



STUDENT MANUAL
STRUCTURAL COLLAPSE TECHNICIAN COURSE
MODULE 1D

UNIT 1: RESCUE TOOL SYSTEM APPLICATION & ASSESSMENT

UNIT 2: RESCUE TOOL SYSTEM OPERATING PRINCIPLES & MAINTENANCE

UNIT 3: RESCUE TOOL LAB FIELD LECTURE & TROUBLESHOOTING

Practical/Instruction Time 4 Hours

Materials Tools for Demonstration

Unit Objective At the conclusion of this section, the Student shall demonstrate proficiency in the inspection of, operation of, maintenance of and the safe use of all power tools.

Enabling Objectives You will:

- Understand the operator’s influence on tool performance
- Understand Electrical power sources, the electrical loads, and tool safety
- Understand the tool assessment criteria
- Be able to perform a pre-use inspection of all gas, fuel, pneumatic, hydraulic, and electric power tool systems



UNIT: 1 RESCUE TOOL SYSTEM APPLICATION & ASSESSMENT

Systems Approach to Tool Selection and Operation

Generally in the fire service we do not use complicated tool systems or if one is used it is either per-connected or stored as a “system” and easy to deploy. In the Federal USAR system we don’t have that luxury. Our tools are stored in small boxes that only allow parts of a tool system to fit, then placed on 2 semis, transported to an unknown location, and stacked for possible use. This system of deployment does not make for quick or easy tool acquisition or deployment, but it is the system that we must live with.

Imagine if the pre-connected hose on your pumper was broken down into the following parts, nozzle, hose, washers, outlet valve, pump, water tank, intake valve, supply hose, hydrant adapter and hydrant wrench and then all stored in separate boxes that were mixed in with 200+ other boxes. It would take a lot of thought and preparation to bring that system together. That is the system we live with.

The Rescue Technician must know and think in these terms. They cannot rely on the logistics team members to provide a complete tool system when requested. There are just too many items in the cache for logistics to remember every complete tool system that could be requested by search, planning, rescue, hazmat, rigging, or any one else on the team. You will be using the tool system and you are responsible to make sure it is all there when you leave the Boo. Many times the rescue site will be miles from the tool cache and a missing part can place the whole operation in jeopardy and make the difference between a rescue or recovery.

Let’s look at all the parts needed for a Stanley DS11 Concrete Chain Saw operation to place hole in slab for entry.

Stanley power unit, unleaded gasoline, motor oil, hydraulic hose (3/4 & 1/2), DS11 chain saw, spare chain, wrench (chain changing), screwdriver (chain tensioning), garden hose, water pressure booster pump (depending on chain and water pressure), 1 1/2” to garden hose adapter, fire hose 1 1/2” (bring water from remote source), hydrant adapter 2 1/2” to 1 1/2” , possible adapter from local standard to NST carried by task force, hydrant wrench.

That is one complete system for the cutting operation. Many of those parts are carried in separate boxes and no part is more important than the next. You can set up the whole system but nothing can happen if you are missing the 1 1/2” to garden hose adapter. It seems like a small part but the whole rescue operation waits while it is requested, picked up and brought to the scene. Depending on the situation at hand that could take hours. Think about being delivered by helicopter to a remote rescue location and you may never get it.

These tools or parts must be identified on the cache list to find box number, the box must be located among the 200+ others at the Boo, they must be opened and tools/parts collected and delivered to rescue site. One problem with just identifying the needed boxes and taking them is that they may have parts from another tool system inside and removing them from the Boo could place that tool system in jeopardy of missing some items.

Now think about the system and tools that will be needed to control and lift out that slab of concrete once you have cut it out with your saw. Imaging that this whole evolution is happening at night and the tool system needed to provide power for lights and electric tools.



RESCUE TOOL SYSTEM APPLICATION & ASSESSMENT

Rescue Tool System Application

The goal is to assemble, operate, and maintain rescue systems to efficiently extricate victims. Inability to do this will; result in further pain and suffering for the trapped victim. The professional rescuer needs to be proficient and capable of quickly determining the proper application and safe operation our rescue tool systems.

When your “*Rescue System*” is not working typically there will only be one thing wrong. Most trouble shooting analysis operates from this premise. The most efficient way to trace the problem will be to start at one end (usually the power source) and work toward the tool, inspecting/isolating/testing each component. It’s usually something simple. This way even if there are multiple problems you are likely to find them. Resist starting in the middle of your system, this will often result in you going back and forth looking for the problem, and if there are multiple problems you will quickly be frustrated not to mention that the rescue process will be losing irreplaceable time.

Experience has taught us that many times the issue is one of application or operation. We must choose the right tool for job, or when forced to use an alternative tool/system, know its limitations. Sometimes this is dictated by environment or proximity to the victim, excessive noise produced by a pneumatic breaker may aggravate the situation. If you need to cut steel but have a concern about heat transfer you may need a colder cutting technique than a torch, i.e. a reciprocating saw or electric rebar cutter. Working in confined spaces often limits what kind of tools we can use. Inherent system inefficiencies such as friction loss can limit our tool operation (Stanley Tool ½ hose), or even work place regulations like the 300 hundred feet OSHA limit on SABA lines. When operating gas engines plan for, and predict the accumulation of carbon monoxide, always monitor the atmosphere.

Therefore within these confines we apply our tools and techniques. Some basic operating principles can help maintain an efficient rescue operation.

1. Know the cache.

Do not become overly dependent on others knowing where and how your tools are stored. Many of our systems can be useless without a single adapter or other seemingly minor component. Assure that when leaving the BoO you have an adequate size up of what you are to do, know where the boxes are, and what is in them. A couple of minutes verifying the inventory, and in service status will save time once deployed to the field and then find out (for example) the extension cords are in a separate box. Think “*Systems*” know that when you finish the floor breach, ropes/ladders may be needed to make entry. Anticipate tool packages and have them staged for use, stay ahead of the rescue operation.



Rescue Tool System Application

2. Proper application and operation of tool systems.

As an example; our diamond saws/cores will not cut cured, engineered concrete at the same rate some of us may be used to with the “training” concrete often used in SCT classes. Blades, bits, torches, cores etc. have specific applications; make sure you have matched the tool system to the work piece.

Speed/Feed Rate of Tool

A good rule of thumb when running a saw, drill, or jack, either electric, hydraulic, or gas powered, is to not load, or apply so much pressure on the tool to slow the RPM’s down more than 15% of full speed. Keep the saw cutting at full speed. Keep in mind that you will run into situations that will require full speed all the time, or for you to start off in a slower speed to begin the cut and then increase RPM’s. If the operator of the tool is pressing too hard and slowing the tool down too much, typically the motor/pumps, and saw blades will overheat, further compromising performance. If the tool can not cut “fast” enough, assess if you are using the right tool/bit/blade or get multiple tools in operation. By maintaining 80% to 90% of full speed RPM or BPM the tool/bit will cut/grind as efficient as it can. Heat, one of the by products of our systems must be controlled. Overheating the working ends of our drills and saw bits can cause irreparable damage. Diamond segments (grinding) will mushroom, cutting edges will round off, and motor insulation will break down.

Some techniques to keep your blades/bits cool:

- A. Ensure adequate lubrication, water or oil
 - B. If dry cutting, pull tool blade/bit out of cut every 10 to 20 seconds to run in ambient air to cool.
 - C. Make sure a properly dressed/sharp bit/blade is in the power tool.
 - D. If the motor is too hot to touch you may need to switch it out, or change tool systems.
3. Anticipate long term operations and plan for replacement of consumables.
 4. Keep conductors of energy as short as possible, air hoses, electric extension cords, and hydraulic lines.
 5. Particularly when operating pneumatic and hydraulic systems with long hoses, consider jogging the tool against the work piece to counter act the friction loss in order to prevent out running the systems ability to keep up with energy consumption.
 6. Consider what type of force you wish to apply to your work piece. Attack the barrier in its weakest mode, i.e. concrete in shear, not compression. If you can locate the rebar and cut these first you remove concrete’s ductile capability. This consideration can also be applied to hand tools vs. power tools choice. Such as a dirty breech executed with sledge hammers in lieu of heavy power tools. Take time to thoroughly size up the barrier and develop a coordinated plan (with back up) to get through it. Make sure the tool and technique are matched to the material being worked on.



Rescue Tool System Application

7. Anticipate the action/re-action of the tool and the barrier. Be prepared to deal with rubble, weight of the cut out, and the speed of the release.
8. Continuously assess the working end of your tool. Keep the bits dressed and sharp. Inspect diamonds for any deformation and integrity. Ensure bits/blades are compatible with the barrier and the desired result i.e. the bull point of a jack hammer will create circular lines of force (general demolition), a chisel bit will create linear lines of force for a more precise/predictable break.
9. Listen for pressure relief valves venting. The tool system may be over loaded.
10. Stay within the operating envelope of your tool package. When you have questions or problems refer to your supervisor and the operating manuals.

General Tool Operation Safety Considerations

When operating power tools always wear the appropriate PPE, gloves, ear protection, safety glasses, helmet, respiratory protection, and work uniform. Do not wear loose fitting clothing or other items that could get entangled in the power tool. Prepare to mitigate any hazard your tool operation may produce, dust, dirty water run off, exhaust fumes, etc. All tools require a general inspection prior to use checking for loose, cracked, or broken components. Check for loose fasteners, proper lubrication, blocked vents, cord damage, and proper operation. Never operate power tools when too tired or under the influence of drugs. A moment of inattention could result in serious injury. When operating tools try to maintain a firm and balanced body position, and try not to over reach. Keep your work area as well lighted as possible. If your tool is not operating properly, place an "Out of Service Tag" on it and turn it in for repair.

There are no perfect or trouble free tool packages. The Rescuer's ability to keep their "*Rescue Systems*" working in the field will be directly proportional to safe and successful rescues.

Rescue Tool System Assessment

The Urban Search and Rescue Response system is a young and evolving program. Part of the evolutionary process is a constant evaluation of tools and equipment. As Rescue Specialists, who better to evaluate the tools and equipment in the cache?

When assessing the tools' effectiveness, it is important to draw your opinions when the tools are being operated in a manner for which it was designed. Often times in a rush to complete a rescue, we tend to operate our equipment outside the parameters for which they were designed. This would not produce an accurate assessment of the tools' true effectiveness.



Rescue Tool System Assessment

Operators Influence on Tool Performance

- No other factor will influence the tools' performance more than the level of training and experience of the operator.
 - Cutting large sections of concrete, with new equipment and equipment that we just don't use every day is a relatively recent addition to the fire service.
 - As a result, operators are inexperienced and tools are not being properly operated. The result is poor performance and increased maintenance.
 - Proper assessments must take this into account and resist the tendency to black ball a piece of equipment due to operator inexperience.

Assessment Criteria

The following is a list of equipment evaluation criteria that will assist in the assessment process.

- Does the tool perform in field situations as well as in training?
- Weight
 - Does the weight of the equipment restrict its transportability when compared to like equipment? Is the equipment too heavy to operate in confining spaces or on poor footing?
- Power source
 - The power sources can be anything from battery powered equipment to propane, gasoline, etc.
 - Batteries should be assessed on duration, ease of recharging and availability.
 - Fuel should be assessed on type, capacity, and transportability. Does the fuel type restrict locations where the tool can operate and is that a hindrance?
- On scene maintenance
 - Can the equipment be serviced and maintained on the rescue site?
 - How often does maintenance need to be performed?
 - Is special equipment required to perform the maintenance?



Rescue Tool System Assessment

- Operating conditions - Can be any other condition which may affect tool performance or how the tool impacts on the operator:
 - Environmental
 - Hazards
 - Confined space
 - CO
 - Noise
 - Fire
 - Atmosphere
 - User interface
 - Ease of operation
 - Day/night
 - Number of personnel required to operate
 - Technical skill required to operate
 - Specialized training
 - Certification
- The only way to improve the task force cache is with feed back from the users. Make notes on tool and operator performance during incidents and training activities. After the incident is over, put these notes in memo form to be given to your Task Force Leader.



UNIT: TWO —GENERAL OPERATING PRINCIPLES & TOOLS MAINTENANCE

Operating Principles of Two Cycle, and Four Cycle Engines

- The key to any successful US&R operation is a thorough knowledge of the tools in the task force's cache. The Rescue Specialist must not only be able to select the appropriate tool to accomplish the task quickly and safely, but be able to trouble shoot minor tool problems and make the necessary on site repairs.
- Unfortunately, the US&R task force is not overly abundant with tools, small tool mechanics, or personnel to shuttle tools back and forth from the work site to the Base of Ops. This requires the Rescue Specialist to pick up the slack and make the minor tool repairs.

2-CYCLE ENGINES

- The predominant engine used for most gasoline powered rescue tools is the 2-cycle engine. The 2-cycle engine has many advantages over the conventional 4-cycle engine for rescue work but requires distinct starting and maintenance considerations.
- By understanding the operating characteristics of a 2-cycle engine, the Rescue Specialist can better prepare for and trouble shoot maintenance issues.
 - The 2-cycle engines have no oil sump. The gasoline oil mixture provides the fuel and lubricating oil. This allows the 2-cycle engine to be operated at almost any angle without loss of lubrication. It is important to mix and maintain the proper fuel/oil mixture. A 2-cycle engine run on a fuel/oil mixture too rich in oil may end up fouling the spark plug and smoke excessively when operated. But an engine run on too lean of an oil mixture can permanently damage the engine.
 - Two cycle engines operate at a higher RPM than 4-cycle engines. The higher Rpm's generate higher operating temperatures. After periods of running under load and at high RPM, the engine should be allowed to cool before shutting off. Allow the engine to run for 10 to 15 seconds at idle. This slows cooling reducing the chance of mechanical damage.
- With every down stroke of the piston, the fuel/oil mixture is drawn into the cylinder. This makes the 2-cycle engine more susceptible to flooding than the 4-cycle engine. To start a 2-cycle engine and reduce the possibility of flooding, the following guidelines should be used when starting a cold engine.
 - Turn the on/off switch to the on position and close the choke. Pull the starter cord briskly until the engine starts. If the engine fires but will not start, open the choke and attempt to start again.
- If after repeated attempts to start have failed, the engine is probably flooded. Remove the spark plug and dry. Replace and repeat the above procedure. If the engine still fails to start check the maintenance items listed below.



Operating Principles of Two Cycle, and Four Cycle Engines

- The maintenance and trouble shooting of all 2-cycle engines no matter what the applications are very similar. The three areas the Collapse Technician may be required to perform maintenance are replacing air filters, spark plugs and clearing fuel systems.
 - Clogged air filter can result in loss of power and prevent starting. Air filters should be checked after every tank full of fuel or more often in dusty conditions. Before removing any air filter, always close the choke. This will reduce the possibility of dirt getting into the engine and causing damage.
 - Spark plugs can become fouled from too rich of an oil mixture or when the engine idles too long. If an engine fails to start or during operation quits, check to see if the spark plug has fouled.
 - The fuel tank on 2-cycle engines is most often vented with a one-way valve to let air in and prevent fuel from leaking when operated at different angles. If after starting, the engine runs only to stall 10 or 15 seconds later, the one-way valve may have become clogged. Open the fuel tank cap slowly and listen for a rush of air to enter. This is a telltale sign of no fuel tank venting.

Four Cycle Engines

These engines (use straight gasoline) typically for US&R, run electric generators. They have an oil sump, or crank case which circulates oil within the engine to provide the lubrication that is done with the gas and oil mixture for 2 cycle engines.

This means that four cycle engines unless otherwise specified (pressurized oil crank case) must be up right to run properly. Aside from this, four cycle engines operate very similar to the two cycle engine.

GASOLINE POWERED CHAIN SAWS

- The chain saw is one of the most frequently used tools in the task force's cache and maybe one of the most dangerous to operate. The large exposed cutting surface requires the operators to be skilled at using a chain saw, for their safety as well as the victim's safety. It is therefore important to know not only about the maintenance aspects of the saw but the possible reactive forces involved in cutting.
- Before every use, the chain saw should be inspected for fuel, chain oil, chain tightness and operation of the chain brake. Most chain saws will allow for the fuel tank to run dry before the chain oil reservoir is emptied. For this reason don't be fooled into thinking that because chain oil remains in the reservoir after a tank of fuel the chain oil does not need to be added. Always refill your chain oil reservoir after each tank of fuel.



GASOLINE POWERED CHAIN SAWS (continued)

- Before beginning work check to make sure the chain is receiving oil. Point the tip of the chain saw towards the ground and run the engine at half to three quarters throttle. You should begin to observe a darkening of the ground underneath the tip of the guide bar. This indicates the chain is receiving lubrication and cutting can begin. The absence of chain lubrication can destroy the guide bar and chain.
- If no oil appears on the ground check the chain oil reservoir to make sure the reservoir has not run dry. If that is not the problem, next check the inlet hole in the guide bar for blockage.
- The chain brake should be checked while running the saw at an idle. Engage the chain brake by pushing the hand guard forward then squeeze the trigger for no longer than a few seconds. The chain should not rotate.
- There are three main reactive forces the operator may encounter during cutting. They are pushback, pull-in and a kickback.
 - A pushback occurs when the chain on top of the guide bar gets pinched which suddenly stops the chain movement. The saw will tend to pushback towards the operator.
 - The opposite of this is a pull-in in which the chain on the bottom of the guide bar gets pinched and the saw is pulled into the work.
 - Lastly, the kickback occurs when the tip of the bar comes in contact with a solid object or when it's movement is restricted. Kickback can happen in an instant with explosive force.
- When cutting wood that may be under stress, a relief cut should first be made in the area of the wood that is under compression. The deepness of the cut depends on the thickness of the material to be cut. For example, a 2x4 may just have to be nicked and a large log may require a cut of several inches. In either case, you do not want the wood to begin to flex from this cut. Your next cut will then be on the tension side of the material completing the cut.
 - Use the "Chipper Chain" when cutting trees, the carbide tipped chain will not clear the kerf. The carbide chain works better of kiln dried lumber and mixed layered i.e. asphalt roof coverings.
- Working in areas of blown down trees or in collapsed structures is very dangerous. Always work in pairs, plan your cuts and keep the nose of the guide bar away from solid objects.
- There is three main maintenance or repair items the rescuer may be required to complete on site. They are:
 - inspecting and changing of the air filter , and spark plug
 - Inspecting and replacing the chain and or guide bar
 - Tensioning the chain and replacing fluids



UNIT: TWO — TOOLS MAINTENANCE

GASOLINE POWERED CHAIN SAWS (continued)

- A clogged air filter can reduce engine performance and increase fuel consumption. Most chain saws have two sets of filters. A pre-filter to remove the larger dirt and wood chips and a fine filter.
 - The pre-filter should be cleaned after every tank full of fuel. This is accomplished by brushing away the dirt with a small brush or by blowing the filter clean with a stream of air.
 - The fine filter can either be a mesh material or a paper filter similar to that found in automobiles. The mesh type filter may be reused after cleaning so long as there are no holes in the filter material. The paper type filters should be discarded when dirty. Mesh filters should be cleaned at least once a day and more often in dusty areas. For this reason, spare filters should accompany the saw to any cutting site.

- Although the methods for replacing air filters vary according to the brand of saw, all manufactures recommend that before the fine filter is removed, brush away any dirt near the carburetor and close the choke to prevent dirt from entering the engine.
 - If deployed to an area of significantly higher altitude then you typically work in and you experience sluggish performance from your saws the carburetor may need to be tuned to the elevation.

- Chain saw chains should be replaced or sharpened when the operator must force the saw to cut or the wood begins to smoke when cutting. A dull chain increases fatigue on the operator and increases the risk of kickback. Since sharpening the chain is time consuming and can involve complex angles, the Rescue Specialist should plan to replace the chain on site.
 - To do this remove the side cover covering the chain sprocket. Relieve the tension on the chain. Once the chain tension is released, remove the chain from the tip of the guide bar. The chain and guide bar can then be removed.
 - Once the guide bar is removed, examine the ridges on which the chain rides for uneven wear. If one side of the ridge is higher than the other, a file must be used to level the ridges. During the course of normal operation, the nose and underside of the guide bar will wear faster than the top. For this reason, every time the saw chain is sharpened or replaced, turn the guide bar over.
 - Reverse the removal procedures when reinstalling the guide bar and chain but only tighten nuts finger tight that holds the sprocket cover in place.



UNIT: TWO — TOOLS MAINTENANCE

- Now that the chain has been replaced, pull the guide bar nose up and out at the same time as turning the tensioning nut. The chain is properly tensioned when the chain is resting on the underside of the guide bar and can be easily pulled along the bar. Run the saw for two or three minutes then readjust the chain tension as necessary.
 - Chains that are overly tight will increase guide bar wear and engine strain. Chains that are too loose, run the risk of being thrown off the guide bar and injuring the operator.

CUTOFF SAW

- The rotary blade power saw goes by many names, cutoff saw, K-12, or Cutquik, but whatever you call it, these saws all have a circular blade driven by a V-belt attached to a 2-cycle engine. These saws can be used to cut wood, concrete or steel depending on the type of cutting wheel attached to the saw.
- Before using, check the cutting wheel for any nicks, cracks or missing segments that could cause the blade to be out of balance and shatter during use. Check the V-belt tension.
- Always place the wheel guard in a position to protect the operator.
- Operators should always stand to the left of the cut to protect themselves in the event of cutting wheel failure or being hit by thrown material.
- During wet concrete cutting, the slurry created can cause slick footing. Make sure you have a stable base and work in pairs.
- The following are general guidelines the Collapse Technician can use when replacing the cutting wheel. Refer to your owner's manual for specific details.
 - To replace the cutting wheel switch the engine off and prevent the cutting wheel from turning by placing the locking pin through the spoke in the V-belt pulley.
 - Remove the nut holding the thrust washer in place and remove the thrust washer. The cutting wheel can now be removed.
 - Reverse the sequence when installing the new cutting wheel. Always make sure blade rotation corresponds to the rotation arrow on the cutting wheel.



UNIT TWO – TOOLS MAINTENANCE

CUTOFF SAW (continued)

- The items that the rescuer may be required to repair or maintain in the field would be cleaning and replacing of the air filter, spark plug and replacing and tensioning of the V-belt.
 - Filters for rotary blade power saws are similar to that of chain saws. There is a pre-filter that is usually a reusable foam filter and a fine filter of mesh or paper. The pre-filter should be cleaned after every tank full of fuel. This element can be cleaned by with a soft brush or by blowing the filter clean with air. The fine filter should be cleaned daily or more often in dirty and dusty conditions such as in cutting concrete. Non-reusable paper filters should be discarded when dirty.
- Remember to close the choke and wipe away any dirt near the filter housing before removing any filter.
- The V-belt or drive belt should be inspected before every use. Look for fraying or any damage to the belt that could cause it to break.
- Most V-belts are replaced in a similar manner. Unscrew the screws holding the arbor bearing and wheel guard in place. Next remove the screws holding the drive arm in place. Place the new V-belt on the drive pulley and reassemble.
- To tension the V-belt, loosen the screws holding the arbor bearing/guard in place. Either tighten the eccentric adjuster or turn the tensioning screw (depending on the manufacturer) until the V-belt can be depressed slightly. Over- tightening of the V-belt may cause premature arbor bearing failure.

CUTTING WHEELS

- The term cutting wheel is a generic term for any number of cutting blades whether they are diamond blades, abrasive blades or carbide tip blades. These blades can be grouped according to the material they are designed to cut. Concrete or masonry blades can be either diamond or abrasive cutting blades. The concrete abrasive blades are composed of a silicon oxide matrix. Metal cutting blades are almost exclusively the abrasive types composed of an aluminum oxide. Lastly, wood cutting blades are made of steel and may or may not be carbide tipped.
- Abrasive cutting wheels no matter what the material they are designed to cut are subject to the same type of wear and use considerations.
- Abrasive blades are particularly susceptible to chipping and cracking.
 - For this reason, blades should not be transported attached to the saw.
- Before using an abrasive blade, inspect the blade for chips cracks and uneven ware. If any are found, replace and discard the damaged blade.
 - Uneven blade wear is characterized by a thinning of the blade towards the outer edge.



UNIT: TWO — TOOLS MAINTENANCE

CUTTING WHEELS (continued)

- If water is to be used during cutting, make sure the blade is compatible for use with water.
 - Not all blades are designed for wet cutting and the application of water could result in blade failure.
- Wet cutting has several advantages over dry cutting.
 - Water helps keep the blade cool, which will prolong the blade life.
 - Water will reduce the air borne by-products of cutting which can clog air filters and breathing respirators.
- When using water, make sure both sides of the blade receive near equal amounts. Unequal water coverage can result in greater wear on one side of the blade resulting in thinning and eventual blade failure.
- After completing your cut, shut the water off first, allowing the abrasive blade to spin and remove excess water.
- Abrasive blades should only be stressed radially and never torsionally by twisting or bending.
 - This could result in sudden blade failure seriously injuring the operator.
- The diamond-cutting wheel is composed of a steel wheel, called a core on which a diamond and steel cutting matrix, called a segment, is welded. Although diamond blades are not as susceptible to chipping and cracking as abrasive blades, other problems can arise with diamond blades which when recognized and corrected, will help to extend blade life and shorten cutting time.
- The first and most important step to prolong blade life is selection of the proper wheel.
 - Wheel segments (the diamond and steel matrix) vary in hardness according to the material they are designed to cut. Some blades are designed for cutting cured concrete while others may be designed to cut asphalt or lightweight concrete. The blades we should be primarily concern with are those designed to cut cured concrete.
- After the proper blade is selected, the blade must be broken-in on the material being cut.
 - Allow the blade to begin cutting by exerting only slight pressure. This exposes the cutting diamonds without generating excessive heat. Cutting can now begin using the back and forth motion. This cools the blade by exposing it to air.
- During cutting operations, periodically examine the cutting wheel for the following problems.
 - Cracked or missing segments can occur due to stresses from twisting or jamming of the blade in the cut or by blade overheating. A telltale sign of segment loss due to overheating will be a discoloration of the core just underneath the missing segment. To prevent overheating expose the blade to air more frequently, cool with water.
 - Check for glazing.



UNIT: TWO — TOOLS MAINTENANCE UNIT:

CUTTING WHEELS continued

- Glazing appears as a shiny smooth surface on the segment. The first sign that glazing has occurred is lack of cutting progress. Glazing can occur at anytime during the cutting process from contact with rebar, overheating or cutting a material too hard for the diamond segment. Once glazing has occurred, cutting progress will be slowed and overheating will result until the blade is reconditioned.
 - To recondition or dress a diamond blade, the operator must find a material softer than the material being cut. Operate the saw in the softer material as you would for the break-in period with light pressure.
- Just as abrasive blades can have uneven wear, diamond segments can also wear unevenly. The most common cause of uneven segment wear is lack of adequate water coverage to one side of the segment, which results in one side of the segment wearing faster than the other.
- The last blade we should be familiar with is the carbide tipped cutting blade. Designed to cut primarily wood, the main advantage of a carbide tipped blade is the long life of the cutting edge when compared to conventional blades. The blades work best at high RPM. Slower Rpm's can result in carbide tip loss.

UNIT: Two — Rescue Tool Power Sources and Operating Principles

Hydraulic Operating Principles

Hydraulic rescue systems have three basic components, power unit with a gasoline engine, hydraulic fluid pump and reservoir with associated valves to control direction and pressure. The hoses transmit the pressurized fluid to the tool, spreaders, and jack hammer etc. This is a closed system as opposed to a pneumatic system which vents/consumes (open system) its power transfer medium. Hydraulic systems have a pressure port (output of the pump), and a return port, hydraulic fluid flowing back into the reservoir. For best operations the fluid temperature should be between 60 and 140 degrees F.

Pressure is applied in all directions within the containers, the hydraulic fluid is mostly incompressible but may contain up to 10% air. The action which creates the mechanical advantage depends on Pascal's Law which explains that a force or pressure on a small surface can be transferred to a larger surface amplifying the force. Think of the small piston attached to the pump handle of a hydraulic bottle jack and reference that to the larger piston or the column that rises as you pump the handle. The small force you create by pumping the small piston with the lever (handle) transmits the force (the pressure in psi) to a larger area (the square inches in psi). This is why by simply jacking this pump by hand you can lift several tons. This is a positive displacement pump, which means that if it pumps against a closed head for very long, the pressure will build till something relieves the strain.



Hydraulic Operating Principles (continued)

System operating pressure is directly related to the load applied, ultimately relieved by internal over pressure valves automatically or by decreasing the load on the working end tool. Think of a vehicle rescue system ram pushing against a vehicle component. The tool system will load up and build pressure till the object is displaced, the operator releases the tool, or the relief valve kicks in.

The Stanley system also has a GPM measure which is critical. This is because we use tools such as saws and jack hammers with this system. These tools reciprocate and spin, not just pushing a piston. The GPM of the pump relates directly to the speed at which the tool runs at.

When hoses are left in the hot sun or on pavement the fluid will expand, building up pressure in the hose, which can prevent coupling or uncoupling of hoses. There are two ways to relieve this pressure.

1. When the hoses are connected to the pump or a tool you can relieve the pressure back through the system by cycling the tool control valve or the flow control on the power unit.
2. When the hoses are not connected and the couplings become “locked up” you must carefully loosen the threaded connection between the coupling and the hose. This will allow a small amount of fluid to leak out lowering the pressure and allowing the connection to be made. Remember to tighten the connectors once the connection has been made.

Safety Issues;

Pressures in hydraulic systems can be 2,000 to 40,000 psi, always assume under pressure.

Treat as “hot” work, have an extinguishing capability handy.

Always wear PPE.

Pneumatic Operating Principles

Pneumatic tools weigh less, very portable, and have many excellent applications. Air tools with the exception of air bags, are often measured in not only in operating pressure but also CFM, cubic feet per minute. This is the amount of air the tool uses to work, the speed of the air is expressed as FPS, or feet per second. These factors can be affected by the friction losses in the hoses. The air in these containers when static represents potential energy and needs to be relieved safely. Cracking valves or couplings may blow “O” rings and launch projectiles. Drain your pneumatic system appropriately.

Our class “D” breathing air will dry out the system “O” rings and cause premature failure, oil regularly by adding a couple of drops into the tool. Extend your usable air supply by jogging your tool to counter act the friction losses in the system. The air consumption of the tool can exceed the regulator and hoses ability to deliver the needed CFM especially when the SCBA bottle is getting low on pressure.

Safety Issues;

Control bleeding off of pressure

Use a pressure relief valve with air bags



Electric Operating Principles

Electric tool systems have 3 general parts, power generation, transmission and tool. It is our responsibility to understand the operation of each part and know where it fits in the operational envelope. It is also important to understand some terms and units of measure concerning electricity. This information is often displayed on the tool. One helpful way to think of these parameters is to liken them to fire ground hydraulics. Volts, is the pressure the pump creates to flow the water, amperage compares to GPM of the water flowed.

Volts, Alternating Current (AC) like our house outlets, or Direct Current (DC) which is battery power. Voltage is the pressure or amplitude of the energy of the electricity.

Amperage, all appliances have a specific amount of amps required to make them work efficiently. The operator can influence the amount of amps or load that the tools draws. For example if you push your recip saw till it bogs down and stalls in the cut, the amps will increase probably causing a circuit breaker or similar protection device to trip or shut the tool off.

Watts is the amount of energy consumed by the tool. You can calculate the amount of watts by multiplying amps and volts.

Generation of power

Generally we get our electric power from an outlet supplied by the electric company this serves us well at home but in the field we need to make and distribute electricity by our own means. Portable generators are the “life blood” in the USAR environment with the Honda 5000w and 6500w being the generators of choice. These Honda generators produce 110 & 220 volts and approximately 41 to 54 amps respectively. The electrical system is protected by circuit breakers and you are protected by Ground Fault Interrupters.

Generator issues

1. Operating with a gasoline motor can cause problems in itself. Honda generators use regular unleaded gas with a recommended minimum octane rating of 86. They also have a low oil sensor that will shut down the motor or refuse to let it start if it senses that the oil is low. This sensor is good for the motor but can cause undue problems if its operation is overlooked. The oil does not have to be very low for this sensor to operate.
2. Any time you are going to transport the generator be sure to shut OFF the fuel valve. If left on gasoline may get into the crank case and dilute the oil. If it is going to be stored for more than two months, drain the fuel from the carburetor float bowl, drain the fuel from the sediment cup and add fuel stabilizer to the fuel left in the tank.
3. Electrical production is accomplished when the motor turns a set of windings. In a 110/220 volt generator there are two of them. Each one of these windings is rated at half the total load of the generator. In 120v mode each winding supplies certain portions of available outlets. In the 120/220v mode they supply the 120v outlets and they are combined at the 220 outlet to supply its needs. It is important to understand this theory and look at the wiring arrangement for your model. Some of the Honda EB models have two duplex outlets each one fed from a different winding. This is important to know when plugging in tools and equipment because you have the opportunity to spread the load out between the windings. Instead of overloading one winding with the draw of two big tools you can opt to split that load between the two winding and allow the generator to operate better with less chance of breakdown.



Generator issues (continued)

4. Max and Rated output. All generators have these two output ratings their label usually reflects the Max output (marketing value). The rated output is what we should follow; it is the amount of power the generator can produce over an extended period of time without damage. The Max rating is for peak periods of short duration like tool startup.
5. Circuit breakers protect the generator and specific outlets from overload. Honda EB model generators generally have a main breaker to protect the windings from accumulative overload and outlet specific breakers to protect each circuit individually. They also have a GFI (Ground Fault Interrupter) circuit protector that is designed to protect humans from shock. The GFI compares the amount of electricity sent out on the hot wire to the amount received back on the neutral wire; if there is a 5mv difference it will trip and stop the electric flow. This should be quick enough to stop personnel from electrocution but is enough to cause muscle reflex which could be dangerous.
6. Most generators have an “Auto Idle” switch. When turned on this mode allows the generator to go to idle speed when it senses that there is no electric draw from any of its outlets. This idle mode saves fuel and generator wear and tear. When electricity is requested (by turning on a light or pulling the trigger on a tool) the generator will come up to full speed and supply the requested energy

Power transmission

1. Once the generator is running, it is our job to get the power to the tool. This is accomplished with extension cords and splitter boxes. All cords are size rated to electrical standards, the smaller the number the bigger the wire. This wire size is something we need to be cognoscente of because it determines the ability of our tools to operate. Electric wire has resistance that relates directly to wire size (similar to friction loss in fire hose) it is important to keep our wire length as short as possible and our wire size as big as possible. All this relates directly to the power needs of our end user, the tool. If we are only powering a 500watt light then 100 feet of 12 gauge cord will work fine but if the end user is a 60lb electric breaker that draws 2000watt and startup and 1600 to 1700watts during operation then a 10gauge cord as short as possible is a must. The matching of cord or wire size to the tool is important to keep the tool operating correctly and to keep it and the wire from overheating and melting.
2. The standard cache rescue section lists 10/3 and 12/3 wire with 20 amp twist lock connectors in 50 and 100 foot lengths. It is important to note that the twist lock connector on a Honda EB generator is a 30amp twist lock. A 20amp twist lock looks like it will fit and if pushed hard enough it will come close but it will not twist or lock in place, this is not a safe operation. We must be sure to match 20amp male to 20 amp female plugs. Having to push connectors or bend outlet prongs to make them fit should not happen. All the tools in the standard cache have regular house plugs so it is important for the rescuer to get all the needed adapters from the cache before leaving the Boo and heading to a job site. The need for male and female house to male and female 20amp twist lock along with splitter boxes can not be overlooked



Electric Tools

1. Electric tools require a predetermined amount of electricity to operate correctly. Supply less voltage or amperage because of wire mismatch, resistance or length and the tool will not be able to do its job. Most tools used by the rescue team have an electric motor somewhere inside the housing. Electric motors require a much greater amount of electricity (amperage & voltage) to start then to run. This can be seen when you start a tool and the lights dim or the motor on a generator bogs down to accommodate the required draw. Once the tool is up to speed its electrical requirements generally fall to those listed on its housing. This initial startup draw can cause circuit breakers to blow if the circuit is near it rated capacity it can also cause a GFI to operate or trip because of voltage leakage in the tool.
2. All tools have an operating envelope that meets their design criteria. Trying to make a tool to work faster by forcing it into a cut, pushing it harder into concrete or steel and overloading its blade will only cause it to heat up internally and in the long run fail. Although a FEMA cache is very large the Rescue section tool numbers are very small, two 1 ½ hammer drills is all we travel with. If we over drive and force it to work outside it's normal operating range it will work slower, heat up and in the end stop working. This would leave the whole rescue team and its entombed victims with one hammer drill to get the job done. Working a tool with the right amount of force can only be learned during training. It is important to understand this theory and work to find the correct operating forces for all the tools in the cache.
3. Generator auto idle was discussed in the generator section but needs a quick review here. The auto idle mode is a good when there is a lot of stand around time or very little tool use but when tools are constantly being cycled on and off and the generator is running up and down it can cause undue tool damage. This damage is caused when the trigger is pulled and the tool motor starts to turn, since the generator is idling it is producing very low voltage and amperage and the tool is requesting normal voltage and high amperage to get the motor turning this delay can cause heat to build up in the tool. Anytime you are using the auto idle you should let the tool and the generator come up to full speed before putting the tool to work. If there will be a lot of on off cycles it is best to turn off the auto idle and allow the generator to run at full speed all the time.

***Operating Principles* CUTTING TORCHES**

Description of Process

- Oxy-fuel cutting is a process whereby a metal is heated to it's kindling temperature (temperature below the melting point) by an oxy-fuel gas flame and then burned rapidly by a regulated jet of pure oxygen. Cutting torches, whether hand held or machine operated are used for this operation.
- The cutting process is a chemical reaction between iron and oxygen. When iron is heated to a temperature in excess of 1600 F (870 C) and then exposed to a stream of high purity oxygen, the iron oxidizes rapidly and produces a mixture of molten oxides and iron called slag. When cutting a narrow slot called the kerf is formed as a result of the loss of metal by the cutting oxygen jet.



Operating Principles CUTTING TORCHES (continued)

- The oxy-fuel cutting process is generally used on materials ranging from 1/32 in. to a thickness in excess of 100 in. The majority of oxy-fuel cutting is done on materials ranging from 1/4 in. to 2 in. in thickness.

Equipment and Supplies

- In order to perform oxy-fuel flame cutting, the following equipment is required as a minimum:
 - Oxygen
 - Fuel gas(Acetylene, Propane, or MAPP gas)
 - Pressure regulators
 - Hoses and fittings
 - Torch
 - Cutting tips
 - Tip cleaners
 - Strikers
 - Protective clothing and safety equipment meeting ANSI-Z49.1

Oxygen

- Oxygen of high purity (99.5% Minimum) is required to perform the operation of oxy-fuel flame cutting. This can be supplied in a variety of high-pressure cylinders and/or in bulk liquid tanks. CAUTION: Oxygen supports combustion! Improper use can result in fires or explosions. Never use oxygen in pneumatic tools, to clean equipment or parts, or to blow dust off clothing.
- Oxygen safety precautions
 - Do not permit smoking or open flames in area where oxygen is stored, handled or used.
 - Liquid oxygen at -297 F can cause freeze burns to the eyes and skin if it comes in contact with them.
 - Keep materials such as oil, grease, wood, kerosene, cloth, tar, and coal dust away from contact with oxygen.
 - Do not place liquid oxygen equipment on asphalt or surfaces with grease or oil deposits.
 - Remove all clothing, which has been saturated with oxygen gas. Such clothing is highly flammable, and should not be worn for at least 30 minutes.



Fuel Gas

- Many different fuel gases are available for oxy-fuel cutting. They include acetylene, propane, methylacetylen-propadiene (MAPP), natural gas, propylene, hydrogen, and several propane or propylene base mixtures. Each of these fuel gases will produce different flame characteristics.
- Acetylene cylinders contain porous filler that is used to absorb acetone. The acetylene in these cylinders is then dissolved into the acetone. This is done to prevent acetylene from being drawn faster than the acetone will release it. The maximum safe rate for being withdrawn from the cylinder is 1/7th of the cylinder's capacity per hour. If this rate is exceeded acetone will be drawn from the cylinder resulting a flame with a purple color.
- Acetylene Safety Precautions
 - Acetylene is not to be used at pressures above 15 psig in free form.
 - Concentrations of acetylene between 1% and 99% by volume in air are easily ignited, and may result in an explosion.
 - Keep cylinders away from overhead welding or cutting. Hot slag may fall on a cylinder and melt the fusible plug.
 - Fusible plugs on acetylene cylinders will melt at 212 F.
 - Acetylene forms readily explosive compounds with copper, silver, and mercury.
 - Acetylene must be kept away from these metals, their salts, compounds, and high concentration alloys.
 - Adequate ventilation is required. Acetylene gas produces a strong garlic odor. Acetylene may displace air in a poorly ventilated area; atmosphere that does not contain at least 18% oxygen may cause dizziness, unconsciousness, or even death.
 - Leave the hand wheel, wrench, or key on the cylinder for emergency shutoff.
 - Always store acetylene cylinders in an upright position. If the cylinder had been laid down on its side put in the upright position for at least 3 hours before using.

Pressure Regulators

- Regulators are pressure-controlling devices that reduce high pressures to a desired working pressure. A pressure adjusting screw adjusts these regulators. Regulators may be single or two stage.
- Regulator Safety Precautions
 - Keep contaminants such as oil, grease, dust, and dirt away from all inlet and outlet connections on regulators.
 - Never use oil on any threads or fittings on any regulator.
 - Before attaching an oxygen regulator to a valve, check to make sure that the regulator meets the pressure requirements of the supply.
 - All regulators should have the pressure adjusting screw backed out before opening the cylinder or station valve.
 - Never use acetylene above 15 psig.
 - Never stand in front of a regulator when the cylinder valve is being turned on.



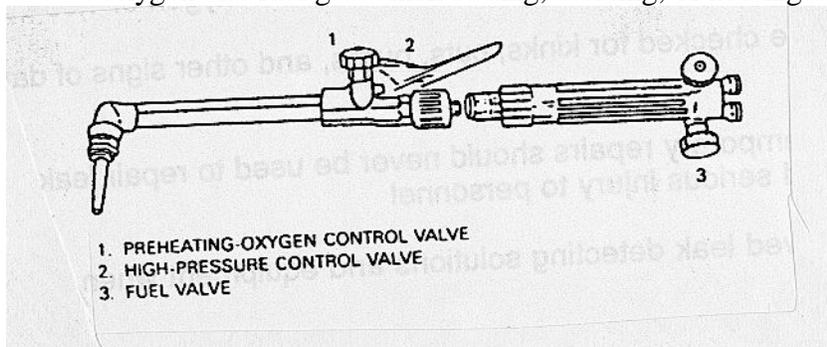
Operating Principles CUTTING TORCHES (continued)

Hoses and Fittings

- Oxygen hoses in the United States are always color coded green. The fittings have right handed threads and a smooth outside surface.
- The fuel gas hoses are always color coded red. The fittings have left hand threads and a notch on the outside.
- These fittings are designed to form a gas-tight seal with the application of very little mechanical pressure.
- The use of undersized or excessively long hoses can result I pressure drops that can result in a low flow rate. Insufficient flow rates can result in overheating of torches and backfires.
- Hose and fittings safety precautions
 - A fuel gas hose should never be used to transfer oxygen or vice versa.
 - Hoses should be checked for kinks, cuts, burns, and other signs of damage before use.
 - Tape or other temporary repairs should never be used to repair leaks; this could lead to fires and serious injury to personnel.
 - Use only approved leak detecting solutions and equipment when checking connections.

Torches

- There are basically three different types of cutting torches. However these torches come in many different styles and shapes.
 - Hand torch: A torch equipped with a one piece body with valves to control the flow of preheated oxygen and fuel gas, a spring loaded valve for the cutting oxygen, tubes carrying the gases to the head which accepts the cutting tip.
 - Combination Hand Torch: A welding torch equipped with valves to control the flow of oxygen and fuel gas which cutting, welding, or heating attachments may be attached.



- Machine torches: A torch equipped with valves controlling oxygen, fuel gas, and cutting oxygen with tubes encased in a body with a head to accept the cutting tip.



Operating Principles CUTTING TORCHES (continued)

- Torches are classified as being either a positive pressure or injector type (low pressure). In the positive pressure torch both the oxygen and the fuel gas are supplied at pressures high enough to sustain sufficient flow of both gases. In the injector type torch the fuel gas is supplied at a low pressure, relying on the high pressure of the oxygen to pull the fuel gas to obtain the correct flow of gasses.
- Torch safety precautions
 - A fire extinguisher should always be at hand when flame cutting for use if an emergency arises.
 - Always extinguish a torch whenever it is not in your hand.
 - If a torch backfires, shut it down, find the trouble, and remedy it before continuing to use the torch.
 - Be careful that a torch is not being directed at another person when lighting.
 - Be sure that the area where the cutting/welding is to be performed is clear of any hazardous or flammable materials.

Cutting Tips

- All oxygen-cutting tips have preheat flame ports (orifices) which are commonly arranged in a circle around the cutting oxygen port. The size of these ports will determine the thickness of the materials to be cut as well as the amount of gas supplied.
- Tips for use with acetylene are usually one piece in design and being flat on the flame end. Tips for use with MAPP and propane gas are usually two pieces in design with milled spines.
- Of all the items needed to perform the oxy-fuel cutting process, besides oxygen itself, the cutting tip has the greatest effect on the quality of the cut.
- During cutting procedures slag will form around the pre-heat and oxygen cutting ports. This will disrupt the pre-heat flame as well as the oxygen cutting jet, resulting in poor performance and quality cut. When this occurs the tip should be removed and cleaned.

Tip Cleaners

- Cleaning is done by means of tools called tip cleaners. There are different types of tip cleaners available to clean the surfaces of oxy-fuel cutting tips.
 - Tip drills; wire broaches (normally called tip cleaners), these are designed to clean the ports of the cutting tip.
 - Re-facing tools are designed to keep the face of the tip flat, providing preheat flames of the same length.



Operating Principles CUTTING TORCHES (continued)

Strikers

- When lighting your cutting torch it is important to use an approved spark lighting device. The use of lighters, matches can lead to personnel injury as well as injury to others around you.

Protective Equipment

- Appropriate protective clothing and equipment is required at all times when using oxy-fuel cutting equipment. As cutting operations vary so will the required protective clothing and equipment, size and the location of cutting will determine this. Some or all of the following may be required:
 - No. 4 or 5 lens tinted goggles or face shields
 - Welding cap or hardhat
 - Safety glasses
 - Leather gloves suited for oxy-fuel cutting
 - Flame resistant clothing
 - Respirators use appropriate respirator for type of fumes that will be produced.

Start Up and Shut Down Procedures

- Secure the cylinders to cart or a substantial support.
- Attach regulators to the valves; ensure valves are free from oil, dust and obstructions. Tighten inlet connection nuts firmly with a close fitting wrench.
- Inspect the hoses for cuts, burns, and kinks. Have them repaired or replaced, if damaged.
- Connect hoses to proper regulators (green oxygen, red fuel gas).
- Attach hoses to the correct torch inlet.
- Before opening either of the cylinder valves, check to make sure that the regulator adjusting screw is backed out, so that no pressure is being exerted on the adjusting screw. This is done to protect the regulator parts from damage due to high-pressure surges.
- Open the oxygen cylinder valve very slowly to allow pressure to increase slowly into the regulator. Warning, do not stand in front of or behind the regulator when opening the valve. After the pressure in the regulator has equalized, open the oxygen cylinder valve completely so the valve will seal. Oxygen cylinder valves are designed to seal when fully opened and fully closed.
- Fuels cylinders equipped with a hand wheel should be opened no more than 1 ½ turns. Acetylene cylinders equipped with a valve that requires a key or wrench should be opened no more than ¾ turn. Fuel gas valves on cylinders should never be opened completely. This is done to allow the valves to be turned off quickly in case of an emergency.



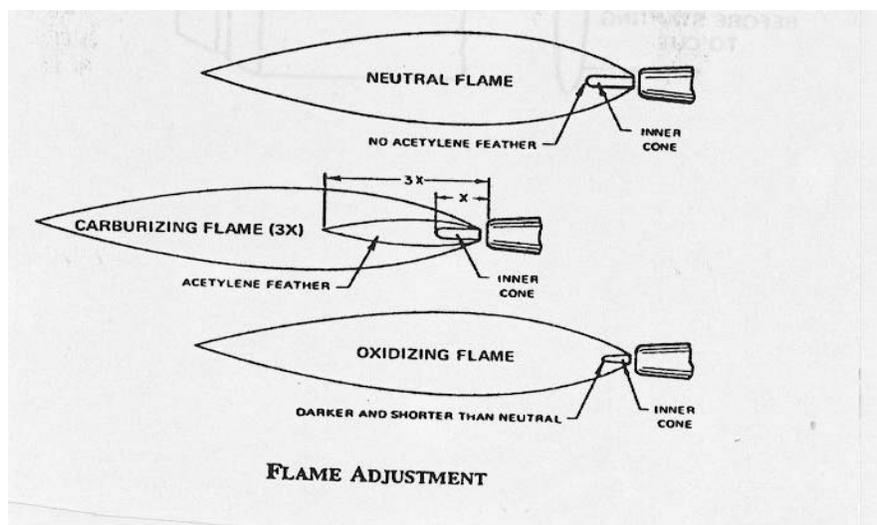
Operating Principles CUTTING TORCHES (continued)

Start Up and Shut down Procedures cont.

- With the torch and tip directed in a safe direction, open the oxygen valve located on the torch body. Turn the adjusting screw on the oxygen regulator and adjust to the recommended pressure for the tip being used. Allow the oxygen to flow for at least five seconds for every 50 ft. of hose. Close the inlet oxygen valve on torch body.
- Next open the fuel gas valve on the torch body. Turn the adjusting screw on the fuel gas regulator and adjust till recommended pressure is obtained. Allow the fuel gas to flow for at least five seconds for every 50 ft. of hose. Close the fuel gas inlet valve on the torch body.
- The recommended procedure for lighting acetylene is to open the fuel gas valve on the torch body slightly (usually 1/8 to 1/4 turn) light with a striker. Adjust the fuel gas valve until the acetylene produces a semi-smokeless flame. Open the oxygen valve slightly to produce a neutral flame.
- To extinguish the flame, turn off the fuel gas valve first then the oxygen valve. This is done to prevent the flame from burning back into the torch body and producing a flashback.
- After the flame has been extinguished, close both the fuel gas and oxygen valves on the cylinders.
- Open the torch fuel gas valve and bleed off the fuel gas from the regulator, hose, and torch. Back out the regulator adjusting screw and close the torch fuel gas valve.
- Open the torch oxygen valve and bleed off the oxygen from the regulator, hose, and torch. Back off the regulator adjusting screw and close the torch oxygen valve.

Flame Adjustment

- The flame adjustment is a critical factor in attaining satisfactory torch operation. The amount of heat produced by the flame depends on the type of fuel gas, intensity of flame, and the type of flame used.





Unit 3; Tool Lab Field Lecture Outline

Speaking Points

Gasoline Engines -Four Cycle

Honda generators have an “auto-throttle” mode like the Stanley power unit. It helps conserve fuel and will not respond to electric loads of less than 1 amp. This system is not effective for tools that only require momentary power, i.e. if we are turning a saw off and on as we work thru the barriers. If you decide to use the auto throttle wait till the engine reaches operating temperature. Hondas have an”Oil Alert” safety switch which can shut the unit off if the oil pressure is too low. The generators should not operate at full capacity for more than 30 minutes. When transporting turn fuel valves off.

With the voltage selector switch in the 120/240 position, you can use the 120 and 240 at the same time. If you do not need the 240 turn the switch to the 120 position. Other operator switches are the main circuit breaker, engine on/off switch and a fuel valve. The Honda generators run on regular gas, however they may not perform as well if using alcohol additive fuels. Every four cycle engine needs three things to start and run.

When troubleshooting start with these three basics.

1. Proper (fresh) fuel
2. Good spark
3. Piston compression

Trouble;

Engine will not start

Possible Remedy;

Engine switch “on”

Oil alert light on, add oil

Enough fuel

Spark at the spark plug

Electric loads removed

Trouble;

Engine starts but immediately shuts down

Possible Remedy;

Check oil alert lamp

Check oil level

Trouble;

No electricity at receptacles

Possible Remedy;

AC breaker on

Check tools plugged in to generator for proper operation



Speaking Points

Chain and Rotary Saws, Two Cycle Engines

Can be operated in any position, produces more exhaust smoke due to oil/gas mix. Operates hotter than four cycles and will foul spark plugs faster. To promote smooth running:

1. Assure proper fuel mix
2. Piston compression
3. Exhaust screen in muffler is clean

Husqvarna saws require a 1:50 gas to oil mixture. Do not use marine grade oil. After 8 to 10 tanks of fuel the saw should be broken in, but may require adjustments to the carburetor and/or oil pump at this time. Train your ear to the sound of a well tuned saw so you can head off problems before they build up. The engine has a decompression valve to help reduce the pressure in the cylinder upon start up. Check chain break by engaging and trying to rotate the chain by hand, it should not move.

To start the saws, chain break off, ignition switch on, pull choke out, place unit on ground and hold firmly with foot and hands, pull the starter cord till the pawls engage then pull sharply. NO DROP STARTS. Push choke back in ½ way when engine fires, when engine starts push choke all the way in. Do not release starter cord while extended, it can damage the saw. If possible re-fuel the saws away from work area in case of fuel spill.

Review how to prevent saw kick back.

Review changing the chain, blade, spark plug, filters, and V belt.

Trouble;

Hard starting/lose of power

Possible Remedy;

Check air filter, spark plug for dust/carbon/oil build up

Wrong fuel mixture

Carburetor needs tuned

Engine flooded, dry spark plug, allow carburetor to dry

Kor-It, Promethean Gas Powered Coring tool

Powered by a four cycle Honda engine, it requires no gas mix, but can be used in any position due to a pressurized oil crank case. The water coolant back pack, water supply can be stretched by adding 7 to 9 ounces of class "A" foam to the water. The water back pack has pressure relief valves. Good centrifugal clutch located in the gear box. Comes with a vacuum operated bit locator powered off the engine adheres to smooth concrete. Troubleshooting, same as above.



Speaking Points

Pneumatic Equipment

Paratech Struts

Ensure the “O” ring is lubricated and in place at all times it is located on the inner threaded tube. If the acme threads are damaged in the field use a metal file to reshape till the collar once again moves freely over them again. If the air nipple is damaged and needs replaced simply remove and install the new nipple, no thread sealant is needed.

Test quarterly.

High Pressure Airbags

Protect the air nipple, no thread sealant need for this either if replacement is needed. Use two wrenches to remove a damaged nipple to prevent damaging the connection to the bag itself. Clean with soapy water, (do not use any petroleum products to clean) fill bag with 30 psi (air) and check for leaks. If any water gets into bag, invert and allow to drain. Operating temperatures between -40 F and 150 F.

Pneumatic Gun

Only field repairable part is the retainer ring at the end of the gun. A retainer key comes with the kit. If the retainer becomes loose, use this key to tighten it back on. Since our application will primarily be powered with class “D” air, it is important that we regularly oil the gun. A couple of drops into the air nipple will suffice. This will prevent the internal rubber parts from drying out.

When operating in a dusty, damp, abrasive environment it will need to be cleaned. Immerse the air gun vertically in a dry cleaning solvent (P-D-680, or Stoddard’s Solvent), to clean. Only operate the air gun when the bit is firmly against an object. When operated without pressure against the bit, the piston may become jammed or turn the bit into a projectile. Always treat the gun as a loaded weapon, and never point it at anyone.

Trouble

Piston stops Reciprocating

Possible Remedy

No air pressure or too low pressure, check supply and hoses for kinks/bends.

Plugged air holes in shuttle valve handle assembly.

Trouble

Piston Stalls, Slow operation

Possible Remedy

Lack of lubrication

Excessive moisture or lubrication

Worn piston spring



Speaking Points (continued)

Pneumatic Gun

Trouble

Loss of Power

Possible Remedy

Air Leaks

Worn/damaged “O” ring seals

Damage to rear bumper

Dull Tool Bit

Trouble

Tool Bit Stuck in Gun

Possible Remedy

Flange on tool bit is flared, file to repair.

Tool bit too soft, check operating pressure for bit being used.

Tool bit not being held against work piece when operating.

Air pressure too high.

Low Pressure Air Cushions

A “patch kit” like you would find with nylon inflatable boat comes with the cushions. Clean and rough up the mating surfaces (patch) with emery cloth and apply three coats of adhesive. Allow each coat to become tacky before applying the next. Press together, removing any air bubbles, apply even pressure with weight or clamp and cure overnight in at least 68 F temperature. If tears/holes are greater than 1 inch in any direction return to Paratech.

Check audible relief valves, hose connections. Inflate to 2 psi and wash with soapy water to check for leaks.

Test quarterly.

Hoses

All Paratech hoses are field repairable. If a hose is damaged/cut, using a knife cut straight down creating a square edge. Using pliers remove the air fittings and ferules by unscrewing clockwise. Where you made the straight cut, replace the air fitting by screwing the ferule back on counter clockwise.



Speaking Points (continued)

Senco Nail Gun

Never use oxygen, carbon dioxide or any other bottled gas except our SCBA tanks or a tool compressor to operate any of our pneumatic tools. Keep your finger off the trigger when not actively shooting nails; carry your finger under trigger to help prevent mis-fires. Always assume the tool is powered and contains fasteners, do not point at anyone. Do not force the tool, check force setting and ensure correct fasteners for your application. Fasteners can ricochet. Disconnect tool from air when clearing a jamb or other maintenance. Do not exceed 200 psi into the tool. A male air fitting should be fitted into tool so it will bleed off pressure when disconnected. To adjust depth, disconnect air and using a wrench adjust the safety element to desired depth. Oil the gun twice a day, with Senco pneumatic oil, 5 to 10 drops into air inlet of gun.

Trouble;

Air leak at tool, sluggish/weak operation.

Possible Remedy;

Verify air supply, tighten/check connections, and tighten screws.

Trouble;

Poor feed, tool jamming

Possible Remedy;

Clean tool, lubricate magazine

Air Regulators

There are two types of regulators used for rescue tools, a larger regulator with a "T" handle is the diaphragm type, it delivers more air than the second type which is a smaller, piston type. Each regulator type uses two pressure gauges; the one on the bottle side reads the pressure in the bottle. The gauge close to the tool reads the out put pressure being sent to the tool thru the hose. This pressure is set by adjusting the "T" handle or a round knob. This changes the size of the diaphragm, or piston surface area, and adjusts the pressure. If you adjust your pressure too high and want to back it down you may find that the regulator is not self venting and the pressure will not drop till relieved thru another opening.

Check that the small valve with the arrow is pointed toward the tool; this is the "on" position. The threaded coupling that attaches the regulator to the bottle has an "O" ring, check that it is in place and not broken. Check your tools operating pressure so you do not over power it. When storing, back the "T" handles, knob, out till off the diaphragm, spring, preventing a memory.



Speaking Points (continued)

Torches

Petro-Gen

Oxy-fuel torch, cuts ferrous metals, can not weld. Assure fresh gasoline with NO additives. Good for making very thick cuts, and long term operations. Requires more maintenance than an oxygen acetylene torch, but if cleaned and taken care of will provide a solid performance. Maintain adequate ventilation and/or monitoring for CO/LEL. Do not open gasoline valves too fast, open ¼ slow, then once pressurized, full open. Keep gasoline pressure at 30 psi. Consult the label displayed on the gasoline tank for operating pressures vs. tip size. Clean and purge gasoline lines, containers, hoses, with carburetor cleaner after every use before storage. Demonstrate flame start up/adjustment and shut down.

Trouble;

Poor flame, tip overheating

Possible Remedy;

Clean/replace tip

Re seat tip in torch head

Trouble;

Raw liquid fuel coming out of tip.

Possible Remedy;

Too much pressure in gas tank

Too low pressure on oxygen

Valve seats on torch varnished

Trouble;

No gasoline flow

Possible Remedy;

High flow ball valve on gas tank closed

Check valve in gas tank blocked by varnish



Speaking Points (continued)

Oxygen – Acetylene

Versatile and easily service anywhere. Quick to put into operation. Cuts and welds ferrous materials only. Set up regulators and adjust to proper pressure for tip size. Do not exceed 15 psi on acetylene. Kit comes with special PPE, goggles, tip cleaner, and a torch wrench. Open oxygen all the way, acetylene ¼ turn open so it can be turned off quickly if needed. Keep acetylene bottle upright. Maintain adequate ventilation and/or monitoring for CO/LEL. Consider posting a fire watch after the burning operations. Take care not have hoses in path of falling debris and flames. Go over torch head/valve set up. Demonstrate flame adjustment, cleaning tips, reverse thread connection, and proper shut down. Review safety precautions. Refer to student SCT manual for more detail.

Trouble;

Poor flame

Possible Remedy;

Re seat tip, clean ports on tip

Trouble;

Not able to get a neutral flame

Possible remedy;

Clean tip

Check pressures for the size tip in service

Trouble;

Blue flame with black smoke

Possible remedy;

Ambient temperature too low < 20 F

Allow bottles to warm up

Trouble;

Not cutting, melting, but not making kerf

Possible remedy;

Working on a non ferrous material

Tip too small

Moving tip too fast

Trouble;

Erratic flame

Possible Remedy;

Purge lines, 5 seconds for every 25 feet of hose.



Speaking Points (continued)

Exothermic Torch

Cutting only, creates a large fire ball. Not a precision tool. The operator needs to keep pushing the sacrificial rod into the work piece. Consumes a lot of oxygen. Will cut metal the O-A, and the Petro Gen won't; such as, bronze, stainless steel, aluminum, copper. Will also spall concrete and burn through heavily rusted metal. Always check the collet for the size rod you are using and that the gasket is in place. The collets often get damaged by burning the rod too close to the handle.

Trouble;

Won't ignite rod

Possible Remedy;

Low battery

Striker, slagged up

Poor electrical connection

Hydraulic Systems

Stanley Tool

Power unit can flow hydraulic fluid up to 2000 psi at 8 gallons per minute. Flows are adjustable via front panel switch next to the pressure out port and the pressure return port connections. All the tools in the FEMA/US&R cache operate at 8 GPM. The engine runs on regular gas, 89 octane, with an oil pressure switch that can shut off the engine if crankcase oil pressure is too low. Electronic throttle to help conserve fuel, and limits noise by controlling idle and running speed when using tools. "Power Link Invertor System" which can provide 110 VAC, between 1000 and 1500 watts depending of motor speed, turns on/off via panel switch. 12 VDC outlet is always on. Lift and latch handle and center lifting point on frame of power unit. Hoses are non-conductive. In cold weather allow tools and fluid to heat up prior to use. In hot weather the hydraulic fluid may expand to the point where you can not easily make or break hose connections, requires bleeding pressure back through the system. This unit can operate on a variety of hydraulic fluids, check with manual for a full list of compatible fluids. Operate in a well ventilated area. Consider the fluid as flammable and have suppression near by while operating.

Power Unit has a fault indicator which will display trouble codes. Refer to manual for interpretation of these codes.

Review the DS-11, Rotary saw, drill, and jack hammer operation including the changing of blades/chains/bits/belt. Review water flow requirements for DS-11.



Speaking Points (continued)

Stanley Tool

Trouble;

Engine will not start

Possible Remedy;

Make sure flow selector is off.

Check battery and battery connections.

Check for fuel.

Defective spark plug.

Fuel filter plugged.

Trouble;

Hydraulic fluid blowing out of reservoir vent.

Possible Remedy;

Hydraulic tank overfilled.

Check/tighten suction connections.

Trouble;

Hydraulic tool will not operate.

Possible Remedy;

Check for correct setting of Flow Selector Switch (5-8 GPM)

Make sure hose circuit is correct, pressure to input of tool, output of tool to return on power unit.

Hydraulic pump/engine coupling defective.

Relief valve stuck open, adjust or replace.

Hydraulic hoses kinked.

Check electrical connections.



Speaking Points (continued)

Hurst Vehicle Rescue Kit

Inspect for leaks. Check hoses for excessive wear and make sure all fasteners are tight. Make sure fluid levels are full; do not use any fluid other than Hurst phosphate ester fluid. The regular gas engine has a fuel shut off, and electrical on/off switch. When cold starting, move throttle to fully down or fast position. And choke to close position, may not need this if engine is warm. Pull recoil starter cord and gently allow it to return once engine is running/warm return the choke to the open position. Move dump valve to the run position, and cycle tool to purge air. Start engine/pump with dump valve open so the gas engine has no load on it during start up. Also have the dump valve open to change out tools. Do not use hands to check for pin hole leaks this pressurized fluid can penetrate skin. Consider the fluid as flammable and have suppression near by while operating.

Trouble;

Engine fails to start or is hard to start.

Possible Remedy;

Out of gas, check tank and fuel filter/line.

Spark plug disconnected or faulty.

Check air filter and plug gap.

Check crankcase oil level.

Trouble;

Engine overheats.

Possible Remedy;

Low oil level.

Air flow obstructed. Always operate in a well ventilated area.

Trouble

Pistons do not advance

Possible Remedy;

Low on the fluid

Loose seals, coupling

Load too heavy

Air trapped in system



Speaking Points (continued)

DC-25X Benner Nawmen Rebar Cutter

Hydraulic/electric powered tool, rated to cut grade 60, #8 or one inch rebar in 5 seconds. 110 VAC, 12 amps, generating 2 HP. Generates a cutting pressure of 30 tons. Good tool when you are concerned with heat transfer or cutting plastic or epoxy coated rebar. Cutting dies replaceable in the field with a wrench. Keep working piece at right angles to the cutting dies, wear eye protection. Check cutting dies for tightness, these blocks can be rotated once chipped for continued use. Keep vents clear of obstructions, maintain a firm grip on tool as the rebar often breaks loose close to finishing cut, this cutter weighs 50 pounds and tool reaction can injure the operator.

You may need to bleed the hydraulics on your cutter if it is running too slow or does not have the pressure to cut. Do not run with no or too low on oil.

Oil (hydraulic fluid) may need to be warmed up prior to use, run tool for two minutes to heat up.

The stopper bolt adjustment is important part of tools operation.

1. Screw in stopper to provide sufficient clearance for rebar.
2. Insert rebar fully into U-shaped support. Make sure the rebar is resting on the base support.
3. Keeping rebar at right angles to the front cutter block, screw out stopper until it is just touching the rebar. Once set, the stopper needs no further adjustment while cutting the rebar of the same diameter, but must be reset for different size rebar.

Without this adjustment the free end of the rebar may fly off, uncontrolled.



Speaking Points (continued)

Ramset Powder Fired Nail Gun

Tool system designed to drive pins into wood, brick, stone, steel, and concrete. Do not use on glass, glazed brick, cast iron, or other brittle materials. Do not use on pressurized tanks. Select the correct pins and powder charges for your application. Do not place hands around muzzle or load till ready to use. If unsure of the of charge strength needed, start with the lowest power. Dry cycle the tool before loading, check slide and magazine feed for correct movement. Properly orient pins and charges into gun. Never point tool at anyone. Do not use around flammable/explosive atmospheres, or where charges could be exposed to high heat. When ready hold tool firmly against work piece at a right angle, verify everyone around tool has safety glasses on. When the fastener is properly set the head of the pin will be flush with the surface. Adjust power and power setting (near rear of tool) as needed. When finished unload and return to case. Disassemble and clean thoroughly after each use, check for wear, and apply a light film of oil. Demonstrate loading and firing.

Treat as a loaded gun.

Trouble;

Difficult to re-cycle, rough action.

Possible remedy;

Bent or damaged piston. Excessive build up of carbon residue.

Trouble;

Reduction or loss of power;

Possible remedy;

Piston not returning to full rear position, or broken piston.

Faulty piston clip.

Dirty tool.

Damage to retractor pawl.

Trouble;

Tool does not fire. **Do not remove tool from surface for 10 seconds.**

Possible remedy;

Failure to depress tool fully.

Build up of dirt fouling firing pin.

Cartridge strip damaged.

Trouble;

Cartridge strip does not feed properly.

Possible remedy;

Cartridge strip damaged.

Strip index mechanism damaged.



Speaking Points (continued)

Electric Power Tools

Hilti DD-130

120 VAC powered tool produces up to 1900 watts. USAR cache comes with diamond and carbide tip core bits capable of making a 2 inch hole. All diamond cores and blades in our inventory can cut wet or dry. To use this system wet you need to fill the water can and attach it to the drill, and close the larger dust collector port. Pump air pressure into water can till enough pressure is developed to maintain a uniform flow. Start the hole by coring on the edge of the bit and slowly bring it upright as the kerf develops. Ensure that water is flowing (through) the center of the core, and by observing the indicator on the handle for flow. Keep a eye on the overload indicator, pressure on the core may need to be reduced if over load indicator lights. Install bit (no tools needed) by turning the chuck CCW and push in it engages. Built in GFI. Assure that the core is firmly in place by attempting to pull it out. Drill speed selector position on the side of the tool may help to select the most efficient speed for the application. Typical speeds, II or III for a 1 5/8 , to 2 1/2 inch hole in concrete. Tool maybe used in any position. Water may not work when working overhead.

Keep the tools ventilation ports open and do not allow foreign objects to get inside tool. Keep tool body clean, do not pressure wash or steam clean as it may affect the electrical safety of the tool. Lubricate the chuck with Hilti spray lube, and ensure the chuck is free of debris. Apply a light coat of oil to the core bits.

Trouble;

Tool does not start.

Possible Remedy;

Check electric supply

Check electric cord, defective trigger switch, GFI tripped.

Trouble;

Motor runs but bit does not turn.

Possible Remedy;

Defective gearing.

Trouble;

Feed rate keeps decreasing.

Possible Remedy;

Reduce water pressure

Defective core bit.

Gear box defective.

Core segments needs re-surfaced.



Speaking Points (continued)

Hilti DD-130

Trouble;

Motor cuts out.

Possible Remedy;

Allow tool to cool off, motor overload has activated.

Check electronics have failed.

Is the cooling fan running.

Trouble;

Water does not flow.

Possible Remedy;

Filter or water flow indicator needs unblocked.

Trouble;

Water escapes at gear housing.

Possible Remedy;

Shaft seal, water swivel, needs replaced.

Trouble;

Core bit can not be inserted into chuck

Possible Remedy;

Repair clean/lube connection end/chuck

Trouble;

Water escapes at the chuck

Possible Remedy;

Connection end or chuck dirty.

Chuck seal defective

DeWalt Reciprocating Saw

120 VAC or battery powered saw. Double insulated with a polarized plug. Speed as determined speed selector wheel and by how far the trigger is depressed. Slower speeds should be used for starting cuts. Wood and bi-metal blades come with the saw. To change blades unplug saw and turn blade release lever up. Insert new blade (shank first) into chuck. Do not force the blades as they cut. Use adjustable saw/blade shoe to prolong blade life. Hold saw firmly against work piece. Lubricate the chuck shaft as needed.



Speaking Points (continued)

Milwaukee Die Cutter (Wizzer Saw)

120 VAC, 4.5 amps, 21,000 RPM. Caution with the paddle switch, when tool is laid down it could easily turn on. Cutting action from this tool may produce harmful dust, wear filter mask as needed along with other PPE. This saw has a special collet and collet nut. Make sure the collet matches the mandrel that holds the cutting wheel tightly. Insert mandrel a minimum of $\frac{3}{4}$ of an inch into collet. You will need a $\frac{1}{2}$ and $1\frac{1}{16}$ open wrench to remove or tighten the mandrel. The tool comes with a trigger lock, to release pull the paddle switch, clicking the “on” switch will immediately unlock trigger. Keep vents free of debris, clean case with mild soap and water, do not get water in tool.

Tips for Using Diamond Blades/Cores

1. You can cut a dry blade wet, but do not use a wet blade dry.
2. Inspect diamond segments prior to use.
3. Inspect for core flatness, bent blades, segment damage, and arbor hole/chuck damage.
4. Check for proper saw machine condition. Spindle bearings should be free of end and radial play.
5. Follow manufactures recommendations on operating speeds for specific blades vs. material to be cut.
6. Maintain a firm grip on tool and wear all appropriate safety equipment.
7. When dry cutting frequently remove the blade from the cut to allow blade to cool.
8. Don't stand in front of a running/cutting rotary saw.
9. Do not cut or grind with sides of the blade.
10. Do not use blades with cracked/missing or uneven segments.
11. Diamond blades get damaged due to;
 - a. Twisting blades while inserted in material.
 - b. Overheating due to inadequate water supply
 - c. Not applying water to both sides of blade.
 - d. Cores get worn thin due to highly abrasive material being cut.
 - e. Blade is too hard for the material being cut.
 - f. Saw machine has defective bearings/arbor/spindle.
12. Short cutting life.
 - a. Improper cooling/flushing of material.
 - b. Rule of Thumb; 2 to 5 gallons per minute cutting concrete
 - c. Check saw machines drive belt.
 - d. Blade will not cut, not broken in properly
 - e. Blade has become dull, dress the blade by grinding on material by apply light pressure to expose fresh diamonds.
 - f. Saw machine/power source defective.
13. Do not force tool.