this is especially important when dissimilar, adjoining materials are involved. The potential hazards arising from these properties and design features necessitate a proper hydrogen hazards analysis before introducing a material, component, or system into hydrogen service. The objective of this guide is to describe the NASA Johnson Space Center White Sands Test Facility hydrogen hazards analysis method one should perform before hydrogen is used in components and/or systems. The method is consistent with standard practices for analyzing hazards. It is recommended that this analysis be made before implementing a hydrogen component qualification procedure. A hydrogen hazards analysis is a useful tool for hydrogen-system designers, system and safety engineers, and facility managers. A hydrogen hazards analysis can identify problem areas before hydrogen is introduced into a system—preventing damage to hardware, delay or loss of mission or objective, and possible injury or loss of life. This guide is based on information from the NASA Safety Standard for Hydrogen and Hydrogen Systems (NSS 1740.16) and experience derived from the development of a similar protocol for oxygen system hazards analysis. It was previously published as TP-WSTF-937

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