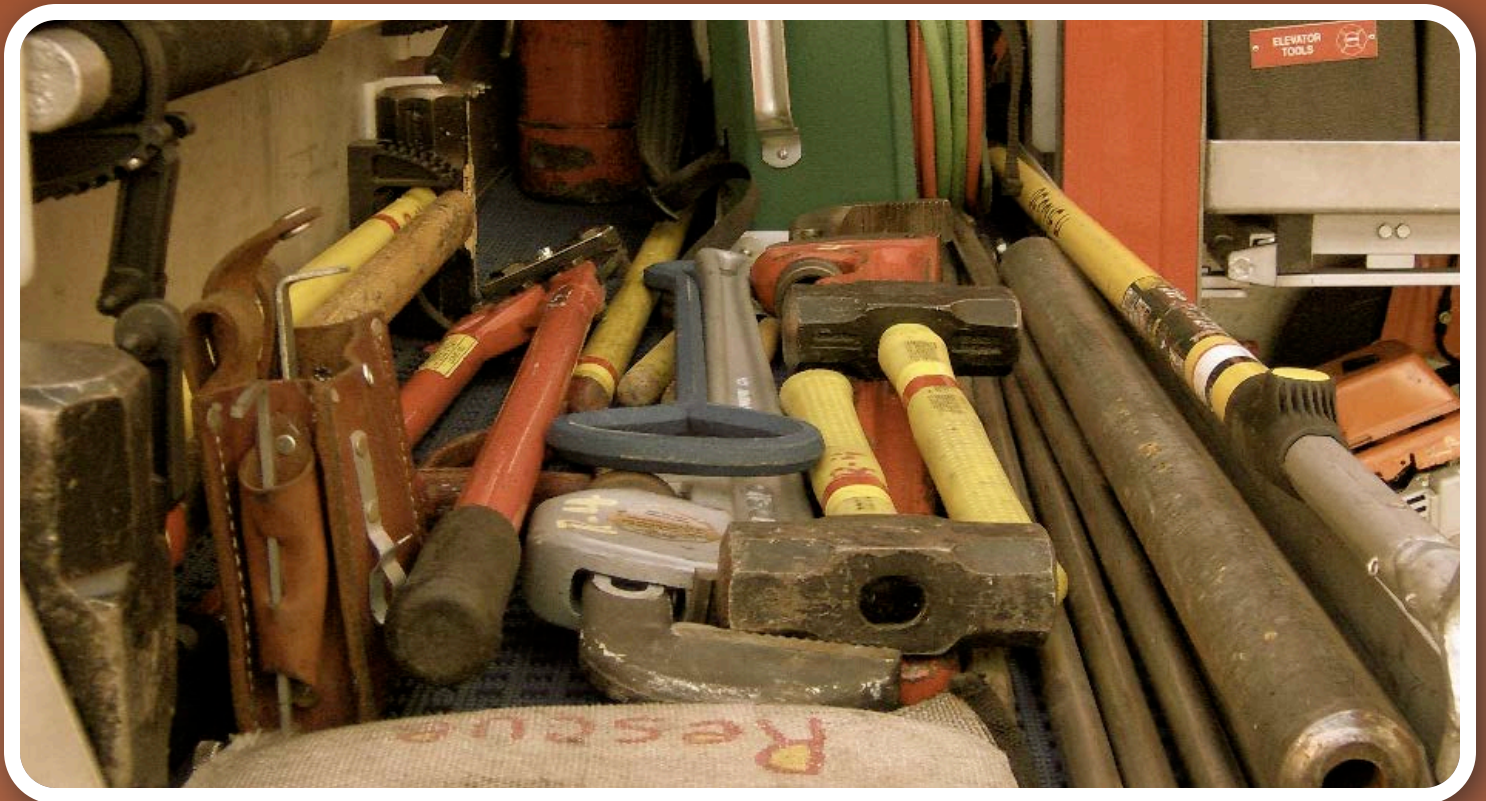


# Firefighting Equipment & Handtools

# 5

Section I - Firefighting Fundamentals



**Gasoline Powered Equipment**

**Hydraulically Powered Equipment**

**Electrically Powered Equipment**

**Pneumatically Powered Equipment**

**Fire Service Handtools**



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# Objectives

- Identify the five categories that fire service tools and equipment are utilized
- Describe how an internal combustion engine works
- Explain the difference between a 2 stroke and a 4 stroke cycle engine
- Describe how to mix 2 stroke and 4 stroke cycle fuel per SDFD standards
- Identify the types of gasoline powered equipment used by the SDFD
- Describe the principle behind hydraulic power
- Identify the types of hydraulically powered equipment used by the SDFD
- Describe how an electric motor works
- Identify the types of electrically powered equipment used by the SDFD
- Describe how pneumatic powered equipment works
- Identify the types of pneumatically powered equipment used by the SDFD
- Describe how levers create a mechanical advantage
- Explain the three classes of levers
- Identify the types of fire service hand tools used by the SDFD
- Describe the procedures for maintaining hand tools



# Introduction to Power Equipment and Hand Tools

Firefighters rely on tools and equipment to successfully accomplish many tasks. In order to respond and work in high stress situations, it is essential that all firefighters have an exceptional understanding of not only the tools available, but how to maintain and operate them in a safe and effective manner. Emphasis is placed on the firefighter during the fire academy to know every aspect of the tools described in this chapter. These tools will not only be the ones you will use to save a life, but they may also be the ones you use to save your own life.

A firefighter should always have a tool in their possession

## Types of Firefighting Tools & Equipment

There are a wide variety of tools and equipment available to firefighters. The tools and equipment utilized on the fire department are the result of over one-hundred years of progress resulting from the lessons learned through trial and error. Some tools are quite generic and flexible in their use, such as a sledge hammer which has many applications. Others are quite specific in their use and have been developed by firefighters for tasks such as gaining access into a jammed elevator door.

In general, we classify our firefighting equipment into the following categories:

- Gasoline Powered Equipment
- Hydraulic Powered Equipment
- Pneumatic Powered Equipment
- Electric Powered Equipment
- Hand Tools

As you read through this chapter, take a moment to make mental slides of each piece of equipment and the situations that may arise where you will need to use it. It will only be through continuous training and experience that you will be able to instinctively recognize and decide which tool is the right tool for the job.



# Gasoline Powered Equipment

## Gasoline Powered Engines

The basic principle behind the internal combustion engine is fairly simple: place a small amount of high-energy fuel (gasoline), in a small enclosed space (cylinder), and ignite it (spark plug). You will create energy from the expanding gas (combustion) as a result. Gasoline powered equipment harnesses the power created from the engine to perform tasks that assist firefighters. Tools such as a chain saw, portable generator and Ram-fan all rely on this theory to operate.

Gasoline powered engines are typically categorized into the following categories, two stroke and four stroke engines.

### Two Stroke Engines

Two-stroke engines power tools such as the chain saw and rescue saw. One quick way to determine if a piece of equipment is a two-stroke or four-stroke engine is to identify a separate oil reservoir for the engine (not to be confused with the oil reservoir for the bar of the chain saw). In two stroke engines, the oil is mixed with the fuel in advance therefore eliminating the need for an additional oil reservoir.

The advantage of a two-stroke engine is that it is lighter and more powerful than a comparable four-stroke engine. Two-stroke engines can work at any angle and orientation to the ground due to the pre-mixed fuel and oil. These engines are also simpler and less expensive to manufacture than a four-stroke engine. The disadvantages of a two-stroke engine is it is louder, wears faster, and is less fuel efficient than a four-stroke engine.

A two-stroke engine operates in two distinct processes: induction and compression, ignition and exhaust.

- Induction and compression occurs when the fuel/air mixture from the carburetor enters the cylinder when the piston is at the bottom of its stroke. The piston travels to the top causing the fuel/air mix to compress.

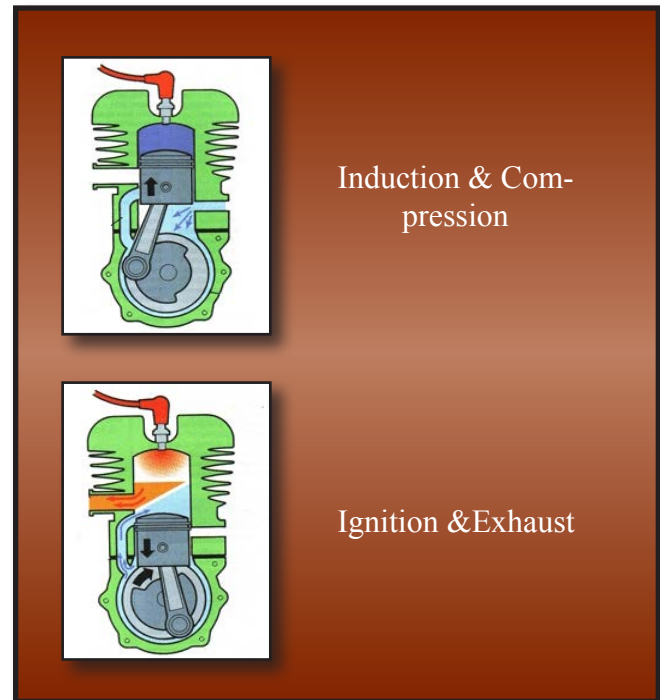


Figure 5-1 Two Stroke Engine Cycles



- The ignition and exhaust occurs when the compressed mix is ignited by the spark plug. This action forces the piston to the bottom of the cylinder, and on the way down the exhaust gases are relieved through an exhaust port.

Each process is one stroke of the piston, therefore calling it a two-stroke engine.

### *Fuel Procedures for 2 stroke Engines*

Two-stroke engines have no separate gas and oil reservoirs. They require the gas and oil to be combined together, forming a mixture called “pre-mix”. The SDFD currently uses “TruFuel” 50:1 Mix Engineered Fuel for all two-stroke engines (See Fueling Procedures below)



Figure 5-2 TruFuel 2 Cycle Fuel 50:1

### Four-Stroke Engines

Four-stroke engines power equipment such as the Ramfan, portable generator, Amkus power unit, Holmatro power unit as well as the common automobile. These engines have separate oil reservoirs used to lubricate the engine. They are more fuel efficient, quieter, and pollute less than a two-stroke. However, they are required to operate on a flat surface, are heavier, and have a lower power-to-weight ratio.

It takes twice as many movements to create power with a four-stroke engine as compared to a two-stroke engine. The four-strokes are the induction, compression, power, and exhaust stroke.

- Induction - During the induction stroke, the piston moves to the bottom of the cylinder and fuel and air enter through an intake valve.
- Compression - The piston moves to the top of the cylinder, compressing the fuel-air mixture during the compression stroke.
- Power - The spark plug fires when the piston reaches the top of the cylinder, forcing it back down to the bottom. This is called the power stroke.
- Exhaust - The piston finally returns to the top of the cylinder, expelling the spent fuel-air mixture through the exhaust valve. This occurs during the exhaust stroke.

Four-stroke power equipment is fueled with “TruFuel” 4 Cycle Engineered Fuel (Grey Can)

Because four stroke engines require a separate oil reservoir, it is necessary to frequently check the oil level. Attached to the oil reservoir cap is a dip stick for checking the oil level. Place the equipment on a flat surface, remove the dipstick, wipe it clean, re-insert it, then remove once more to check the level. If oil does not read in checkered portion of the dip stick, add 30 weight oil or contact Station 23 for assistance.



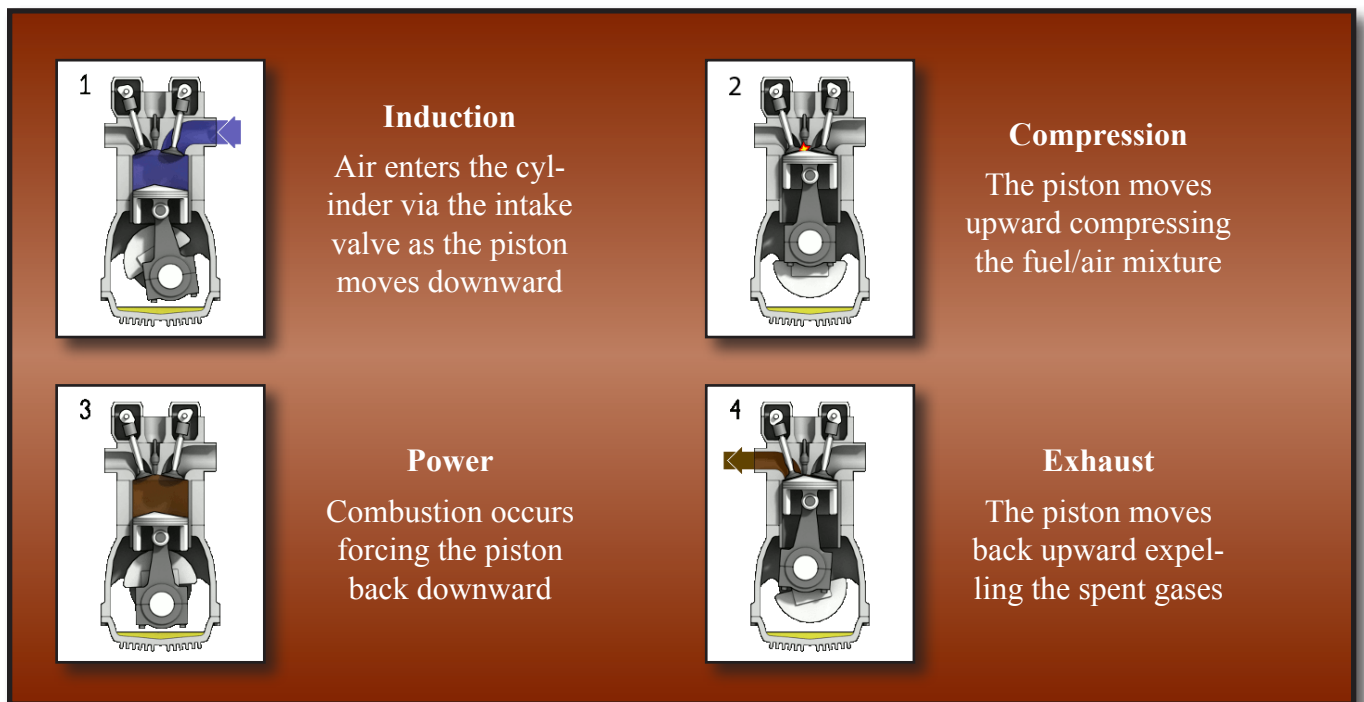


Figure 5-3 Four Stroke Engine Cycles

## SDFD Power Equipment Fueling Procedures

TruFuel shall be used to fill all firefighting and station small engine equipment (generators, saws, lawn mowers, blowers, edgers, etc.). TruFuel is a high octane, ethanol-free, long shelf life fuel that comes either as 4-cycle or pre mixed 2-cycle product. TruFuel pre-mix eliminates the need to measure and mix. For our use, the fuel is packaged in color coded, 32 ounce, DOT-compliant cans. The fuel will remain stable for more than five years in the sealed can, and two years if the can is opened. The fuel doesn't require any fuel stabilizers (such as Sea Foam).

Two types of canned fuel are provided:

- 2-cycle 50:1 pre-mix fuel (red can) [Figure 5-2](#).
- 4-cycle straight gasoline (grey can) [Figure 5-4](#).

Each engine or truck will carry two cans of each fuel type. TruFuel shall be carried in the original packaging until completely consumed. It shall not be transferred to any other container. There is no need for the use of a filter funnel when transferring fuel from the original packaging into the power equipment.



Figure 5-4 TruFuel 4 Cycle Fuel



## Gasoline Powered Equipment Maintenance and Repair

It is imperative that our power equipment is properly maintained and in working condition. Lives may depend on the operation of the tool. It is every firefighter's responsibility to know how to operate and maintain all emergency power equipment on all fire apparatus. Power equipment should be checked daily for readiness and should be started and run at a minimum of once every four shifts. Typically, all power equipment is started on the first shift of the four day work cycle.

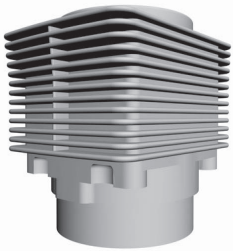


Figure 5-5 Air Cooled Cylinder

Fire station 23 is the designated repair facility for all SDFD portable power equipment. If tool discrepancies are found, repairs needed, or should you have any questions or concerns regarding a tool, you should contact station 23 personnel for guidance. The following paragraphs cover general maintenance topics regarding power equipment. More tool specific maintenance information will follow later in this chapter.

Most gasoline powered equipment is air-cooled. Gasoline powered equipment does not have a radiator and water pump to circulate coolant around the cylinders to cool the engine like a car. Instead, the cylinder is surrounded by fins to dissipate heat, [Figure 5-5](#). It is important the fins are kept clean and free from debris. For example, after using the chain saw, the fins may become clogged with roofing material, sawdust, and other debris. If the fins are not properly cleaned, it can cause the engine to overheat and seize, thus ruining the engine.

In the past, it has been common practice to store gasoline powered equipment in the ready or start position. This includes the chain saw left with the master control lever in the start position and the rescue saw slide control in the start position. Although this leaves the equipment in a constant state of readiness, it also leaves the passageway from the fuel tank to carburetor open. Due to the viscosity of gasoline, the carburetor may leak fuel into the cylinder, past the piston, and into the crankcase. This can lead to serious engine damage and potential catastrophic failure of equipment. It is now the policy of the SDFD to leave the power equipment in the "OFF" position until it is time to put the tool in operation.

Do not manipulate the carburetor adjusting screws. This is only to be performed by station 23 personnel using a tachometer. If the power equipment is not running properly, (e.g. chain saw engine stops while idling, or the chain creeps while the engine is idling; the engine idle is choppy or has poor acceleration) contact station 23.



## Gasoline Powered Equipment Safety

Gasoline powered equipment is to be used with due regard for safety. Each year there are numerous injuries that result from the misuse or mechanical failure of powered equipment. The following are a few key safety precautions that should be taken each time you operate gasoline powered equipment or tools.

- Gasoline engines not only generate a lot of force, but they generate heat and noise. Gloves and ear protection should be worn when operating these tools.
- Do not operate gasoline powered equipment in confined spaces or poorly ventilated areas as the exhaust fumes contain carbon monoxide gas.
- Ensure all appropriate safety gear and PPE is being utilized when operating these tools, including eye protection.
- Probationary firefighters and fire recruits will remove their neck ties prior to starting or operating any power equipment.



## Stihl Chain saw



1. DESCRIPTION: ONE CYLINDER, TWO-STROKE CYCLE, GASOLINE POWERED, CHAIN SAW
2. USAGE:
  - 2.1. Ventilation
  - 2.2. Forcible Entry
  - 2.3. Rescue
3. ACCESSORIES:
  - 3.1. Slot screwdriver/socket tool, [Figure 5-6](#).
4. SPECIFICATIONS:
  - 4.1. 3.72 cubic inch engine
  - 4.2. 12,000 rpm max. speed
  - 4.3. 20" guide bar with carbide tipped chain
  - 4.4. Hand guard with chain brake
  - 4.5. 50:1 Fuel oil mixture
  - 4.6. Lubricate chain with 30 wt. oil
  - 4.7. Weight - 19 lbs
5. ADDITIONAL EQUIPMENT:
  - 5.1. 2-ladders (escape routes)
  - 5.2. Roof ladder
  - 5.3. Thermal imager
  - 5.4. Roof hook / Pike pole
  - 5.5. Axe and ladder man's belt
  - 5.6. Square nose shovel
  - 5.7. Rope bag / Drop bag



Figure 5-6 Chainsaw Tools



- 5.8. Partner
- 5.9. Charged hose line
- 5.10. Fuel
- 5.11. Tools to maintain and clean saw

## 6. SAFETY PRECAUTIONS:

- 6.1. Wear full protective safety gear and eye protection
- 6.2. Never lug or bind chain
- 6.3. Change chain when 3 teeth in a row or 6 total are damaged or missing

## 7. DAILY CHECKS:

- 7.1. Fuel & oil levels
- 7.2. Chain tension
- 7.3. Pull cord
- 7.4. Start & run

## 8. STARTING & OPERATING PROCEDURES: [LINK 5-1](#)

*Reference Appendix A - Academy Truck SOG - Drill #6 for step by step written instructions*

## 9. CHAIN SAW MAINTENANCE:

- 9.1. Properly remove chain by first releasing the chain break by pulling guard back toward handle bar. Now unscrew the hexagon nuts and remove the sprocket cover. Back off the chain tension screw by turning left (counter clockwise) to the end of its thread. Now you can lift the chain off the bar and sprocket.
- 9.2. Properly clean bar by removing dirt from groove with thin blade, blow oils and dirt out with compressed air, clean with all-purpose cleaner.
- 9.3. Properly clean chain with all purpose cleaner or wire brush. Blow dry and oil chain with 30 wt oil.
- 9.4. Properly tension chain, [Figure 5-7](#):
  - 1. Check chain tension when chain is cool and fully oiled.
  - 2. Raise chain from bar groove and let snap back.
  - 3. Tension is correct when the chain moves freely around the bar when firmly pulled by hand (use glove or rag to protect fingers), and the bottoms of all straps and cutters touch the underside of the bar rails fairly snug.



Figure 5-7 Proper Chain Tension



4. If chain tension needs to be adjusted, the tension adjustment screw is located on the inside of the chain bar between the bar and motor housing.
  1. First loosen the hexagon nuts on sprocket cover.
  2. Now tension the chain by turning the tension screw clockwise until there is little chain sag on the underside of bar. Make sure the drive link tongs are properly located in the guide bar groove.
  3. Screw hexagon nuts finger tight.
  4. Hold bar up and tension the chain until it lies against the underside of the bar.
  5. While still holding the bar nose up, tighten the two hexagon nuts.

9.5. Clean engine area.

1. Remove fan housing and plastic cover on top of cylinder. Clean all deposits from cooling fans and housing area.
2. Reassemble fan housing, pull starter rope out six inches. Place fan housing in its proper position then release starter rope. This will engage starter pulls so fan housing will seat properly.

9.6. Clean air filter, [Figure 5-8](#).

1. Remove plastic cover and air filter. Clean all deposits from air filter.
2. Reassemble air filter and replace plastic cover.



Figure 5-8 Air Filter

## Stihl Chain Saw Schematic



Figure 5-9 Right Side Chainsaw Schematic



Figure 5-10 Left Side Chainsaw Schematic



## Stihl Rescue Saw

### 1. DESCRIPTION:

One cylinder, 2-stroke cycle, gasoline powered rescue saw.

### 2. USAGE:

- 2.1. Ventilation
- 2.2. Forcible Entry
- 2.3. Rescue

### 3. ACCESSORIES:

- 3.1. Blades:
  1. Metal
  2. Wood (carbide tipped)
  3. Masonry and cast iron
  4. Combination
- 3.2. Tools for changing blades

### 4. SPECIFICATIONS:

- 4.1. 5500 RPM max. speed
- 4.2. Metal blade carried on saw
- 4.3. 50:1 Fuel oil mixture

### 5. ADDITIONAL EQUIPMENT:

- 5.1. P-Pry tool
- 5.2. E-Source of extinguishment
- 5.3. B-Blade box and extra blades
- 5.4. B-Battery kit
- 5.5. F-Fuel
- 5.6. T-Tools for changing blades
- 5.7. D-Debris cover

### 6. SAFETY PRECAUTIONS:

- 6.1. Wear full protective safety gear and eye protection
- 6.2. Never lug or bind blade
- 6.3. Be cautious of sparks and the possibility of blade disintegration
- 6.4. Clear area of unnecessary personnel when starting saw
- 6.5. Check and clear of flammable objects
- 6.6. Make sure the RPM on the blade is higher than the saws RPM







## Rescue Saw Blades



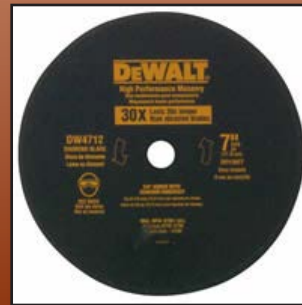
Metal Blade



Wood Blade



Combination Blade



Masonry Blade

6.7. Check for proper blade direction

7. STARTING & OPERATING PROCEDURES: [LINK 5-2](#)

*Reference Appendix A - Academy Truck SOG - Drill #10 for step by step written instructions*

8. MAINTENANCE: [LINK 5-2](#)

*Reference Appendix A - Academy Truck SOG - Drill #10 for step by step written instructions*



## Stihl Rescue Saw Schematic



Figure 5-11 Right Side Rescue Saw Schematic

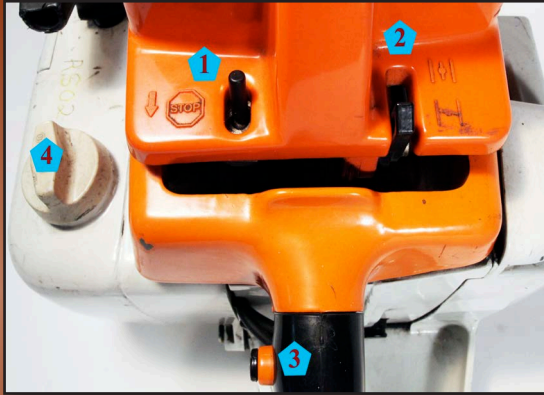


Figure 5-12 Left Side Rescue Saw Schematic



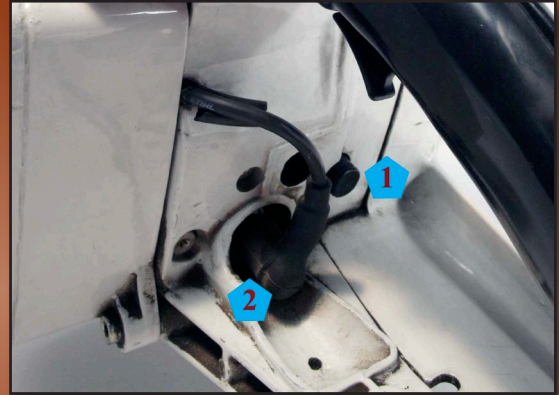
## Additional Rescue Saw Components

### Rescue Saw Controls



- 1 - Start / Stop Switch
- 2 - Choke On/Off
- 3 - Trigger Lock
- 4 - Fuel Cap

### Rescue Saw Controls



- 1 -Decompression Switch
- 2 - Spark Plug



## Gasoline Ram Fan

### 1. DESCRIPTION:

One cylinder, 4-stroke cycle, Honda 5.5 hp, gasoline powered, 5 position, rapid tilt, ramfan turbo ventilator.

### 2. USAGE:

- 2.1. Ventilation

### 3. SPECIFICATIONS:

- 3.1. Unleaded fuel only
- 3.2. 16 inch diameter fan with 21 cast aluminum turbo blades
- 3.3. Weight 84 pounds
- 3.4. Air flow:
  - 3.5. Actual = 6,500 cfm
  - 3.6. Entrained = 13,000 cfm
- 3.7. Oil alert protection system
- 3.8. Full width locking handle
- 3.9. Heavy duty wheels and rock guard for use in rough terrain
- 3.10. Run time 58 minutes

### 4. ADDITIONAL EQUIPMENT:

- 4.1. Unleaded fuel
- 4.2. "Smoke-O"

### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection
- 5.2. Keep hand away from grill
- 5.3. Keep curtains and other objects away from intake side of blower
- 5.4. Position ejector so that it will not obstruct ingress or egress of personnel
- 5.5. Do not move while in operation
- 5.6. Wear hearing protection when in close proximity to ejector

### 6. STARTING, OPERATING & MAINTENANCE PROCEDURES: [LINK 5-3](#)

*Reference Appendix A - Academy Truck SOG - Drill #4 for step by step written instructions*





## Portable Generator

### 1. DESCRIPTION:

One cylinder, 4-stroke cycle, Honda 13.0 hp gas-line powered generator.

### 2. USAGE:

To provide power for department electrical equipment.

### 3. ACCESSORIES:

- 3.1. 4 three prong outlets
- 3.2. 1 three prong twist lock outlet
- 3.3. 1 four prong twist lock outlet

### 4. SPECIFICATIONS:

- 4.1. 120/240 volt AC current
- 4.2. 6500 watt output

### 5. ADDITIONAL EQUIPMENT:

- 5.1. Unleaded fuel
- 5.2. Extension cord
- 5.3. Electrical adaptors

### 6. SAFETY PRECAUTIONS:

- 6.1. Wear full protective safety gear and eye protection
- 6.2. Never ground generator
- 6.3. 20 amp fuse for overload
- 6.4. Switch to turn electricity on and off
- 6.5. Never start or stop motor with load on it (equipment attached)

### 7. STARTING, OPERATING & MAINTENANCE PROCEDURES: [LINK 5-4](#)

*Reference Appendix A - Academy Truck SOG - Drill #4 for step by step written instructions*



# Hydraulically Powered Equipment

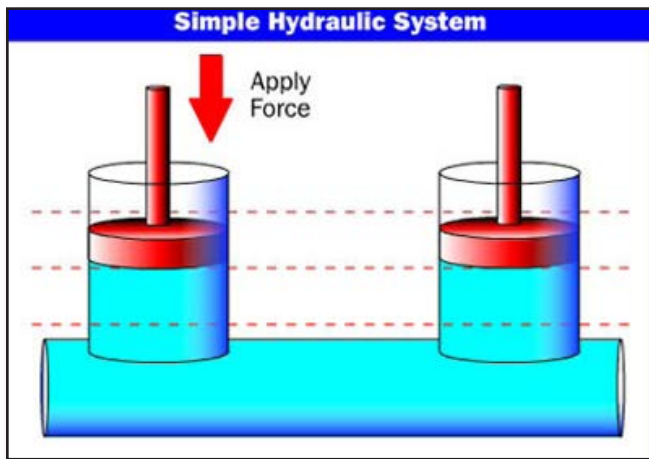


Figure 5-13 Simple Hydraulic System

The basic idea behind any hydraulic system is simple: Force that is applied at one point is transmitted to another point using an incompressible fluid. The fluid utilized is almost always an oil and the force is typically multiplied in the process.

If you apply a downward force to one piston, [Figure 5-13](#), then the force is transmitted to the second piston through the oil in the pipe. Since oil is incompressible, almost all of the applied force appears at the second piston, due to the efficiency of this system. An attribute of a hydraulic system is the pipe connecting the two cylinders can be any length and shape, allowing it to snake through all sorts of things separating the two pistons.

Hydraulic systems are beneficial because it is easy to add force multiplication to these systems. By trading force for distance, we are able to change the size of one piston and cylinder relative to the other in order to create a mechanical advantage.

For example, in [Figure 5-14](#), the piston on the right is 9 times larger than the piston on the left. So any force applied to the piston on the left will create a result that is 9 times greater on the piston to the right.

For example, if you apply a 100-pound downward force to the left piston, a 900-pound upward force will result on the right piston. The only catch is that you will have to depress the left piston 9 inches to raise the right piston 1 inch.

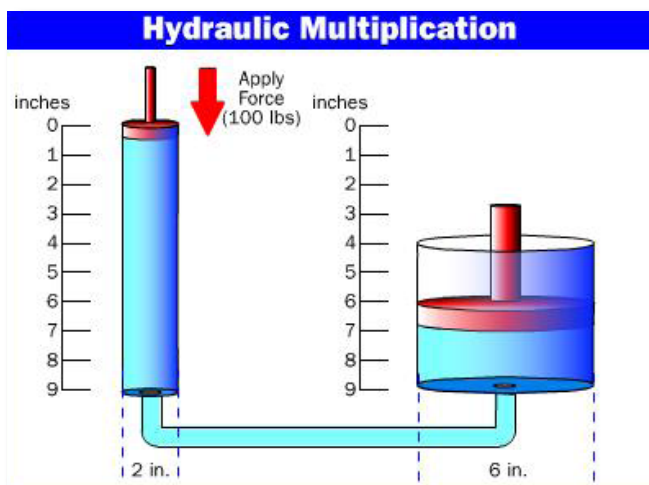


Figure 5-14 Hydraulic System with Multiplication

In order to place force on the hydraulic fluid you need to have a power source. Typically hydraulic equipment is powered by an engine or manually.

## Hand Powered Hydraulic Pump

An example of a manual powered hydraulic pump would be a car jack. By pumping the handle up and down you are exchanging distance traveled by your hand to achieve an increase in the lifting force. The SDFD utilizes an 8 ton, hand operated, hydraulic jack that is carried on all truck companies.



## Gasoline Powered Hydraulic Pump

The other type of hydraulic pump is powered by an engine. Although these are typically four stroke gasoline powered engines, we classify these tools as hydraulically powered equipment. The SDFD utilizes two gasoline powered hydraulic pieces of equipment, the amkus tool and holmatro tool. These portable hydraulic tools are used to perform vehicle rescue and extrication while generating pushing, pulling and cutting forces up to 60,000 lbs.

## Hydraulic Equipment Maintenance & Repair

When hydraulic power equipment is in need of repair or maintenance, departmental procedures shall be followed. The equipment shall be tagged utilizing a shipping tag (FDM-15) and sent to fire station 23.

## Hydraulic Equipment Safety

All of the same safety precautions and PPE that you would wear while working with gasoline powered equipment should be worn when working with hydraulically powered tools. However, hydraulically powered tools additionally require precautions and safety measures that are unique.

Below are the unique safety precautions to utilize when operating hydraulically powered equipment:

- Check to ensure the appropriate amount of hydraulic fluid is in the power unit.
- Inspect the hydraulic hoses carefully prior to each use for cuts or damage. Pin hole size leaks have been known to cause devastating injuries to firefighters due to the high pressure of the fluid contained inside the system.
- Do not try to over power the hydraulic tool. You will loose the man vs. machine conflict and cause injury to yourself!
- Wear all available PPE and eye protection when operating the equipment.
- Hydraulic fluid is an oil. Leaking fluid will create a slip hazard and will cause a safety issue when operating the equipment.
- The hydraulic hose couplings should only be connected and disconnected while the power unit is placed in the neutral position. Failure to do so may cause a high pressured hydraulic fluid injury to the firefighter.



# Amkus Tool



## 1. DESCRIPTION:

High-powered, self-contained, hydraulic: spreading, pushing, pulling and cutting device. It operates without flames or sparks, is a one person operation, hand held, and is completely portable.

## 2. USAGE:

- 2.1. Rescue
- 2.2. Forcible entry

## 3. ADDITIONAL EQUIPMENT:

- 3.1. Grab hooks and chains
- 3.2. Shackle hooks
- 3.3. Re-enforcement plate
- 3.4. Cribbing
- 3.5. Unleaded fuel
- 3.6. Pry tool
- 3.7. Blanket
- 3.8. Medical kit
- 3.9. Source of extinguishment
- 3.10. Traffic cones
- 3.11. Battery pack

## 4. SPECIFICATIONS:

- 4.1. Power Unit: [Figure 5-15](#)
  1. Weight - 100 lbs. with hose, hydraulic oil and fuel



Figure 5-15 Amkus Power Unit





2. 1 cylinder, 4-stroke cycle, 3.5 hp engine
3. 2 gallon hydraulic reservoir
4. 2 20' sections of hydraulic hose
5. Hydraulic pump operates at 10,500 psi and delivers a constant flow of non-toxic mineral base fluid to the rescue tool

4.2. Spreader tool:

1. Weight - 44 lbs. with hose, oil and tips
2. 20,000 lbs. pressure/force at the tips
3. Aluminum alloy arms with titanium tips

4.3. Cutter: [Figure 5-16](#)

1. Weight - 30 lbs
2. 60,000 lbs. cutting force
3. Special notch for cutting stock and rebar

4.4. Rescue rams: [Figure 5-17](#)

1. 30,000 lbs pushing
2. 15,000 lbs pulling
3. 20" Ram:
  1. Extends from 14"- 20"
  2. Weight: 23 lbs
4. 40" Ram:
  1. Extends from 24"- 40"
  2. Weight: 33 lbs
5. 60" Ram:
  1. Extends from 34"- 60"
  2. Weight: 43 lbs
6. 10" Extension



Figure 5-16 Cutters

5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection.
- 5.2. Use as a one person operation
- 5.3. Never handle the inside of the spreaders or cutters when in operation
- 5.4. Keep area clear of debris, which may become projectiles
- 5.5. Protect victims from flying debris
- 5.6. Never stand between tool and vehicle
- 5.7. Stabilize vehicle prior to operation
- 5.8. Ensure scene safety



Figure 5-17 Rescue Rams



## Holmatro Tool



### 1. DESCRIPTION:

One cylinder 4-stroke cycle, gasoline powered, HCT-3150 Combination Rescue Tool

### 2. USAGE:

Rapid intervention for medium to heavy rescue

### 3. SPECIFICATIONS:

#### 3.1. PPU-20 Power Unit:

1. Unleaded fuel only
2. Weight- 51.8 lbs
3. 1.6 horsepower
4. 2 stage radial pump
5. 3 quart fuel capacity
6. 60 dba noise level at 15 feet
7. Uses non-toxic mineral base fluid for hydraulic operation (1.8 quarts)

#### 3.2. HCT-3150:

1. Maximum spreading force 15,000 lbs
2. Maximum spreading distance 14 in
3. Cutting force at notch 67,600 lbs
4. Squeezing force at tips 11,900 lbs
5. Maximum working pressure 10,500 psi
6. Weight 34.5 lbs



#### 4. ADDITIONAL EQUIPMENT:

- 4.1. Unleaded fuel
- 4.2. Pry tool
- 4.3. Pressure relief tool (for use on hose only)
- 4.4. For vehicle extrication bring same additional equipment tools as the amkus tool
- 4.5. For other situations, bring additional equipment as needed

#### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection
- 5.2. Ensure scene is safe and hazards minimized
- 5.3. Ensure object is stabilized prior to cutting/spreading
- 5.4. Keep hands away from spreader/cutter

# Electrically Powered Equipment

An electric motor operates by converting electrical energy into mechanical energy based on the principle of magnets and theory of magnetism. An electric motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets, opposites attract and likes repel. An electric motor, [Figure 5-18](#), uses this principle to create rotational motion by placing magnets with alternating poles inside a housing and introducing electricity. Engineers have been able to utilize this principle to create tools that have become useful in the fire service.

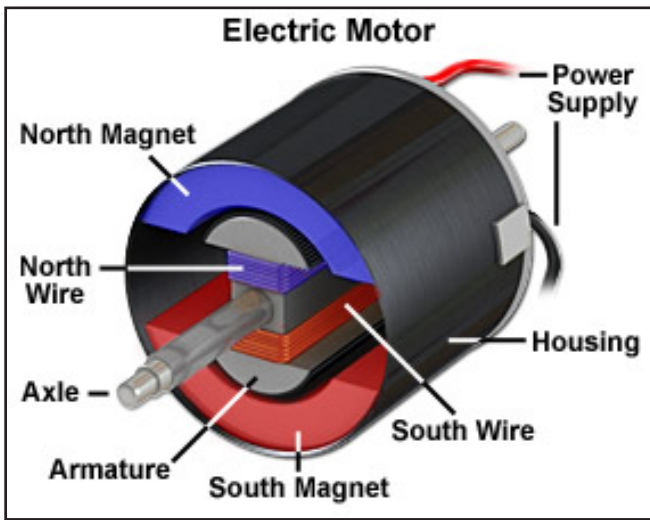


Figure 5-18 Electric Motor

Electrically powered tools are generally placed in two categories for the fire service:

- Electrically Powered - The tool requires a cord to be plugged in to a power source such as a wall outlet or a generator
- Battery Powered or Cordless - The tool operates off a rechargeable battery.
- Both of these tools have pros and cons. The electrically powered drill can be used indefinitely but its range of motion is limited by the cord. A cordless drill will have a limited duration of use but is highly mobile and a versatile range of motion.

## Electrical Equipment Safety

Electrically powered tools are effective and efficient when used safely and correctly. There are several general safety points that must be discussed before using them:

- Not all electrically powered tools are considered intrinsically safe. Intrinsically safe means the electrical and thermal energy in the tool is always sealed from the outside environment. The tool and wiring is therefore incapable of releasing sufficient electrical or thermal energy to ignite a hazardous or explosive environment.
- Only a properly tested and grounded power source may be utilized to operate electrically powered tools.
- Most new electrically powered tools are grounded internally. This can be confirmed by the presence of a 3 prong plug on the electrical cord, [Figure 5-19](#). Older style electrical tools may only have two prongs and must be

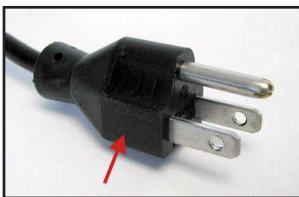


Figure 5-19 Grounded Electrical Tool



grounded using a grounding cord connected to the tool and a ground source, such as a cold water pipe.

- To avoid overloading your power source or generator, know the amperage and wattage required to operate your tool compared to that available by your power source.
- Always inspect your tool and cord for any signs of damage or malfunction.
- Always wear full PPE appropriate for the situation. Gloves and eye protection are mandatory when using any electrically powered tool.
- Use extreme caution whenever cutting into a hidden or concealed space. Live wires, water or gas lines are often found hidden within walls, ceilings and floors.





## Genesis E-Force 14C Rescue Tool



### 1. DESCRIPTION:

- 1.1. 76 Watt, 28V, Battery operated combination rescue tool

### 2. USAGE:

- 2.1. Rapid intervention for medium to heavy rescue
- 2.2. Forcible entry

### 3. ACCESSORIES:

- 3.1. Spare batteries
- 3.2. Battery charger

### 4. SPECIFICATIONS:

- 4.1. Weighs- 41.6 lbs
- 4.2. Maximum spreading distance- 14.2 in
- 4.3. Maximum spreading force- 176,000 lbs
- 4.4. Maximum cutting force- 110,380 lbs
- 4.5. Maximum pulling force- 10,900 lbs
- 4.6. Operating pressure- 10,500 lbs



## 5. ADDITIONAL EQUIPMENT:

- 5.1. Pry tool
- 5.2. Cribbing
- 5.3. Debris Carrier
- 5.4. For vehicle rescue bring same equipment as Amkus
- 5.5. For other situations, bring equipment as need

## 6. SAFETY PRECAUTIONS:

- 6.1. Wear full protective safety gear and eye protection
- 6.2. Ensure scene is safe and hazards minimized
- 6.3. Ensure object is stabilized prior to cutting/spreading
- 6.4. Keep hands away from spreader/cutter



## Half-Inch Drill

### 1. DESCRIPTION:

1100 watt, 115 volt, one half inch, reversible, electric powered drill.

### 2. USAGE:

- 2.1. Overhaul
- 2.2. Forcible entry

### 3. ACCESSORIES:

- 3.1. Stabilizing handle
- 3.2. Two 2 3/4" auger bits
- 3.3. 18" extension
- 3.4. Assorted wood and metal bits

### 4. ADDITIONAL EQUIPMENT:

- 4.1. Goggles
- 4.2. Grounding cord
- 4.3. Extension cord
- 4.4. Source of power
- 4.5. Source of extinguishment
- 4.6. Pry tool

### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection.
- 5.2. Ground tool when cutting into concealed space.
- 5.3. Unplug cord when changing bits.
- 5.4. Only use department generators or properly tested house current.
- 5.5. Have firm stance and grip before starting drill.







# Recipro Saw



## 1. DESCRIPTION:

120 volt, 700 watt, 2-speed, electrically powered reciprocating saw

## 2. USAGE:

- 2.1. Overhaul
- 2.2. Ventilation
- 2.3. Vehicle Extrication

## 3. ACCESSORIES:

- 3.1. Five Blades:
  1. Wood
  2. Metal
  3. Combination
  4. Wood scroll
  5. Metal scroll
- 3.2. Allen wrenches for changing blade

## 4. SPECIFICATIONS:

- 4.1. Identify type and use of blades:
- 4.2. # of teeth per inch
- 4.3. Color
- 4.4. Size and shape
- 4.5. Referencing blade # to manufacturer chart in carrying case

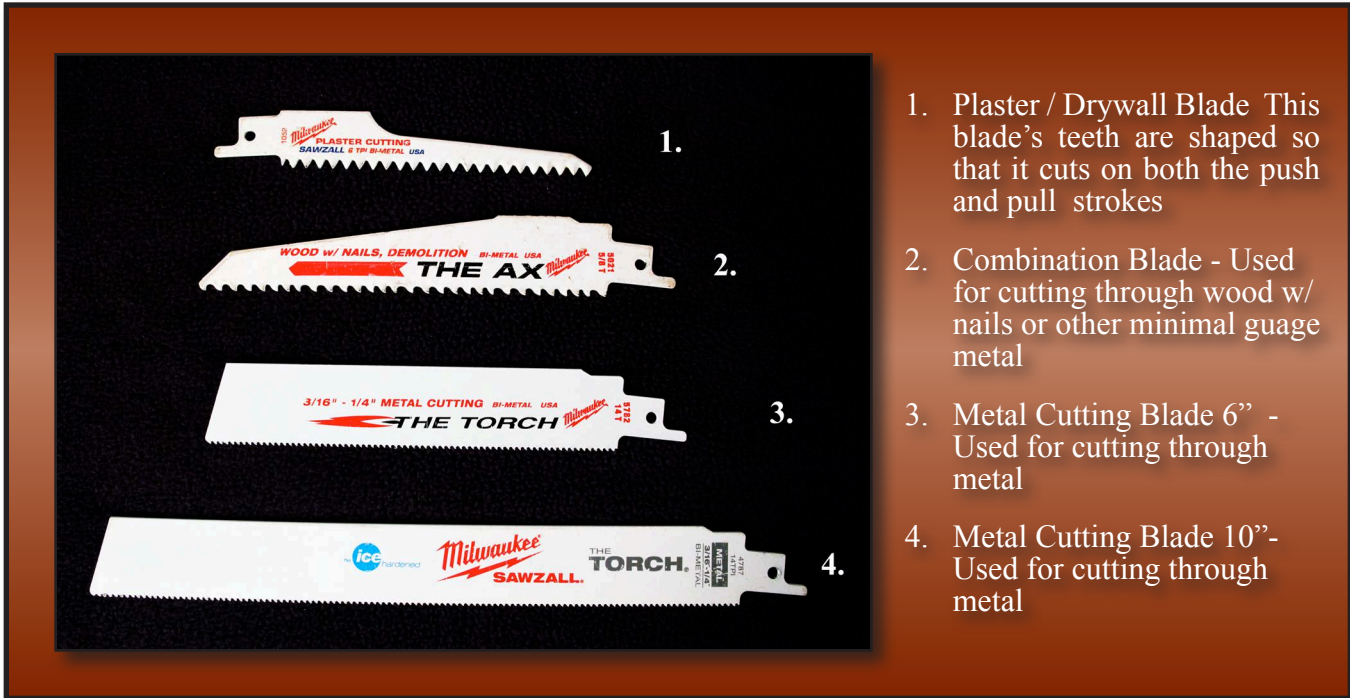


Figure 5-25 Recipro Saw Blades

5. ADDITIONAL EQUIPMENT:

- 5.1. Goggles
- 5.2. Grounding cord
- 5.3. Extension cord
- 5.4. Source of power
- 5.5. Source of extinguishment
- 5.6. Pry tool

6. SAFETY PRECAUTIONS:

- 6.1. Wear full protective safety gear and eye protection
- 6.2. Ground tool when cutting into concealed space
- 6.3. Unplug cord when changing blades
- 6.4. Only use department generators or properly tested house current



## Electric Ramfan

### 1. DESCRIPTION:

805 Watt, 110/220 volt, 2 horsepower, high velocity flow, stackable, ramfan turbo ventilator

### 2. USAGE:

Ventilation

### 3. SPECIFICATIONS:

- 3.1. 16" diameter fan with 21 cast aluminum turbo blades
- 3.2. Weight 49 pounds
- 3.3. Free flow equals 3,000 cfm
- 3.4. Duct flow equals 2,375 cfm
- 3.5. Non-sparking lexan polycarbonate housing
- 3.6. Uses 12" or 16" duct for confined space
- 3.7. Motor is intrinsically safe for confined space use:
  1. Class I, Group D = gas & vapors
  2. Class II, Groups E, F, G = combustible dust

### 4. ADDITIONAL EQUIPMENT:

- 4.1. Source of power
- 4.2. Extension cord
- 4.3. Electrical adapters

### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection
- 5.2. Keep hands away from grill
- 5.3. Keep curtains and other objects away from intake side of blower
- 5.4. Only use department generator or properly tested house current





## Water Vacuum

### 1. DESCRIPTION:

830 watt electric water vacuum

### 2. USAGE:

Water removal from carpets, concrete, wood, and vinyl

### 3. SPECIFICATIONS:

#### 3.1. Four assemblies:

1. Motor assembly
2. Float check assembly
3. 6 gallon tank and backpack assembly
4. Discharge hose, suction hose, wand and heads assembly

### 4. ADDITIONAL EQUIPMENT:

- 4.1. Extension cord
- 4.2. Grounding cord
- 4.3. Source of power

### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection
- 5.2. Avoid hot electrical sources with wand
- 5.3. Tank weighs 50 lbs more when full
- 5.4. Only use department generators or properly tested house current





# Thermal Imager

## 1. DESCRIPTION:

K65 FLIR Thermal Imaging Camera (T.I.C.). Detects and converts thermal energy radiated and generated from surrounding objects into a visual image.



## 2. USAGE:

- 2.1. Search & rescue
- 2.2. Size-up and scene assessment
- 2.3. Locate seat of fire and extension
- 2.4. Identify potential flashover
- 2.5. Determine entry and ventilation points
- 2.6. Overhaul
- 2.7. Hazmat incidents

## 3. SPECIFICATIONS:

- 3.1. Weighs 2.4 lbs
- 3.2. Powered by rechargeable lithium ion batteries / 4 hours of operation
- 3.3. Color palette selection with a 2X zoom feature
- 3.4. On screen system status LED indicators
- 3.5. High and low sensitivity modes
- 3.6. Image & video capture capabilities
- 3.7. 3 Buttons
  1. Green Button = ON/OFF
  2. + Button = Imaging Mode Selector
  3. (magnifying glass) Button = 2X Zoom Selector
- 3.8. 5 Imaging Modes
  1. Basic Mode
  2. Fire Mode
  3. Black & White Mode
  4. Search & Rescue Mode
  5. Heat Detection Mode

Auto range	High sensitivity range	Explanation
		75% power.
		50% power.
		25% power.
		Flashing indicator. At least 5 minutes of available power remains.

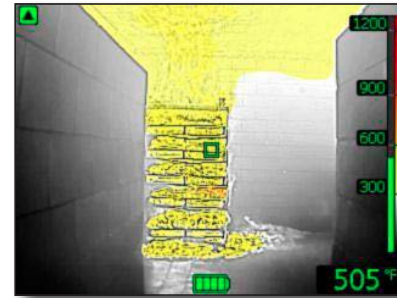




## 5 Imaging Modes

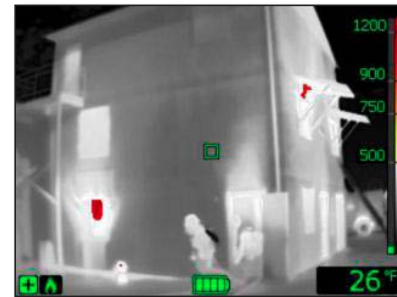
### *Basic Mode*

- Default multi-purpose mode
- Delivers optimum infrared image by auto-ranging between high and low sensitivity
- Colorization: 300 –1200 F°
- High Sensitivity Range: -4°Fto 300°F
- Low Sensitivity Range: 300°Fto 1202°F
- NFPA Standard User Interface (TI Basic)



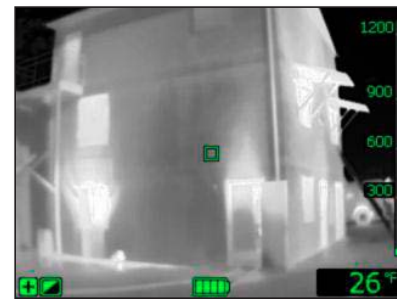
### *Fire Mode*

- Fire Mode is similar to Basic Mode EXCEPT it has a higher temperature starting point for colorization
- Auto-Ranging
- Colorization: 500–1202 F°
- High Sensitivity: Range -4°Fto 500°F
- Low Sensitivity Range: 500°Fto 1202°F



### *Black & White Mode*

- Multi-purpose mode similar to default mode but without colorization.
- Auto-Ranging (No colorization)
- Black & White Mode is also an NFPA Standard Interface mode



### *Search & Rescue Mode*

- Search and Rescue mode is specifically optimized for maintaining high contrast in the infrared image
- No Auto-Ranging
- Colorization: 200 –302 F°

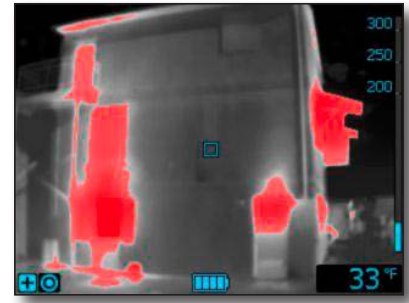




## 5 Imaging Modes

### *Heat Detection Mode*

- Heat Detection mode is optimized for “hotspots” searches during overhaul to ensure there is no hidden fire remaining.
- Useful for forensics, size-up and locating thermal patterns (ie. signs of people that were seated in a car seats to ensure everyone is accounted for after an accident, locating people in water and in vast landscapes, etc...)
- Gray scale palette with colorization of ~20% of the hottest areas of the scene
- No Auto-Ranging
- High Sens. Range -4°F to 302°F





### 3.9. Display Symbology

1. Basic Mode - A multipurpose mode for the initial attack with life-saving operations and control of the fire
2. Black & White Mode
3. Fire Mode - Similar to Basic Mode but with higher-temperature starting point for the heat colorization
4. Search & Rescue Mode - Optimized for maintaining high contrast in the infrared image while searching for people
5. Heat Detection Mode - Optimized for searching hotspots during overhaul after the fire is out.
6. Low-sensitivity mode indicator. The indicator is displayed when the camera identifies a hot area and automatically switches to low-sensitivity mode
7. Overheating indicator. The indicator provides a visual warning to the user that the thermal imager is about to shut down due to internal overheating.
8. Change in color reference indicator symbol. When a new mode is selected, a change in the color temperature reference triangle appears above the reference bar and remains visible for 1 second.
9. Reference bar
10. Temperature bar
11. Spotmeter temperature
12. Battery condition indicator
13. Spotmeter
14. Plus sign indicating the camera is not in Basic Mode.





#### 4. ADDITIONAL EQUIPMENT

- 4.1. Mount & Charger
- 4.2. Spare Battery

#### 5. SAFETY PRECAUTIONS:

- 5.1. Do not rely on the thermal imaging camera as the sole means of navigation or deviate from standard operating practices during use.
- 5.2. Thermal energy is not transmitted through glass and water and may be reflective off of smooth surfaces.
- 5.3. Not intrinsically safe.
- 5.4. Clean with mild soap and water, wipe down with soft terry cloth towel only.





## Gas Detector - POLI MP400 Series

### 1. DESCRIPTION:

POLI MP400 Multi-gas Detector is a durable, reliable, easy-to-use portable instrument for detecting the presence of Oxygen (O<sub>2</sub>), Hydrogen Sulfide (H<sub>2</sub>S), Carbon Monoxide (CO) and combustible gas (LEL). It is designed to withstand rough handling in harsh environments.

### 2. USAGE:

- 2.1. For detecting the presence of O<sub>2</sub>, H<sub>2</sub>S, CO and combustible gas LEL
- 2.2. Confined space entry
- 2.3. CO alarm calls
- 2.4. Natural gas leaks
- 2.5. Gasoline spills
- 2.6. Odor calls
- 2.7. Overhaul
- 2.8. Hazardous materials incidents
- 2.9. Anytime a hazardous atmosphere is suspected

### 3. SPECIFICATIONS:

- 3.1. Water Resistant
- 3.2. User-friendly large graphical display
- 3.3. Triple alarm system: audible, visual and vibrating
- 3.4. Rechargeable Li-Ion Battery - Use USB-Micro cable
- 3.5. 16 hours of continuous operation
- 3.6. 2 push buttons
- 3.7. Intrinsically Safe

### 4. ALARM LEVELS:

- 4.1. O<sub>2</sub> - 19.5% low & 23.5% high
- 4.2. H<sub>2</sub>S - 10 ppm low & 20 ppm high
- 4.3. CO - 25 ppm low & 200 ppm high
- 4.4. LEL - 10% low & 20% high



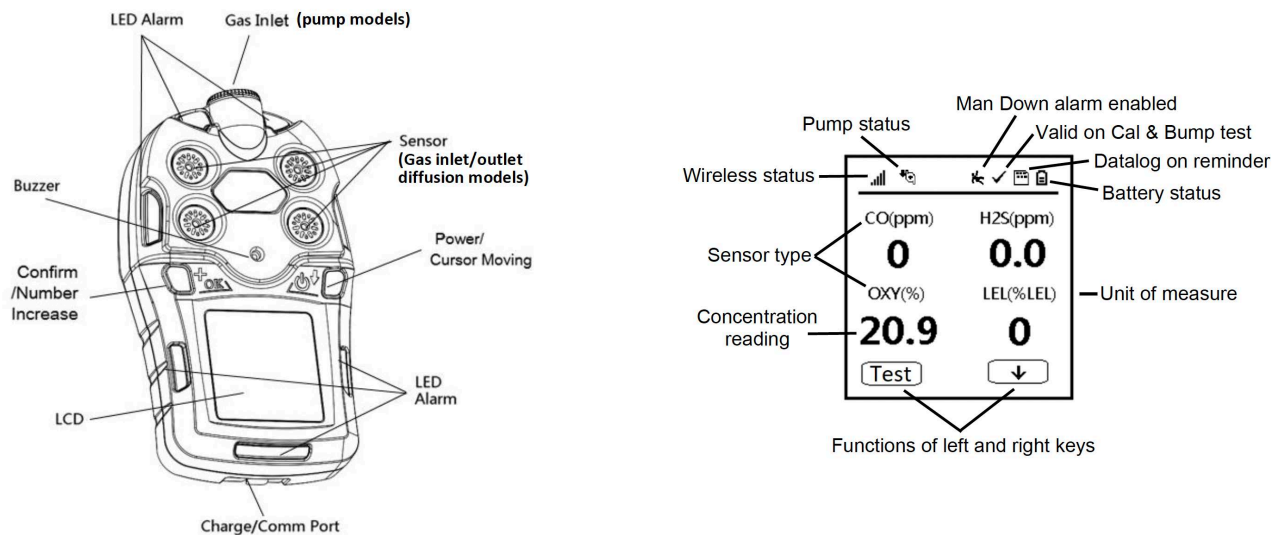


## 5. ADDITIONAL EQUIPMENT:

- 5.1. Optional Sampling Pump and Tubing (select specialty units)
- 5.2. Rechargeable Li-Ion Battery

## 6. SAFETY PRECAUTIONS:

- 6.1. Do not block sensors
- 6.2. Do not alter or modify instrument



## 7. OPERATION:

### 7.1. Power On

1. Ensure you are in a fresh air atmosphere (i.e. away from rig exhaust, etc.)
2. Press and hold the [O/↓] Down Key for 3 seconds, until the buzzer beeps and the red LED turns on.
3. After a warm up and self-test sequence that lasts approximately 2 minutes, the unit enters normal reading mode, showing real time gas concentrations.

### 7.2. Normal Mode

1. Unit will continuously monitor air in atmosphere and display instantaneous gas concentrations.
2. Other values like STEL, TWA, Peak, Min, Date, LEL gas, etc. can be checked by pressing the [O/↓] Down Key (Right) to cycle through these screens one by one.
3. The [+ /OK] Test Key (Left) checks alarm function and last bump and calibration date.
4. Two text and symbol boxes at the LCD bottom are mapped to the Left [+ /OK] and Right [O/↓] keys. The text or symbol in the boxes varies with the menu.



### 7.3. Alarms

1. The instrument has two alarm set points:
  1. HIGH Alarm
  2. LOW Alarm.
2. If the gas concentration reaches or exceeds the alarm set point, the instrument shall alert the user by 3 methods:
  1. Red LED Flashes
  2. Vibrates 1x/second
  3. Audible Alarm

### 7.4. Shut Down

1. Press and hold the [O/↓] Down Key for a 5-second count down, until “Unit Off” is displayed.

## 8. CALIBRATION

### 8.1. Required

1. Every 6 Months
2. After exposure to a gas

### 8.2. Performed at the dedicated Battalion calibration station

1. Connect a USB cable to docking station
2. Follow simple calibration instructions
3. Takes approximately 3 minutes to perform

## 9. TROUBLE SHOOTING

- 9.1. Take it to your Battalion calibration station and try to calibrate it.
- 9.2. If the detector fails calibration, swap it out with the 4-gas detector from the BC vehicle.
- 9.3. The BC will take the detector to Logistics for further troubleshooting and/or shipping or warranty repairs.
- 9.4. If a spare unit is available, the BC will swap and receive a loaner device.

## 10. CONCLUSION:

- 10.1. When used properly, the POLI MP400 Air Gas Detector will provide the ability to accurately perform atmospheric monitoring, contributing to the safety of all personnel.



LINK TO: MP400 Air Gas Detector - Quick Start Guide



LINK TO: MP400 Air Gas Detector Operating Manual



# Greenlee GT-16 Voltage Detector

## 1. DESCRIPTION:

The Greenlee GT-16 Voltage Detector is intended to check for the presence of AC voltage, signaling the user with an intermittent tone and a flashing LED. The LED flashes periodically to confirm battery condition.



## 2. USES

- 2.1. Identifying hot and neutral conductors
- 2.2. Finding a break in a wire
- 2.3. Detecting the presence of AC voltage at outlets, switches, circuit breakers, fuses, and wires and cables, including Romex®.

## 3. SPECIFICATIONS:

- 3.1. Indicators: LED and Tone
- 3.2. Voltage Range: 5 VAC to 1000 VAC
- 3.3. Frequency Range: 50 Hz to 500 Hz
- 3.4. Operating Conditions:
  1. Temperature: 32 °F to 104 °F
  2. Less than 80% relative humidity (noncondensing)
  3. Altitude: 6500' maximum
  4. Indoor use only.
- 3.5. Battery: One 1.5 volt battery (AAA)

## 4. SAFETY PRECAUTIONS:

- 4.1. Do not assume that no voltage indication means that the circuit is de-energized.
- 4.2. Beware that this tool may not recognize energized DC electrical currents (vehicle batteries, solar panel systems etc.)
- 4.3. Do not use the unit if it is wet or damaged
- 4.4. Do not apply more than the rated voltage
- 4.5. Do not operate with case open
- 4.6. The tester will not detect voltage through metal conduit, on armored or shielded cable, romex saturated with water, or at a distance such as through a wall



## 5. OPERATION:

- 5.1. Turn the unit on by rotating the sensitivity adjustment thumbwheel away from the OFF position.
  1. Verify that the LED flashes periodically.
  2. If the LED does not flash, the battery is not working and needs to be replaced.
- 5.2. Test the unit on a known live circuit before each use.
  1. If the unit does not function as expected on a known live circuit, replace the battery.
  2. If the unit still does not function as expected, place unit OOS
- 5.3. Place the tip on or near the circuit or unit to be tested.
  1. Tone and flashing LED indicate the presence of voltage (5 VAC to 1000 VAC).
  2. Use maximum sensitivity to detect low voltages.
  3. Reduce sensitivity to find breaks in wires or to identify hot and neutral conductors.
- 5.4. Test again on a known live circuit after use to verify proper operation.

## 6. MAINTENANCE:

- 6.1. Battery Replacement
  1. Disconnect the unit from the circuit.
  2. Rotate the outer battery cap clockwise and remove it.
  3. Rotate the metal inner cap and remove it.
  4. Replace the battery (observe polarity).
  5. Replace the metal inner cap.
  6. Replace the outer battery cap.
- 6.2. Cleaning
  1. Periodically wipe the case with a damp cloth and mild detergent; do not use abrasives or solvents.



## Streamlight E Flood Litebox HL

### 1. DESCRIPTION:

The Streamlight E Flood Litebox HL can be used as a hand held light or scene light. Has a swiveling neck, 3 brightness/lumen settings, and a diffuser lens for broad or focused light.

### 2. USES

- 2.1. Scene lighting
- 2.2. Search light

### 3. SPECIFICATIONS:

- 3.1. 6 LEDs (shock resistant, 50,000 hour life span)
- 3.2. 3 Brightness/Run time settings:
  1. High 3,600 Lumens, 2 hour run time
  2. Middle 2,400 Lumens, 4 hour run time
  3. Low 1,200 Lumens, 8 hour run time
- 3.3. Diffuser lens for broad or focused light beam
- 3.4. Swivel neck to 90 degrees
- 3.5. High Impact, Weatherproof housing
- 3.6. Weighs 10.4 lbs

### 4. SAFETY PRECAUTIONS:

- 4.1. Do not look directly into light
- 4.2. Never leave your H.I.D. LiteBox/ E-Flood LiteBox HL with its lamp face against any surface including skin while in operation. The resultant heat build-up can cause a fire or burns
- 4.3. E-Flood LiteBox HL is not approved for use in hazardous atmospheres.

### 5. OPERATION:

- 5.1. On/Off Toggle Switch
- 5.2. Brightness/Lumen setting
  1. The center of the lens on the E-Flood LiteBox HL is equipped with a concentric switch that is used to select the brightness setting (Hi-Med-Lo).
  2. Depress the center of the switch to select the desired output.
- 5.3. The outer ring of the switch can be turned to achieve a more or less defined beam spread.





6. MAINTENANCE:

- 6.1. Maintenance free battery
- 6.2. Keep charged using Streamlight charging bracket
  1. Use ONLY a 12V vehicle power source OR Streamlight AC chargers 22240
- 6.3. Completely drained battery can be charged in 10 hours





# Pneumatically Powered Equipment



Figure 5-20 Air Compressor

Pneumatic (air or gas) powered equipment and tools operate similar to hydraulic powered equipment and tools. Pneumatics and hydraulics are applications of fluid power. Pneumatics use an easily compressible gas such as air or a suitable pure gas, while hydraulics use relatively incompressible liquid such as oil. This distinguishing characteristic is what places pneumatics into a class of its own.

Pneumatics can power equipment such as paint spray guns, hoists, motors, lifting pads, hammer drills and other power tools. Pneumatic tools typically operate in conjunction with an air compressor, Figure 5-20. In order to increase a pneumatic tool's mobility, the fire service has adapted most of its pneumatic tools to operate from compressed air stored in SCBA cylinders, Figure 5-21 .

## Advantages of Pneumatic Systems

- Operate using lower pressures than those used in hydraulic tools
- Don't require an ignition source to operate
  - Basic ON - OFF type controls
  - Reliability
    - Pneumatic systems tend to have long operating lives and require very little maintenance.
    - Because gas is compressible, the equipment is less likely to be damaged by shock. The gas in pneumatics absorbs excessive force, whereas the fluid of hydraulics directly transfers force.
  - Compressed gas can be stored, allowing the use of machines when electrical power is lost.
- Minimal risk of fire (compared to hydraulic oil) and can be designed to be overload safe.



Figure 5-21 SCBA Bottle

## Disadvantage of Pneumatic Systems

- The air is compressible, making accurate speed control and position control difficult. Pneumatic systems often requiring ancillary control systems.



## Pneumatic Equipment Safety

Pneumatic equipment and tool safety, although safer in some regard to that of other powered equipment, has its own safety hazards.

- Pneumatic lifting devices such as air bags, can lift very heavy objects. Failure of one of these devices could be catastrophic therefore, preventative support measures (cribbing, shoring) must be utilized.
- Pneumatic tools can be loud, always wear hearing protection.
- Pneumatic tools often require the addition of light weight oil to lubricate the moving parts in order to prevent tool failure due to friction and heat.



# Air Bags



## 1. DESCRIPTION:

Maxiforce Airbag Systems are a multi- application, portable inflation system used for the lifting and displacement of heavy rigid objects.

## 2. SPECIFICATIONS:

- 2.1. Piston type high pressure regulator:
  1. The working air pressures are fixed, no adjustment needed.
  2. Air pressure reduced from 4500 PSI to 215 PSI
  3. The pressure relief valves is factory set to 165 PSI.
- 2.2. Dual (Deadman) safety relief and control:
  1. single input/dual output
- 2.3. Interconnecting hoses:
  1. Five 16' sections of hose
  2. Color coded & interchangeable
- 2.4. Airbags:
- 2.5. Neoprene, reinforced with three layers per side of Kevlar reinforced fabric
- 2.6. Sizes range from 6 x 6 up to 36 x 36 inches



2.7. Common Bag Specifications:

Model	Size	Capacity (tons)	height
1. KPI-5	10" x 10"	5	5.4"
2. KPI-12	15" x 15"	14	8.2"
3. KPI-17	15" x 21"	19	8.9"

3. ADDITIONAL EQUIPMENT:

- 3.1. Cribbing
- 3.2. Crowbar
- 3.3. Scott Adapter Tool for Quick Connect Coupling
- 3.4. Debris Carrier / Outrigger Pads

4. SAFETY PRECAUTIONS:

- 4.1. Wear full protective safety gear and eye protection
- 4.2. Never stack more than two bags



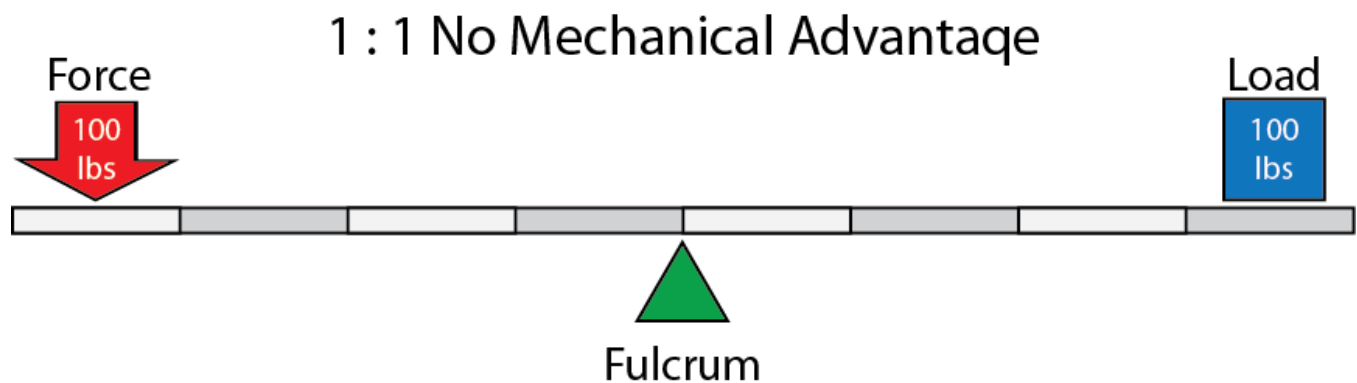
# Fire Service Hand Tools

The fire service has long since relied on the hand tool to perform the basic function of firefighting. A hand tool is a device for doing a particular job that does not use a motor, but is powered solely by the person using it. In order for hand tools to be effective or useful, they must give the user some sort of mechanical advantage. Although there are several principals used to create mechanical advantage, the hand tool primarily uses the principle of the lever.

## The Lever Principle

A lever can be a rigid rod or pole to which a force is applied to overcome resistance while pivoting around a fixed support called a fulcrum. A lever is a simple machine used to gain force, gain speed, or change direction. Crowbars, seesaws, wrenches, wheelbarrows, nutcrackers, hammers, bats, balance scales, and thousands of other items use levers or combinations of levers. Arms, legs, hands, feet, and other parts of the body are also considered levers.

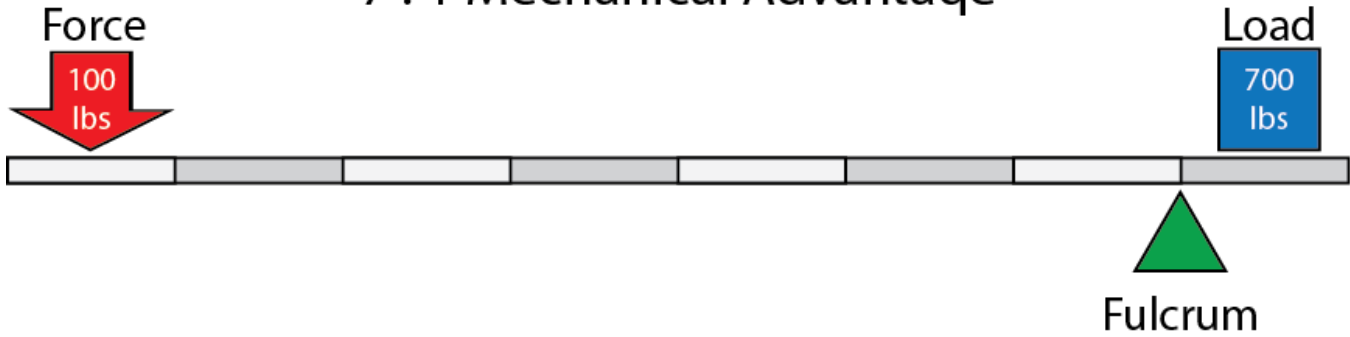
Levers achieve a mechanical advantage by moving the fulcrum in relation to the load. In the image below, 100 lbs of force is required to raise a load of 100 lbs because the fulcrum is located equal distance from the load and the applied force. In order to raise the load 1 ft in elevation, 1 ft of distance must be traveled by the force.



In this next image, we see that moving the fulcrum closer to the load will now increase our mechanical advantage. By applying the same 100 lbs of force, we can now lift a load of 700 lbs. In order for us to achieve this increased lifting power, we must sacrifice distance traveled. Because the fulcrum is now closer to the load, for every 1 ft of upward motion the load is lifted, the applied force must travel 7 ft of downward motion.



# 7 : 1 Mechanical Advantage



## Classification of Levers

Levers can be classified into three categories, Figure 5-23:

- First Class - The fulcrum is between the force arm and the load arm. Seesaws, crowbars, and oars are first-class levers.
- Second Class - The load is between the force arm and the fulcrum. Wheelbarrows and nutcrackers are second-class levers.
- Third Class - The force is applied between the load and the fulcrum. Brooms and a kicking leg are third-class levers.

Levers not only allow us to apply greater force and exert less energy, but also allow us to increase speeds and travel shorter distances. Understanding the principles of levers is an important key for firefighters when determining the best type of hand tool to select for a particular situation. The difference between a great firefighter and an average firefighter is knowing how to improvise and adapt to certain situations. Having a strong understanding of these basic principles will allow you to operate more successfully.

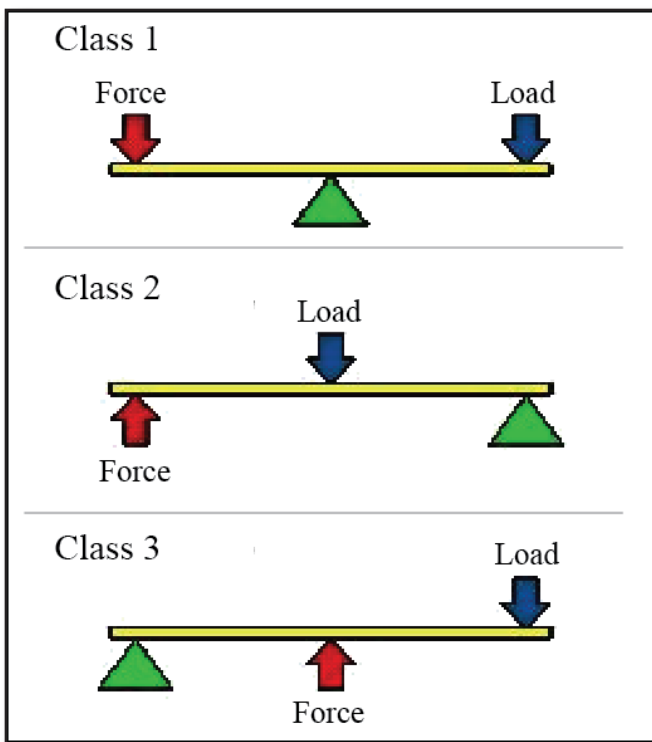
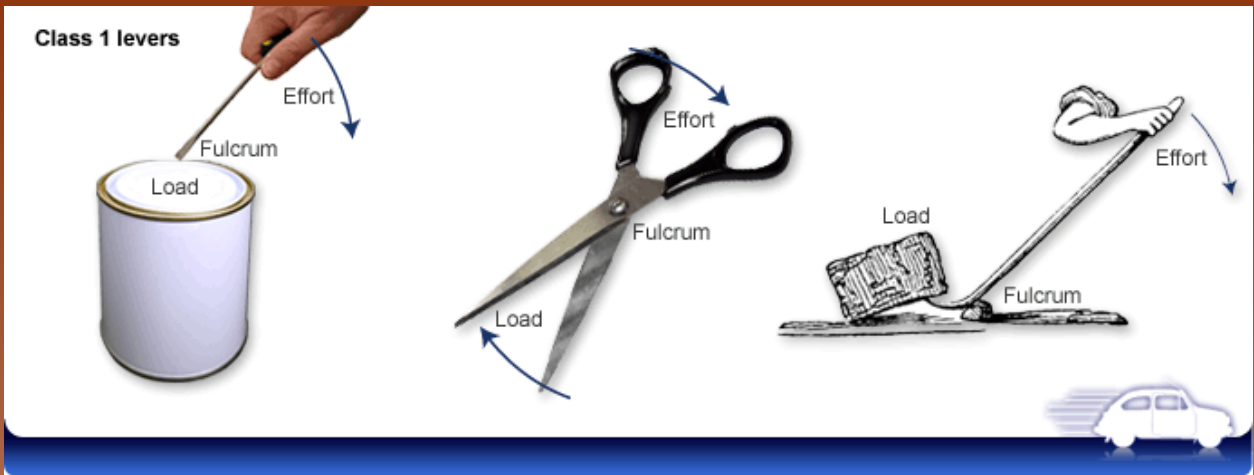


Figure 5-22 Classification of Levers

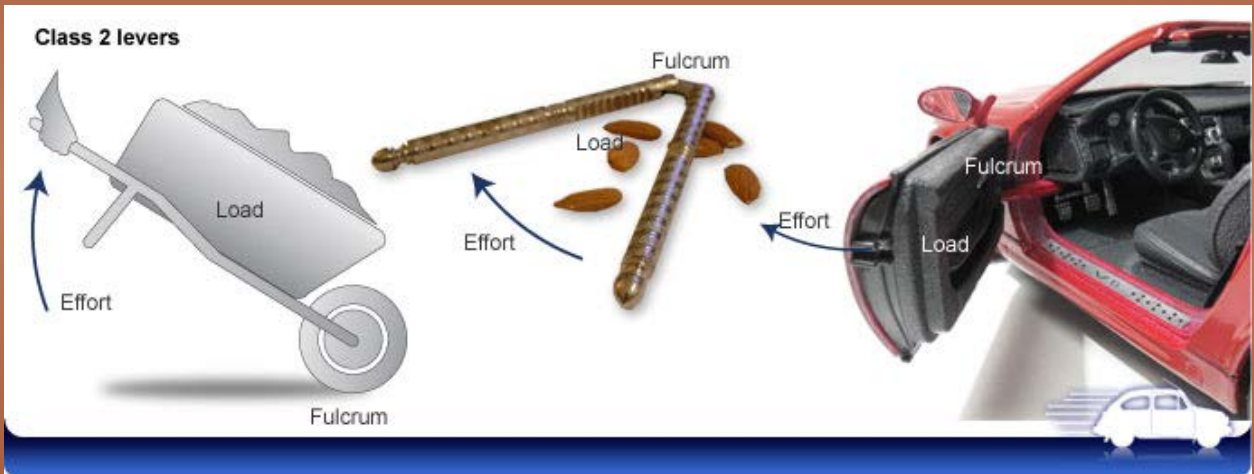


# Examples for Classes of Levers

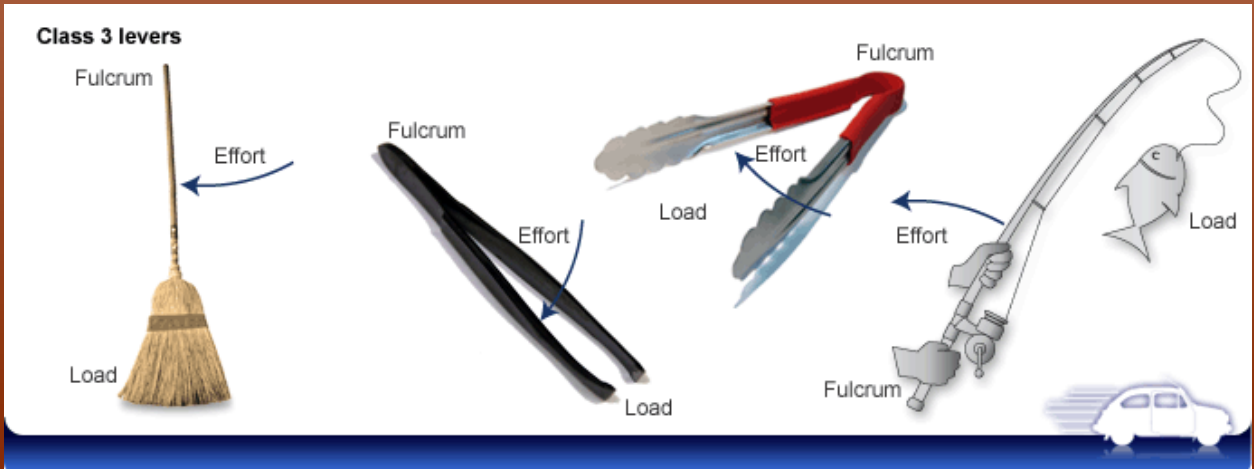
## Class 1 Levers



## Class 2 Levers



## Class 3 Levers



*Diagrams Courtesy of University California Irvine*



## Types & Uses of Hand Tools

Hand tools can be used for just about any situation. As firefighters we use them to pry open doors, cut through metal bars and strike hard surfaces. Hand tools can be used to cut, strike, pry, pull, push, scoop and perform just about any other action necessary.

In an attempt to categorize the numerous hand tools we use as firefighters, the following pages contain tools that have been grouped together by their most common function or use.

- Forcible entry hand tools
- Rescue hand tools
- Structural firefighting hand tools
- Wildland firefighting hand tools
- General use hand tools & equipment

Just because we have categorized a tool under one of the above headings, does not mean they can not be used for other functions or operations. A particular tool may have many different uses and it is up to the firefighter to make the appropriate choice to determine which tool is right for the job.

Thorough and detailed instruction on the use of these hand tools can be found in the Forcible Entry chapter of this drill manual.

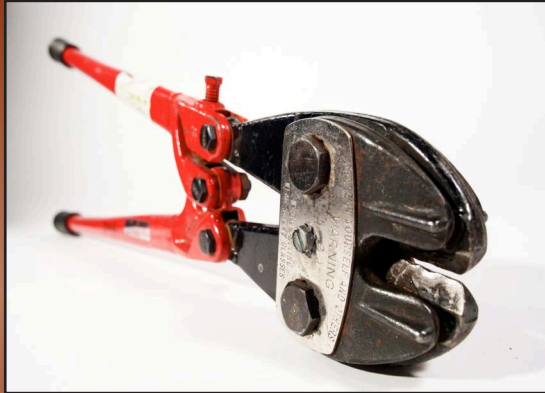






## Forcible Entry Hand Tools

Bolt Cutters



Uses: Cutting & forcible entry through chain, padlocks, bolts, light weight security bars and wire fence

Apparatus: Engine, Truck, Brush

Flat Head Axe



Uses: Striking & cutting, forcible entry (w/ halligan bar), ventilation, overhaul

Apparatus: Truck

Halligan Bar



Uses: Prying, forcible entry (w/ sledge hammer or flat head axe) through doors, windows, security bars, vehicle extrication, rescue

Apparatus: Engine, Truck

Sledge Hammer



Uses: Striking tool & forcible entry through doors, walls, and other barriers

Apparatus: Engine, Truck, Brush



## Forcible Entry Hand Tools (Continued)

### Crow Bar



Uses: Prying, forcible entry, rescue, overhaul

Apparatus: Engine, Truck, Brush

### K-Tool



Uses: Forcible entry through doors with commercial dead bolts causing minimal damage. Used in conjunction with halligan bar and sledge or flat head axe

Apparatus: Truck

### Vehicle Lock-Out Kit



Uses: Forcible entry into vehicles causing minimal damage

Apparatus: Engine, Truck

### Elevator Tool Kit



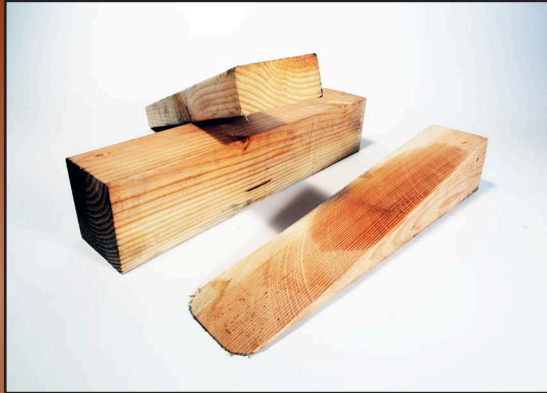
Uses: Forcible entry through elevator doors causing minimal damage

Apparatus: Select Engine Co's & All Truck Co's



## Rescue Hand Tools

Cribbing



Uses: Stabilizing & shoring heavy objects or vehicles during rescue

Apparatus: Select Engine Co's & All Truck Co's

Pry Axe



Uses: Cutting or prying primarily during vehicle extrication

Apparatus: Truck

Pry Bar



Uses: Prying & forcible entry, primarily used to lift and move heavy objects

Apparatus: Engine, Truck

Seat Belt Cutter



Uses: Vehicle & aircraft rescue, quickly cut seat belts

Apparatus: Engine, Truck



## Rescue Hand Tools (Continued)

### 8 Ton Hydraulic Jack



Uses: Lifting heavy objects during rescue

Apparatus: Truck

### Step Chocks



Uses: Stabilize or shore heavy objects and vehicles quickly during rescue & extrication

Apparatus: Truck

### Ratcheting Straps



Uses: Stabilizing or moving heavy, dynamic objects

Apparatus: Truck

### Ajax "Strip-n-Peek" Tool



Uses: Vehicle trim and molding removal tool. Is designed to expose hazards while preparing to extricate a victim from an auto accident. It measures approximately 10" long and weighs 8.5 oz.

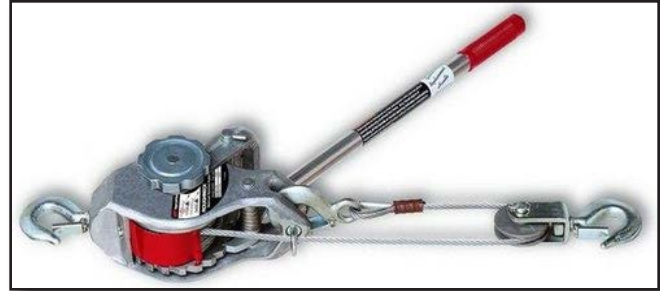
Apparatus: Engine & Truck



## Come-a-Long

### 1. DESCRIPTION:

Model C-400H Come-A-Long.



### 2. USAGE:

- 2.1. To raise or pull loads
- 2.2. To lower or release loads
- 2.3. To stabilize objects

### 3. SPECIFICATIONS:

- 3.1. 3 Hooks
- 3.2. 20' Cable
- 3.3. Single line capacity = 1700 lbs
- 3.4. Double line capacity = 3400 lbs

### 4. ADDITIONAL EQUIPMENT:

- 4.1. Grab hooks and chains
- 4.2. Shackle hooks
- 4.3. Cribbing

### 5. SAFETY PRECAUTIONS:

- 5.1. Wear full protective safety gear and eye protection
- 5.2. Maintain three or more wraps of cable on drum
- 5.3. Handle will bend when unit is overloaded C (safety feature)
- 5.4. DO NOT reach around corners
- 5.5. DO NOT use for lifting, lowering or moving persons
- 5.6. Pull in straight line
- 5.7. Do not use as a sling or choker



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## Structural Firefighting Hand Tools

Firefighter's 6 lb Pick Headed Axe



Uses: Striking & prying during firefighting, forcible entry, ventilation & overhaul operations

Apparatus: Engine, Truck, Brush

Scabbard or Axe Belt



Uses: Safely carry and store a pick headed axe

Apparatus: Select Engine Co's & All Truck Co's

Roof Hook or Rubbish Hook



Uses: Sounding roof & pushing ceiling during ventilation operations, pulling walls & ceiling during overhaul

Apparatus: Select Engine Co's & All Truck Co's

Pike Pole



Uses: Pulling ceiling or walls during firefighting & overhaul, sounding roof during ventilation operations

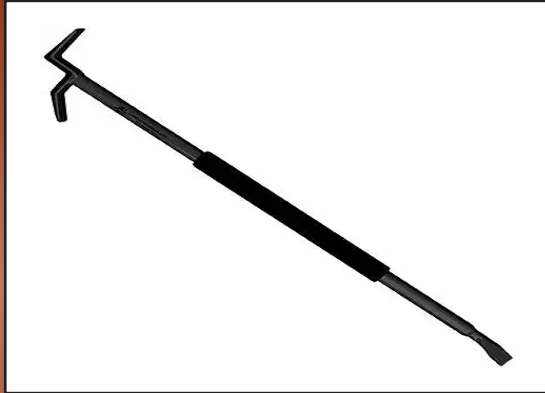
Apparatus: Engine, Truck





## Rescue Hand Tools (Continued)

### New York Hook



Uses: Pry Tool / Forcible Entry, Overhaul

Apparatus: Engine - 6' Hook  
Truck - 6' & 8' Hook



*New York Hook - Training Drill*

### Scoop Shovel



Uses: Scoop and remove debris during overhaul operations

Apparatus: Truck

### Square Nose Shovel



Uses: Scoop & remove debris or dirt from flat or hard surfaces, diking & damming during haz-mat spills

Apparatus: Engine, Truck

### Spade Shovel



Uses: Scoop & remove debris or dirt from soft surfaces & wildland firefighting

Apparatus: Engine, Truck



## Wildland Firefighting Hand Tools

Wildland Shovel



Uses: Scooping, scraping, & “cutting line” during wildland operations & mop-up

Apparatus: Brush

Pulaski



Uses: Scraping & “cutting line” (grasses & brush) during wildland operations & mop-up

Apparatus: Brush

McLeod



Uses: Scraping & “cutting line” (grasses & brush) during wildland operations & mop-up

Apparatus: Brush

Brush Hook



Uses: “Cutting line” & heavier brush during wildland operations

Apparatus: Brush



## Wildland Firefighting Hand Tools (Continued)

### Hose Roller



Uses: Rolling 1" & 1 1/2" single jacket hose into packs

Apparatus: Brush

### Belt Weather Kit



Uses: Measure temperature & humidity

Apparatus: Select Brush Rigs

### Drip Torch



Uses: Mixture of diesel fuel & gasoline used to "fire out" & "back-fire" vegetation

Apparatus: Brush

### Hose Clamp



Uses: Clamping single jacket 1 1/2" wild-land hose and smaller

Apparatus: Engine & Brush



## General Use Handtools & Equipment

### Air Hose & Chuck



Uses: Fill tires & pressurize water extinguishers

Apparatus: Engine, Truck, Brush

### Allen Wrenches



Uses: Tighten & loosen allen head screws

Apparatus: Engine, Truck

### Ball Peen Hammer



Uses: Striking objects

Apparatus: Engine & Truck

### Facom Insulated Adjustable Wrench



Uses: For working on, or in close proximity to, energized electrical equipment or conductors operating at a max voltage of 1000V ac or 1500V dc.

Apparatus: Engine, Truck, Brush

## General Hand Tools & Equipment (Continued)

### Corn Broom



Uses: Sweep debris & move water in salvage cover chutes

Apparatus: Engine, Truck

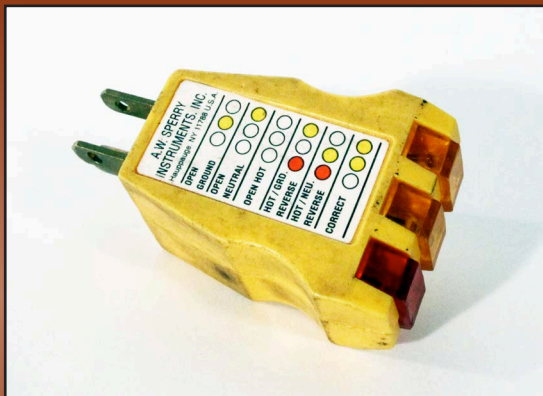
### Electrical Adapters



Uses: Connecting electrical equipment to power using standard three prong or three prong twist lock connections

Apparatus: Select Engine Co's & All Truck Co's

### Electrical "Slater" Circuit Tester



Uses: Determining a safe power source and ground of an electrical outlet

Apparatus: Select Engine Co's & All Truck Co's

### Electrical Tape



Uses: Wrapping electrical connections & cords

Apparatus: Engine, Truck



## General Hand Tools & Equipment (Continued)

### Extension Cords



Uses: Extending electrical cords to reach a power source

Apparatus: Select Engine Co's & All Truck Co's

### Flood Lights



Uses: Generate a safe external source of light

Apparatus: Select Engine Co's & All Truck Co's

### Fuel & Filtered Funnel



Uses: Storing fuel & filling gasoline powered equipment

Apparatus: Engine, Truck, Brush

### Golf Tees



Uses: Temporarily plugging leaks, such as fuel

Apparatus: Engine, Truck



## General Hand Tools & Equipment (Continued)

### Graphite Powder



Uses: Lubricating hose & appliance couplings

Apparatus: Engine, Truck, Brush

### Grounding Cord



Uses: Grounding tools or power equipment which are not already grounded internally or double insulated

Apparatus: Truck

### Hack-Saw



Uses: Cutting metal during forcible entry or vehicle extrication

Apparatus: Engine, Truck

### Hand Lantern



Uses: Portable flash light

Apparatus: Engine, Truck



## General Hand Tools & Equipment (Continued)

### Hose Strap



Uses: Securing a charged hoseline to ladder rungs

Apparatus: Engine, Truck

### Hydrant Shut-Off Key



Uses: Shutting down the valve which feeds a fire hydrant or city water main

Apparatus: Engine, Truck

### Hydrant Wrench



Uses: Opening & closing the valve stems on a fire hydrant. Tighten or loosen couplings.

Apparatus: Engine, Truck, Brush

### Pipe Wrench



Uses: Manipulating metal pipes

Apparatus: Engine, Truck, Brush





## General Hand Tools & Equipment (Continued)

### Plug-n-Dike



Uses: Plugging or stopping fluid leaks (fuel). Kneading the dry powder with a small amount of water will form a putty and allow you to plug leaks.

Apparatus: Engine, Truck

### Push Broom



Uses: Sweeping or moving debris

Apparatus: Engine, Truck

### Redwood Plug



Uses: Temporarily plugging holes or leaks

Apparatus: Engine, Truck

### Road Flares



Uses: Traffic warning & control. Ignite vegetation during “burn out” or “back fire” operations.

Apparatus: Engine, Truck, Brush



## General Hand Tools & Equipment (Continued)

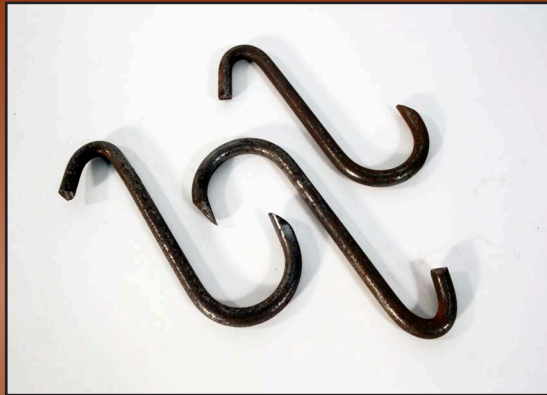
### Rubber Mallet



Uses: Striking metal objects

Apparatus: Engine, Truck, Brush

### Salvage Cover Hooks



Uses: Hanging salvage covers by their metal grommets

Apparatus: Truck

### Staple Gun



Uses: Securing plastic visqueen to roofs & battens during salvage operations

Apparatus: Truck

### Spanner Wrench



Uses: Tightening & loosening hose couplings and appliances

Apparatus: Engine, Truck, Brush



## General Hand Tools & Equipment (Continued)

### Sprinkler Tong



Uses: Stopping the flow of water from a fused or activated sprinkler head

Apparatus: Engine, Truck

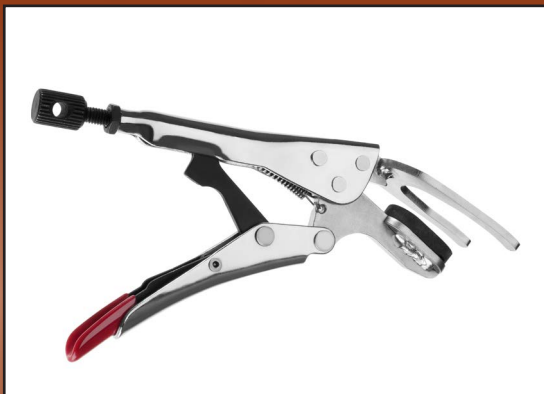
### Teflon Tape



Uses: Create impermeable connection on sprinkler and gas pipe threads

Apparatus: Engine, Truck

### Quick Stop Sprinkler Tool



Uses: Stopping the flow of water from a fused or activated sprinkler head

*(See Chapter 23 - Salvage and Overhaul for instruction)*

Apparatus: Engine, Truck

### Vice Grips



Uses: Clamping pliers for object manipulation

Apparatus: Engine, Truck, Brush



## General Hand Tools & Equipment (Continued)

### Hay Hook



Uses: Lifting or moving hay bundles or other heavy soft objects during overhaul operations

Apparatus: Truck

### Mop & Bucket



Uses: Mopping up water during salvage operations

Apparatus: Truck

### Squeegee



Uses: Moving or directing water on flat surfaces during salvage operations

Apparatus: Truck

### Utility Key



Uses: Securing gas and water utilities to a structure

Apparatus: Engine, Truck



## BATTERY PACK

1. Multi-Bit Screwdriver 5 in 1
2. Philips Screwdriver #3 - 6"
3. Slotted Screwdriver 5/16" - 6"
4. Slip Joint Pliers
5. Insulated Adjustable Wrench - 11"
6. Voltage Detector
7. Wire Cutters
8. Strip-n-Peek Tool

Apparatus: Engine, Truck, Brush

## Safety & Maintenance of Hand tools

Hand tools will function as designed when they are properly maintained and kept in good condition. As firefighters, we pride ourselves in keeping our tools and equipment in the best working condition. Failing to do so may have consequences causing severe injury or death to both firefighters and the public. The following are general maintenance rules for hand tools to ensure our safety.

### Maintaining Wood Handled Tools

- Inspect the handle for cracks, blisters, or splinters.
- Sand the handle if necessary to eliminate splinters.
- Wash the handle with mild detergent and rinse, wipe dry .
- Do not soak the handle in water because it will cause the wood to swell.
- Apply a coat of boiled linseed oil to the handle to preserve it and prevent roughness and warping.



- Do not paint or varnish the handle.
- Check the tightness of the tool head.
- Limit the amount of surface area covered with paint for tool marking.

### Maintaining Fiberglass Handled Tools

- Wash the handle with mild detergent, rinse, and wipe dry.
- Check for damage or crack.
- Check the tightness of the tool head.

### Maintaining Cutting Edges

- Inspect the cutting edge for chips, cracks, or spurs.
- Replace cutting heads when required.
- File the cutting edges by hand; grinding weakens the tool.
- Sharpen blade as specified in departmental SOP.

### Maintaining Unpainted Metal Surfaces

- Keep free of rust.
- Oil the metal surface lightly; light machine oil works best.
- Do not paint metal surfaces — paint hides defects.
- Inspect the metal for chips, cracks, or sharp edges, and file them off when found.

### Maintaining Axe heads

- How well an axe head is maintained directly effects how well it will perform
  - If the blade is extremely sharp and ground too thin, pieces of the blade may break when cutting gravel roofs or striking nails and/or screws in roof decking or flooring.
  - If the blade is too thick or dull, it is difficult to drive the axe head through ordinary objects.
- **DO NOT PAINT AXE HEADS!**
  - Paint hides faults in the metal.
  - Paint may cause the cutting surface to stick and bind.



## Summary

We have all heard the saying, “Use the right tool for the job.” The tools in the fire service are designed for more than one job. A halligan bar can be used to pry a door jam, punch a hole in sheet metal, or as a step to hop over a fence. The Amkus spreaders can be used to remove a car door, roll a dashboard, or lift a vehicle or heavy object off the ground. As a firefighter, you must learn the use and practice your skills with all of the tools available to you on your apparatus. It is only through experience and training that you will be able to effectively use the tool in the many situations that you will be exposed to during your career.

In order for a tool or piece of equipment to perform to our standards, we must be cognizant of its maintenance. After not starting a gasoline powered Ramfan for a period of time, the small passages in the carburetor will become clogged after the fuel varnishes. An axe head left unchecked on a reserve apparatus may end up being used at a fire with a loose head and torn leather scabbard. Success and firefighter safety is achieved when we properly maintain our tools and equipment.



# Media & Links Index



Two Stroke Animation



Four Stroke Animation



Rescue Saw Procedures



Academy Truck Company Standard Operating Guide - “Spiel Book”



New York Hook - Training Drill



New York Hook - FDNY Manual



POLI MP400 Air Gas Detector - Quick Start Guide



POLI MP400 Air Gas Detector - User Manual



OPEN

***NOTE: If you have any additional information or content that you feel would be appropriate to contribute to this Chapter or would like to report any errors or misrepresentations, please contact the SDFD Training Division or email the Drill Manual Revision Staff at***

***SDFDDrillManualTeam@SanDiego.gov***





# References

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