

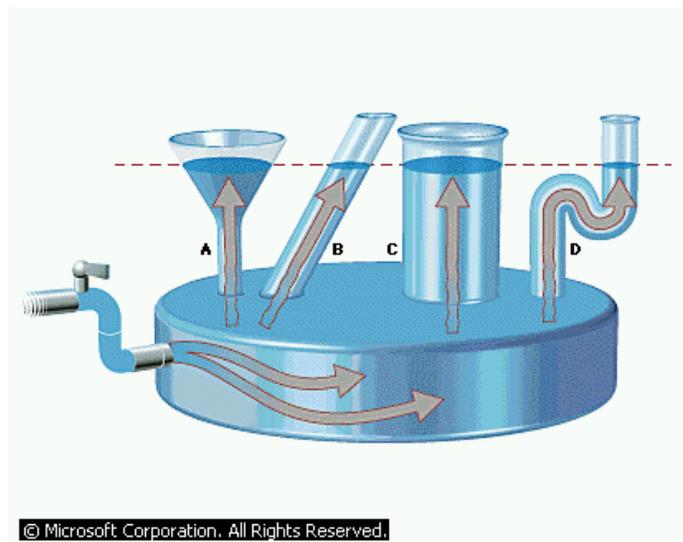
HYDRAULICS

OBJECTIVE

Rescue Squad personnel need to be completely familiar with all aspects of the hydraulic components carried on their vehicle. A basic knowledge of hydraulics as a discipline is necessary in order to understand the potential forces that can be generated. This includes not only what type of hydraulic system the vehicle is designed with but also how the various tools are configured so as to determine the stress that can be exerted when using the system. Once these principles are mastered, then personnel will be able to effectively grasp the inner workings of their hydraulic tools, understand the forces they can apply to various objects, how to repair the tools, and how to spec tools for future needs.

DEFINITION OF HYDRAULICS (Text Book)

Hydraulics is the science of transmitting force and/or motion through the medium of a confined liquid, or, the application of fluid mechanics to engineering devices involving liquids, usually water or oil. This is based on Pascal's law, which states that the pressure exerted on a liquid is transmitted undiminished in every direction and acts with equal force on equal area and at right angles to the container walls.



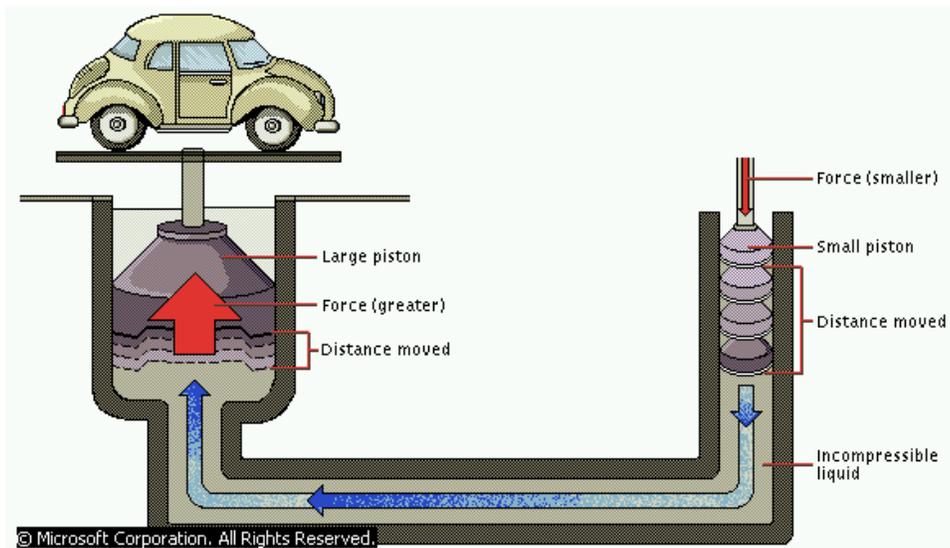
Pascal's Law

As liquid flows into the large container at the bottom of this illustration, pressure pushes the liquid equally up into the tubes above the container. The liquid rises to the same level in all of the tubes, regardless of the shape or angle of the tube. © Microsoft Corporation. All Rights Reserved.¹

¹"Pascal's Law," *Microsoft® Encarta® Encyclopedia 2000*. © 1993-1999 Microsoft Corporation. All rights reserved.

Definition of Hydraulics (Street Use)

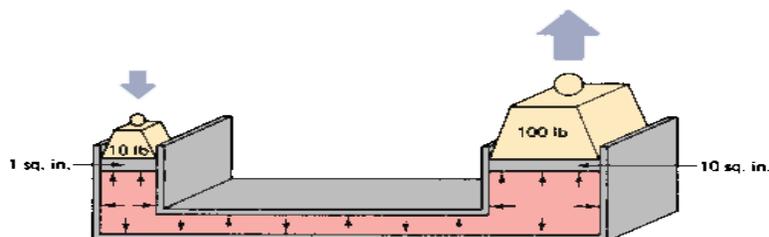
Force that is applied at one point is transmitted to another point using an incompressible fluid. This force is almost always multiplied in the process. This means that when you push a fluid with a cylinder having a small diameter through a tube into a cylinder having a larger diameter, you achieve hydraulic multiplication. The amount of this increase in pressure depends upon the relationship between the surface areas of the two cylinders. The larger the difference, the greater the pressure increase. Similarly the



larger the difference, the greater distance that the smaller cylinder has to travel in order to push the larger cylinder the same distance.

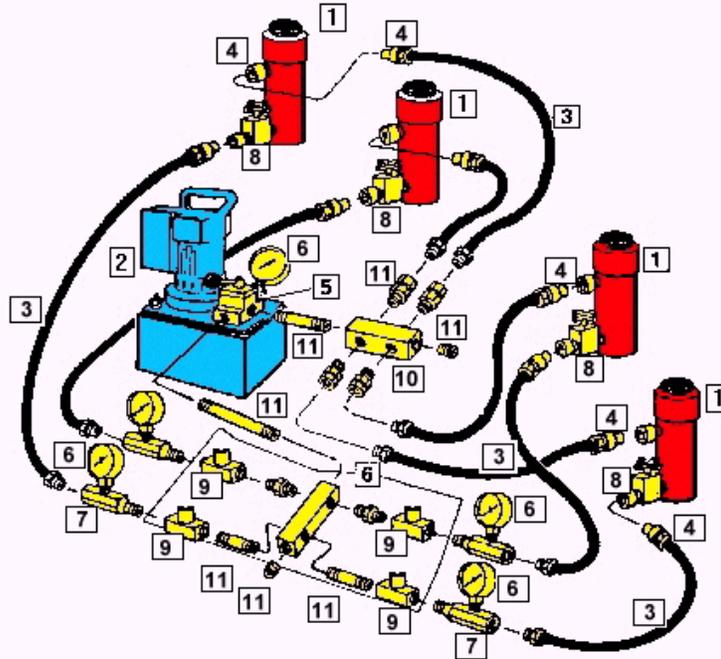
Conversion of Pressure to Force (Principle behind our Hydraulic Tools)

Force is equal to Pressure times Area ($F=P \times A$). If one piston has a unit area of 1 and the other piston a unit area of 10, a unit force of 1 applied to the smaller piston, corresponding to a pressure of 1 per unit area, will result in a force of 10 per unit area on the larger piston. This exemplifies why we can achieve relatively great forces while only using small pumps.



COMPONENTS OF A HYDRAULIC SYSTEM

DOUBLE ACTING RAM/PISTON SYSTEM USING AN ELECTRIC PUMP WITH SHUT OFF VALVES, LOAD LOWERING VALVES, 4 PLACE MANIFOLD, GAUGES & MISCELLANEOUS PLUMBING



FLUIDS

For our purposes, there are generally two types of fluids. These are:

- Compressible – A fluid that will allow its volume to change and thusly will not transfer in a one to one relationship. These are mainly organic fluids such as isopropanol or a liquefied gas.
- Incompressible – A fluid that, when pressurized, substantially retains its volume and exerts pressure equally in all directions.

Incompressible fluids can be further broken down into the following two property groups:

- ◆ Non-fire resistive – The overwhelming majority of hydraulic components and systems are designed to use oil-based hydraulic fluids. The ever-accelerating performance potential of power systems has dictated the need for superior lubricating oil-based fluids. These, obviously, are not the fluids of choice for the fire service since they are highly flammable and corrosive.

- ◆ Fire-resistive – These are fluids that significantly reduce the flammability of the lubricant and yet retain some of the properties of oil. These types of fluids may be classified as follows:

- (a) 100% Water

1. It is non-flammable
2. Cheap
3. Can be used in a pinch
4. Will corrode equipment

- (b) Water Containing – These are fluids that are primarily water based with other petroleum products added in some form.

- (i) Water Glycol - Solution of glycol in water with a variety of additives

1. Decent corrosive protection
2. Decent anti-wear properties
3. 40% water so it could freeze
4. Toxic

- (ii) Invert Emulsion – A stable emulsion of water dispersed in oil.

1. Decent corrosive protection
2. Decent anti-wear properties
3. 40% water so it could freeze
4. The emulsion is fairly stable (does not separate)
5. Toxic

- (c) Synthetic – fluid compounds that are formulated without the use of water although their consistency will approximate water.

- (i) Phosphate Ester – compounds of phosphoric acid and aromatic ring-structure alcohols

1. Extremely fire-resistive
2. Relatively non-toxic
3. Non-conductive
4. Good corrosive protection
5. Good anti-wear protection



- (ii) Synthetic Hydrocarbons (polyol esters) – compounds of long-chain fatty acids (animal/vegetable fats) and synthesized organic alcohols

1. Good fire resistance
2. Non-toxic
3. Good anti-wear protection
4. Good corrosion protection
5. Non-conductive
6. Supports microbial growth



- (iii) Polyether Polyol -are non-aqueous, 100% synthetic, fire-resistant hydraulic fluids, approved by FMRC as a “less hazardous hydraulic fluid.” These products contain additives which provide rust and oxidation protection, as well as superior anti-wear properties.

1. *Oxidation resistance and hydrolytic stability far superior to polyol ester*
2. *Readily biodegradable*

3. *High viscosity index*
4. *Low pour point*

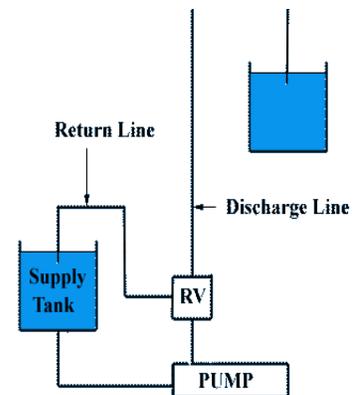
Reservoirs

A reservoir stores the liquid that is not being used by the hydraulic system. It allows gases to escape, dissipates heat, and allows foreign matter to settle out from the liquid.

The shape of the tank should be high and narrow versus shallow and broad. The oil level should be as high as possible above the intake strainer in order to prevent the vacuum at the opening from forming a vortex or whirlpool effect.

The size of the tank must be large enough to provide a reserve of fluid when all the tools in use are fully extended. It must, conversely, be able to contain the full volume of the system when all tools are shut down. In addition, it must allow for expansion of the fluid during heat build up. A rule of thumb is that a reservoir's size should be two to three times the pump's output per minute. On most of our vehicles, usually two to three gallons is sufficient.

Most reservoirs are located above or next to the pumps. This creates a flooded suction and cuts down on the possibility of cavitation and creation of a vortex. The proximity of the reservoir to the outside air is critical because heat dissipation will be greatly affected in a closed in area.



Hydraulic Pumps

Hydraulic pumps convert mechanical energy from a prime mover (engine or electric motor) into hydraulic (pressure) energy. This pressure energy is used then to operate an actuator. Pumps push on a hydraulic fluid and create flow.

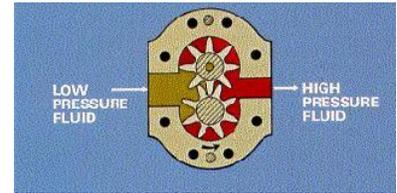
Pumps may be classified in the following ways:

Nonpositive-Displacement Pump

The volume of liquid delivered for each cycle depends on the resistance offered to the flow. (Example = A waterwheel picks up fluid and moves it but if the outlet is restricted, or we are trying to pick up more fluid than is available on the inlet side, then the waterwheel will just churn away. Our engines have nonpositive-displacement main pumps.) No definite volume of liquid is delivered.

Positive-Displacement Pump

A definite volume of liquid is delivered for each cycle of the pump operation, regardless of resistance, as long as the capacity of the power unit driving the pump is not exceeded and the fluid in the supply side (inlet) is maintained. (Example = primer pumps on our engines, well pumps, etc.) A sealed case around the gear or vane traps the fluid and holds it while it moves. As the fluid flows out the other side, it is sealed against back up. This sealing is the positive part of positive displacement. Since these pumps are enclosed in a casing, there is usually a pressure regulator or pressure relief valve in the system.



Methods for Powering Hydraulic Pumps

Manually operated:

Usually in conjunction with a single-action pump. The force that is applied is transmitted to the lever that pushes down on the reservoir.

Electric Motor:

An electric motor turns the hydraulic pump. A reservoir is usually gravity fed and the capacity of the motor and the stages of the pump (one or two stages) determine the pressure.

- ◆ DC (Battery) operated
- ◆ AC operated

Internal Combustion engine:

A small fuel powered engine is hooked up to a hydraulic pump via a crankshaft usually in a vertical orientation.

- ◆ Gasoline powered
- ◆ Diesel powered
- ◆ Propane powered
- ◆ CNG Powered

Air Pressure:

Compressed air is used to run a hydraulic pump.

Power Takeoff Unit:

A jackshaft is aligned with the vehicle drive shaft. By manually or mechanically transferring the thrust of the engine along the drive shaft, which would normally go to the rear axle, to the jackshaft, we now have a power unit to turn our hydraulic pump. The fire service uses PTO devices to drive pumps and /or generators that, in turn, power pumps.

Hydraulic Actuators

A hydraulic actuator receives pressure energy and converts it to mechanical force and motion. An actuator can be linear or rotary. A linear actuator gives force and motion outputs in a straight line. It is more commonly known as a **cylinder** but also referred to as a **ram**. A rotary actuator produces torque and rotating motion. It is more commonly called a **hydraulic motor**.

Cylinders

A cylinder is a hydraulic actuator that is constructed of a piston or plunger that operates in a cylindrical housing by the action of liquid under pressure. The most common types of cylinders in the fire service are as follows:

- ◆ Single-Acting Cylinder - This cylinder is operated hydraulically in one direction. When oil is pumped into a port, it pushes on a plunger, thus extending it. To return or retract a cylinder, oil must be released to a reservoir. A plunger returns either because of the weight of the load or from some mechanical force such as a spring. Example = bottle jack, floor jack)
- ◆ Double-Acting Cylinder - This cylinder must have ports at both ends. Pumping oil into one end moves a piston to extend a rod while any oil in the rod is pushed out to a reservoir. To retract, the flow is reversed. A double-acting directional valve controls the flow direction. (Example = log splitter, spreader, ram)
 - Unbalanced – here is a difference in the effective working area on the two sides of the piston. Thus the piston has a greater capacity in one direction than the other. The head end of the cylinder is usually installed toward the greater load. (Example = our **spreaders and cutters**)
 - Balanced – The effective working area on both sides of the piston is the same, and it exerts the same force in both directions. (Example = our **rams**)
- ◆ Telescoping Ram-Type Cylinder - A series of rams are nestled in a telescoping fashion. Except for the smallest ram, each ram is hollow and serves as a cylinder housing for the next smallest ram. A ram assembly is contained in a main cylinder housing, which also provides the fluid ports.
- ◆ There are several other types of cylinders (differential, non-differential, cushioned, lockout, etc.) but they are not commonly used in our industry.

Hydraulic Motor

Not to be confused with a hydraulic pump. A hydraulic motor converts mechanical energy from a prime mover (engine, electric motor, etc.) into hydraulic (pressure) energy. A pump, which is mechanically linked to a prime mover (engine), draws fluid from a reservoir and forces it to a motor. A motor, which is mechanically linked to a workload, is actuated by this flow so that motion or torque is conveyed to the work. They

can be a gear type or vane-type in design (much like our primer pumps). Motors are rated in Torque, Pressure, and Displacement. Torque and pressure indicate how much load a motor can handle. Displacement is the amount of oil that must be pumped into a motor to turn it one revolution. (The same as our engine company pump displacement.).

- ◆ Fixed Displacement – constant volume, depending on the Rpm's, delivered to the workload
- ◆ Variable Displacement – variable volume, independent of the Rpm's, delivered to the workload (hydrostatic drives).

SYSTEM TYPES

If we keep in mind the principles of Pascal's Law, then it is easy to see why there are systems using basically only two operating pressures. If we remember that the relationship of the surface area of the fluid being pushed through our lines to that of the surface area on the bottom of the actuator (cylinder), then we can see why a manufacturer would produce a system that falls into one of two categories.

Low Pressure System

This system relies on using a low-pressure (up to 5,000 psi) two-stage pump to move the fluid into the head end of the actuator (spreader, ram, etc.). Once in the actuator, the fluid pushes against the large diameter (surface area) of the piston. Usually systems that utilize low-pressure pumps have "bulkier and larger" components (tools) necessitated by that larger plate on the bottom of the piston.

An example of a low-pressure system is the Hurst Rescue System. This is why the Hurst spreader (model 32B) is heavier than some other spreaders. These low-pressure systems tend to be a bit heavier because the capacity of the tool is partly determined by the working pressure of the system (5000psi) times the surface area of the piston. Since high pressure systems multiply by a higher pressure (10,000psi), then the surface area of the piston head can be smaller and generally lighter.

High Pressure System

This system relies on using a high-pressure (up to 10,500 psi) two-stage pump to move the fluid into the head end of the actuator (spreader, ram, etc.). Once in the actuator, the fluid pushes against the piston. In this case, the piston surface area does not need to be as large as that of the low Pressure system in order to attain the same degree of force that is delivered in the low-pressure system. Thus these tools are potentially smaller and lighter. The potential downside of this is that the tool has to be engineered much differently and the capacity might be somewhat compromised. All the components of the system must be built to accept the higher pressures. **Remember:** The amount of increase in pressure depends upon the relationship between the force of the fluid and the surface area of the head end of the piston!

Components of Hydraulic Rescue Systems

Prime Mover

As explained earlier, there are many means for powering pumps.

Electric Motor

Usually a small 3-5 hp version that is mounted directly on top of a reservoir with the drive shaft mounted vertically. It gets its energy from a circuit that is powered by a separate generator. These motors draw up to 63 amps to start and up to 35 amps to run.



Two or Four Stroke Internal Combustion Engine



Usually a small 3-5 hp version that is mounted directly on top of a reservoir. Its orientation is usually so that the drive shaft is mounted vertically.

PTO Driven

A jackshaft is incorporated with the vehicle's drive train and when engaged, turns a pump, which in turn supplies hydraulic fluid under pressure directly to the tools.

Hydraulic Pump

For the most part, systems can be configured in a permanent state or have some mobility to them. Most apparatus have a pump(s) that is permanently mounted to the vehicle. In some cases, portable pumps may be secured in a compartment to be used for remote operations. These pumps, depending on the design of the system, produce pressure ratings in the 800 –10,500 psi range for low-pressure systems and in the 5,000 –15,000 psi range for high-pressure systems. They are usually a piston, gear, or vane type pump.

A relief valve is incorporated into the pump to dump the fluid back into the reservoir in the event of over-pressurization. The pump is attached to the crankshaft of the prime mover. Most often the pump is submersed in a reservoir of hydraulic fluid. This causes the suction to be flooded all the time and prevents an unwanted interruption of fluid to the pump.

Many systems have a two-stage configuration. This allows for an increase in pressure when the tool encounters resistance and thus the force we are attempting to apply is enhanced. (**Remember:** pressure is used on one end of the system to create force on the other end.) A reduced flow will result when using the second stage. This is the same as going from second gear in your car down to first gear. The engine speed will remain the same but the wheels will turn slower. In a low-pressure system this will usually occur around 1200 – 1600 psi. In a high-pressure system it will occur around 6600-7000 psi.

In the first stage of operation, the pump and engine are supplying volume to the tool to simply open or close the tool. Once the tool encounters resistance the engine RPM's increase and the pump sends the fluid out under pressure by increasing the number of pistons working in the engine. This increased pressure multiplies against the surface area of the piston inside the tool to a number greater than the opposing force (strength of nadir bolt, u bolt, hinge, etc.). It is important to remember that the system only provides enough power to overcome (cut, spread, push, pull) the opposing force. This is no different than a person moving a table, only enough force is applied to push the table across the floor, rather than throwing it across the floor.

Note: If you give the tool a few seconds to increase pressure and it still cannot cut, spread, etc. the load, make sure the dump valve is fully engaged and not partially pressurized. Also, be sure that the tool, especially the cutter, is strong enough to cut the desired load.

Reservoir

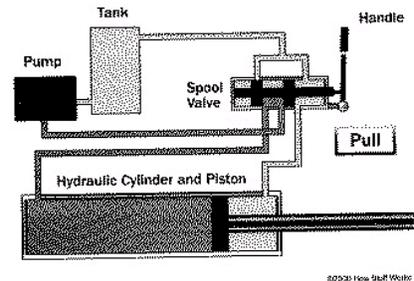
In most systems the reservoir is designed to be part of the prime mover (power plant) and is located directly under it. The hydraulic pump is encased in the reservoir as a nice neat package. This entire system is then located in a compartment which is well ventilated to dissipate heat. The normal capacity for these reservoirs is about 7 to 10 quarts of fluid.

In some systems the reservoir can be a stand-alone tank (as in the Amkus Ultima System). This tank, when possible, is located above the pump to help with suction. Tank capacities can range up to 10 gallons depending on the configuration and space available. The larger the capacity, the greater the heat dissipation.

By-Pass Valve(s)

A directional-control valve (by-pass valve or dump valve) is usually mounted on the reservoir that is plumbed directly after the pump with ports leading to either the actuator (tool) or the reservoir but can also be down line in a remote configuration. This allows pressurized fluid to either go toward the actuator (tool) and operate it or be returned to the reservoir. The most common type of directional valve is the spool valve.

The spool valve can be located remotely since its job is really to allow circulation of pressurized fluid from the pump back to the reservoir. It helps with the dissipation of heat and lessens the wear on the pump by allowing a constant flow.



One thing we must remain careful of is not to let the directional valve remain in the open position (towards the tool) and not be using the tool. This has the same effect as pressurizing a hand line with no water moving. If the attack crew is not flowing water, the circulation valve should be opened. Similarly, hydraulic fluid should be redirected back to the reservoir if there is a long pause in using the tool or immediately when their need for the tool is terminated.

Hydraulic Lines

There needs to be some way to carry the fluid from the pump to the tool (actuator). Rubber hose is normally specified for this job because of the amount of vibration. When the motor pulses with each stroke or revolution, there is an associated vibration. If the system was plumbed with rigid piping, then the couplings in the system may come loose. By using rubber hose, a seamless run in just about any length can be achieved.



The hose should be double jacketed. The tube that is used to transport the fluid should be made out of several layers of cotton braid depending on the desired strength rating. The other tube is made out of a wire or kevlar braid to withstand abrasion. There should be no sharp bends in the hose, since that would decrease the bursting pressure below its rated value. Since there is possibility of a hazardous atmosphere, the hose should also be non-conductive. There are always two lines married together. One line carries the pressurized fluid to the tool and the other returns the fluid to the reservoir.

Since these lines are pressurized and they will expand and contract, they should never be installed in a tight straight line as this will reduce the ability to flex with operating temperatures and pressures.

Tools (Actuators)

It has already been determined that most of our tools are either single acting or double acting cylinders. What we put on the ends of the cylinders determines the way we use it.

Tools that use single acting cylinders

Bottle Jacks



A simple telescoping cylinder that ranges from 1 to 50 tons. It has a handle to jack (move) the internal pump and force fluid into the chamber. A release mechanism (turn screw) is used to allow the fluid to return to the reservoir and gravity returns the cylinder to its resting position. This is a good elementary lifting or spreading device with limited stroke. Be careful when releasing the pressure with the turn screw. If jack is still loaded turn slowly to slowly lower the load. Always remember to crib as you lift. The top of the jack can be screwed up to make contact with the load prior to giving it lift. This should always be done to maximize the lift of the jack.

Floor Jacks

A simple telescoping cylinder that is attached to an arm with a resting plate on the end. The cylinder is oriented in a horizontal position. The arm is usually operated in a scissors or alligator motion. Because of this design, a great deal of strength is compromised. The ratings are usually in the 1 ½ to 10 ton range with a 20 ton capacity being very rare.

Floor jacks are great for lifting smaller objects with great efficiency. It is important to remember that these tools do not lift straight up but lift up and back towards the handle.



Porta-power

Porta-power tools are another single acting cylinder that was adapted to the auto body industry to bend and reshape metal. The revolutionary idea here is that the inventor separated the two main elements of a jack – the pressure-developing pump from the pushing ram and then connected them with a hose in the middle.

There are multitudes of attachments that can be used and this is the basis for today's power actuated tools. The normal capacity for the pump is 10 tons. However, the rated strength of the attachment



may not match the normal capacity of the pump. A 10 ton pump and a 1 ½ ton spreader equates to a disaster!



The “rabbit tool” is an example of the offshoot of the porta-power. This is really a bottle jack with an adapter and used remotely from the pump.

Tools that use double acting cylinders

Spreading Tools

This tool is a variation of the floor jack. It uses a double acting cylinder to extend and retract a pivot bar that is attached to various length arms. It gets its strength from the engineered configuration of that pivot bar. This allows the tool to bend, lift, spread, and pry with maximum force and efficiency. The tool must be constructed as to avoid all possible racking of the arms or a significant possibility of a catastrophic failure could result.

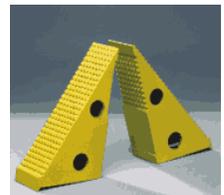


Since it utilizes a double acting cylinder force in both directions can be achieved. The capacities are dependent on the size of the pressure plates in the cylinder as well as the length of the arms (levers). They are typically in the 10,000 to 50,000 lbs. range.

The tool is controlled by a directional spool valve located somewhere near the base on the tool. This “dead man” switch allows a positive neutral position to be obtained when not in use.

The tool is comprised of aluminum alloy forging and extrusion, heat-treated steel, and machined aluminum and steel.

There are a variety of tips available for the ends of the arms. These are used for grabbing, piercing, and holding items.



Cutting Tools

Using the double acting cylinder the cutting tool pushes and pulls two blades to form a scissors or cutting motion. Depending on the size, composition, and shape of the blades, various thickness and strength of



metal may be severed. Normally the greatest cutting capacity is achieved at the notch located at the base of the tool.

The tool is controlled by a directional spool valve located somewhere near the base on the tool. This “dead man” switch allows a positive neutral position to be obtained when not in use.



The tool is comprised of aluminum alloy forging and extrusion, heat-treated steel, and machined aluminum and steel. Its capacities are in the 25,000 to 210,000 lbs. range.

It is critical to have an in-depth knowledge of the tools on the apparatus. Not all tools can cut everything that may be found on the street. Resources must keep up with changes in vehicle construction and improvements in rescue tools. Attempting to cut a load too great for the type of tool can have catastrophic consequences.

Combination Tools



These tools are nothing more than hybrids of the spreaders and cutters. They operate on the same principle as the above tools although their capacities are generally less than if the tool was designed for one specific purpose.



Rams



These are the simplest forms of double acting cylinders. They can be used for pushing, pulling, shoring, stabilizing, or supporting.

The tool is controlled by a directional spool valve located somewhere near the base on the tool. This “dead man” switch allows a positive neutral position to be obtained when not in use.



In the pushing mode, they usually have a capacity in the 15,000 to 18,000 lb. range. Pulling is a lot less, somewhere in the 5,000 to 6,000 lb. range. This is because the plate at the head end of the cylinder has a smaller circumference than the bottom plate. Thus, less surface area equals less multiplication.

They come in various sizes from 10 inches to 70 inches. The ram ends are heat-treated steel and usually have a serrated surface to make better contact.

Also now available are telescoping rams that offer pushing forces of over 29,800lbs on the first piston and 14,800 lbs on the second piston. Lengths of 41 and 59 inches of ram extension can be achieved. These rams offer a greater push in a smaller more compact housing. However, there is no pulling force available with these telescoping rams.



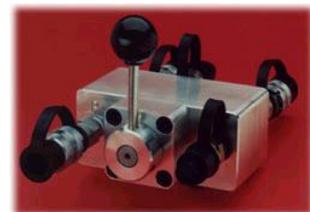
Manifolds



A manifold is a device that allows us the connection of more than one tool to a single hydraulic supply line from a single power source. This device allows the automatic changeover to any of the connected tools. Manifolds are available with a pressure dump valve that would allow the tool, after it has been used, to be disconnected rather than return and use the system dump valve.

A word of caution is needed. This device is designed to operate one tool at a time. Not multiple tools at the same time. If an attempt is made to operate two or three tools simultaneously, “hydraulic intensification” is created. This is where the fluid exiting out of the first tool under pressure is intensified into the intake of the second tool and again in to the third tool. This intensity compromises the safe maximum operating pressures of the tools and, in the best case, locks the tool up. The worst case is a catastrophic failure. When using the manifold there is an order that must be used to hook the tools to the system. If you have completed your operation with one tool, the manifold should be damped and repressurized prior to using the next tool.

Remember that all ports of the manifold must be in use or fluid will discharge from the unused couplings. Jumper hoses are provided for the use of less than three tools.



Lift Cylinders

Hurst lift cylinders are another tool in the toolbox for heavy lifting requirements. Although not found often, MCFR is virtually the only departments in the Metro area that carries these tools on their Rescue Squads. There are several nuances particular to this system that must be understood to completely operate this equipment. When using the cylinders, the fluid is transmitted to the cylinders through the Mobile Selection Manifold also known as the MSM valve.



Pictured, the MSM valve operates with a control lever valve and (2) two metering valves that control the flow of the fluid individually to each output port. The control valve is a three position valve, up, neutral, and down. The metering valves are screw type valves with a clockwise turn to close and counter clockwise to open. Each MSM valve will support 2 lift cylinders. To supply the MSM valve, a regular Hurst hose off an electric pump or a portable pump will suffice. In order to supply the fluid to the cylinders, special hoses are needed to connect from the output ports of the MSM valve to the cylinders. Operationally, connecting all hoses correctly will aid in the safe use of the lift system. Connecting the specialty hoses from the MSM valve to the cylinder must be completed with a locking turn of the coupling (see below). All hoses should be coupled together without excessive force. If you cannot make the connections without excessive force potentially there is pressure in the hose lines that will need to be relieved before continuing.



CORRECT



NOT CORRECT



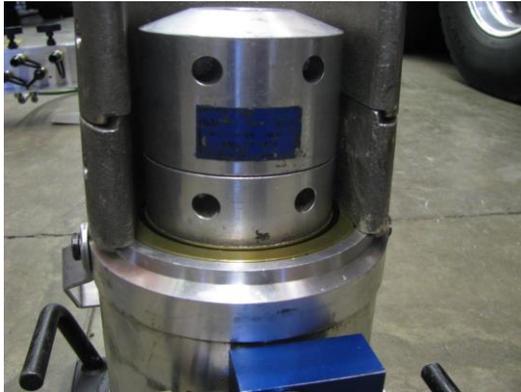
The lift cylinders consist of several configurations. There are two, 3 piston cylinders, a 2 piston short cylinder and a tall 2 piston cylinder in our inventory.



The following chart shows the specifics of the cylinders.

Cylinder Specifications :		HP 7 / T 280 R	HP 19/ T 185 R	HP 17 / T450 R
Total stroke		11 in.	7.24 in.	17.7 in.
Stroke	piston 1	3.6 in.	3.74 in.	8.8 in.
	piston 2	3.7 in.	3.5 in.	8.9 in.
	piston 3	3.7 in.		
Lifting Force	piston 1	96,439lbs.	96, 439 lbs.	96,439 lbs.
	piston 2	44,510 lbs.	44,510 lbs.	39,340 lbs.
	piston 3	15,286 lbs		
Height Retracted		8.7 in. (220 mm)	8.7 in. (220 mm)	15.2 in. (385 mm)
Oil Requirement		85.4 cu. in. (1.4l)	79.3 cu. in. (1.3l)	172.7 cu. in. (2.83l)
Weight		29.8 lbs. (13.5 kg)	30.8 lbs. (14 kg)	51.8 lbs. (23.5 kg)

Along with the cylinders, there are stacking rings and cylinder extensions to allow for a higher lift in a shorter clearance area. The stacking rings are designed to support the load while adding the cylinder extensions on the 1st stage piston only. When installing the cylinder extensions (aluminum hockey pucks) the smallest one is always used first as its design is to fit the cylinder, then stack other cylinder extensions on top. The fork provided is used to install the stacking rings and cylinder extensions while the load is supported by the cylinder piston thus providing safety against crushing injuries.



CORRECT



NOT CORRECT

Notice the cylinder extension fit the first stage piston (largest piston) almost exact spreading the force across the entire cylinder.



CORRECT



NOT CORRECT

Additionally base plates must be used with any lift. The tall base plates must be used with the tall cylinders, and they may be used for the short cylinders as well. The black short bases are to be used with the short cylinders.



Once the lift is complete and readying the equipment for service, care must be given to release all hydraulic pressure from the hoses. After the dump valve is activated so there is no longer pressured fluid to the MSM valve, you must activate the MSM valve both up and down (with the metering valves open) to release hydraulic pressure in the hoses and the MSM. The uncoupling of the hoses should be as easy as coupling during set up.

Note:

Lift cylinders are generally used for lifting heavy loads, consequently insuring the foundation for the cylinder base plates are as level and secure as possible. Heavy lifting requires meticulous cribbing for safety and safe operation of these cylinders.



Accessories



There are multitudes of accessories that are available for the various hydraulic tools. These range from tips for the spreaders to chain and shackle packages for the rams. The only limiting factor on using these tools is our own imagination.



MAINTENANCE

If we are to expect our tools to enhance our ability to work efficiently and safely, then we must assure that they are in peak operating condition. This is especially true since most will be operated in conditions that are out of the “normal” parameters. It is for this reason that the rescue squad personnel to be able to inspect, maintain, and repair components of the hydraulic system.

Tools should be cleaned, inspected, and wiped down daily. Fluid levels should be checked prior to running daily. After incidents and on a monthly basis, tools should be cleaned by wiping the tools and hoses down with a rag. Blades and tips should be lightly lubricated to prevent rust and couplings should be cleaned by rinsing in warm, soapy water, then rinsed in clean water, then dried. Check the manufacturers recommendations and follows all guidelines for maintenance.

INSPECTION

POWER UNIT

OBSERVATION	SATISFACTORY	REPAIR NEEDED
Entire tool - clean - signs of damage		
Fluid Levels - gas - oil - hydraulic fluid		
Electrical Connections - tight - damage		
Feet - in place - secure		
Frame - screws and nuts tight - guards in place		
Body - seals leaking - dents or gouges		
Directional Valve - tension - operates easy		
Motor/Engine - runs properly		
Pigtails - intact - cuts - abrasions		
Quick Disconnects - clean - operates easily		

SPREADERS

OBSERVATION	SATISFACTORY	REPAIR NEEDED
Entire tool - clean - signs of damage		
Tips - tight - signs of damage		
Arms - damage		
Pins - removable		
Body - seals leaking - dents or gouges		
Frame - screws and nuts tight - guards in place		
Piston Rod - clean - damage		
Control Valve - tension - operates easy		
Pigtails - intact - cuts - abrasions		
Quick Disconnects - clean - operates easily		
Tool Speed Time Open Close		

CUTTERS

OBSERVATION	SATISFACTORY	REPAIR NEEDED
Entire tool - clean - signs of damage		
Blades - damage		
Pivot Pin - proper torque		
Body - seals leaking - dents or gouges		
Frame - screws and nuts tight - guards in place		
Piston Rod - clean - damage		
Control Valve - tension - operates easy		

Pigtails - intact - cuts - abrasions		
Quick Disconnects - clean - operates easily		
Tool Speed Time Open Close		

COMBINATION TOOL

OBSERVATION	SATISFACTORY	REPAIR NEEDED
Entire tool - clean - signs of damage		
Tips - tight - signs of damage		
Blades - damage		
Pivot Pin - proper torque		
Body - seals leaking - dents or gouges		
Frame - screws and nuts tight - guards in place		
Piston Rod - clean - damage		
Control Valve - tension - operates easy		
Pigtails - intact - cuts - abrasions		
Quick Disconnects - clean - operates easily		
Tool Speed Time Open Close		

RAMS

OBSERVATION	SATISFACTORY	REPAIR NEEDED
Entire tool - clean - signs of damage		
Feet - in place - secure		
Body - seals leaking - dents or gouges		
Piston Rod - clean - damage		
Control Valve - tension - operates easily		
Pigtails - intact - cuts - abrasions		
Quick Disconnects - clean - operates easily		
Tool Speed Time Open Close		

ACCESSORIES

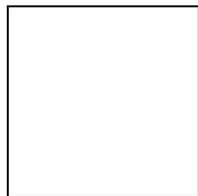
OBSERVATION	SATISFACTORY	REPAIR NEEDED
Hoses - clean - intact		
Reels - operational - clean		
Manifold - operational - pigtails		
Chains - damage - lubricated		
Tips - damage - clean		

STORAGE

All components of the hydraulic system should be stored in a weatherproof compartment if possible. In addition, all tools and accessories should be mounted in a fashion as to keep the equipment from bouncing around and becoming damaged or damaging something else. They should also be stored for quick and efficient service if needed.

The power unit should be housed in a fashion that would promote good air circulation and yet keep it clean and dry. This is especially important for the reservoir.

Probably the most important factor in storage is the ease with which the tools and accessories are accessible. These tools are heavy and improper lifting, bending, and stretching could cause injury. An efficient system is the best system.



REPAIR

If the system is stored properly and regularly inspected, then a good life expectancy of the equipment can be expected. Be aware, however, that sometimes repairs are needed. By becoming familiar with all of the components of the system and the tools that go with it, personnel should be able to do some of the minor repairs. Consultation with the department assigned mechanic should always be considered before attempting repair.

