Exhibit J

DELTA

MECHANICAL
SYSTEM
THEORY

MECHANICAL
SYSTEM THEORY
VEHICLE ARREST SYSTEM

MFG. UNDER U.S. PATENT #4,097,170 4,158,514 4,318,079 4,354,771 4,490,068 4,576,508 4,715,742

U.K. PATENT # GB 2,127,893B 2,138,883B

40355 DELTA LANE • PALMDALE, CALIFORNIA 93551, USA • PHONE (661) 575-1100 • FAX (661) 575-1109

E-MAIL: info@deltascientific.com

Doc #100-35 P-3

'DELTA' STYLE HYDRAULIC POWER UNITS
TT AND DSC SERIES PHALANX® BARRIERS
THEORY OF OPERATION

Power Source

Delta Scientific Corporation's barricade systems are powered by a hydraulic oil power unit (HPU). This unit is typically mounted remote from the Barrier(s) and attached to them by hoses or steel pipes. The hydraulic power unit provides the tremendous lifting force necessary to raise the heavy steel weldments of the Barriers. The forces generated are in the range of 20,000 to 25,000 pounds for these large Phalanx® Barricades. An industrial grade electric motor drives the hydraulic gear pump to produce the HPU system pressure.

Power Storage

The HPU stores the pressurized hydraulic oil produced by the gear pump in an accumulator. The accumulator thus provides a high pressure reserve of oil available to move or maintain the position of the Barricade. The pressure of the oil in the accumulator is maintained by the automatic cycling of the pump motor on and off between the low and high settings of a pressure switch. It is important to note that the pump motor thus runs independently of any command from the Barrier control panel; if pressure is low the pump motor will run, if the pressure is within bounds (even with the Barrier moving) the pump motor will be off.

In addition to providing the high pressure oil to move the Barriers, the accumulator also acts as a hydraulic spring to cushion the various parts of the hydraulic system during normal operation and when the Barrier is performing its' designed task of arresting vehicles.

Power Access

To move a Barrier we must direct the pressurized oil in the HPU to the appropriate up or down side of a hydraulic cylinder in the Barrier. This is done by shifting a directional valve mounted on the HPU. The shifting is accomplished by energizing one of two electric solenoids on the valve. The valves used by Delta are known as 'two position, electrically actuated, spring detented'. The spring detent allows the valve to remain in the position it was last shifted to without being constantly energized. This saves energy and allows the Barrier to remain in its commanded position even if power is interrupted to the HPU.

Using two or more of these directional valves allows us to independently control two or more Barriers from one HPU. This feature is useful where Barriers are placed in multiple lanes at the entrance of a facility.

GOOD HYDRAULIC PRACTICE

Safety Precautions

At all times observe good safety practices when working on either the electrical or mechanical system. Particular attention should be paid to the danger of working on the Barrier when the power is on. The Barrier is a powerful hydraulic press that can easily crush anything in its way. Keep hands free of the mechanism when the power is on or the HPU is up to pressure. Turn off the electric power and bleed the hydraulic pressure down to zero before working on any part of the system. Traffic should be controlled around the Barrier(s) during any work so that vehicular accidents do not occur if the Barrier should happen to rise. After work is complete, do not allow traffic over the Barrier until all control and safety functions have been verified to be properly working.

Cleanliness

To maintain system efficiency and reliability great care must be taken to prevent any form of dirt, sand or grit from entering the hydraulic system. Only new, clean filtered hydraulic oil should be used for charging the unit. Unless specifically ordered as filtered, new oil should be pumped through a 25 micron filter when charging. See **Commercial Hydraulic Oil Interchangeability Chart** for our recommended oils. The tests conducted at the factory on the system have been done with the HPU charged with Shell 'Tellus' 46. This grade is for moderate temperatures and is available in most of the worlds leading cities.

Hydraulic oil is subject to degradation and contamination with age, so follow the recommendations in the Maintenance section of this manual.

Location

The hydraulic power unit should be mounted indoors in a clean, dry location away from excessive heat or cold. As an alternate the unit can be mounted outdoors if provided with a suitable cover designed for the area to exclude moisture or dust as appropriate. While HPU's have been mounted below grade in concrete pits, we do not recommend this as drainage becomes extremely important. A drain backup can cause the power unit to go under water with severe damage resulting. Also, the water condensation found in most pits is detrimental to the HPU components.

It is important that the hydraulic power unit be mounted at approximately the same or higher elevation as the Barrier(s). If the HPU is mounted lower than the Barrier(s), the oil in the lines may repeatedly drain back to tank and make the Barrier motion erratic. The power unit can be at elevation greater than the Barrier(s) if it is understood that breaking a line at the Barrier will cause oil to flow in that direction.

System Component Description

The hydraulic power unit (HPU) is assembled on a steel framework, which supports the hydraulic oil reservoir and major components. Provision is made to permit bolting or lagging of the frame to a suitable foundation. See the appropriate General Arrangement drawing for hole and interface dimensions. The power unit has been pre-tested for function and leaks at the factory prior to shipment. Preparation for shipment calls for the draining of the test oil, however, approximately one inch [25 mm] will remain in the tank after draining.

Oil Reservoir Tank

The oil reservoir forms the largest component of the hydraulic power unit. It is integral with the backplate of the skid base and forms the structure to which other components are attached. On the top is mounted the filler breather cap by which oil can be added to the tank. The capacity of the reservoir is nominally 20 gallons [75 liters]. This is also approximately the charge of oil that will be required to fill the lines and hydraulic cylinders of the Barriers.

The tank's level is indicated by a sight glass on its' front face. The reservoir should only be filled with the hydraulic system pressure at zero, otherwise overflowing can occur as a result of oil being displaced out of the accumulator. The proper oil level is within 1 inch [25 mm] of the sight glass top at zero system pressure.

The reservoir tank holds the suction strainer on the pump suction line and also provides the mounting for return line filter. A oil level switch is provided to shut the pump/motor off should oil loss threaten pump failure. A reservoir heater can be supplied if the ambient temperature so dictates.

Drains are furnished at tank bottom (both sides) for removing water and/or changing fluids. This should be done at the intervals directed in the **Maintenance** section. A removable cover is provided for clean out and access to the components inside.

Gear Pump/Check Valve

The gear pump is mounted on a motor adapter and attached to the motor drive shaft by a flexible coupling. The set screws in the coupling halves should be checked for tightness on the pump and motor shafts prior to start up. The pump seals, as are all other HPU component seals, are Buna-N. A check valve is located at the pump. Its purpose is to prevent the pressurized oil in the high pressure side of the unit from running back through the pump after the motor shuts off. If it were to fail you would likely see the fan on the pump motor run backwards and the system pressure fall until zero.

Do not start the pump/motor until oil has been put into the reservoir. The pump can only be run dry for a few seconds before damage to the gears and the housing occurs. The suction line to the pump is provided with a shutoff valve to facilitate maintenance. This valve must be fully open at all times except when replacing the pump. A closed pump shutoff valve can destroy the pump in seconds.

Motor

The motor is mounted horizontally and bolted to the HPU framework as will as to the other side of the pump/motor adapter. It is a totally enclosed fan cooled (TEFC) design, three phase. The motor voltage and rating is shown on its nameplate; as a multi winding motor is furnished, the as wired voltage is shown on the Delta motor placard attached to the motor starter enclosure.

Motor/pump direction of rotation is critical. A direction arrow decal is provided. The motor must run in this direction when site power is brought to the HPU skid. If the motor does not run in the proper direction on startup, reverse any two incoming wires to the control circuit disconnect switch.

Phase Monitor (Optional)

An optional phase (voltage) monitor may be supplied to protect the motor from improper phasing, phase loss, or low voltage. The monitor will drop out the motor starter circuit if the three phase power is phased wrong or if the voltage is too low. The unit has been properly phased at the factory. If the motor does not run on initial startup, reverse any two incoming wires to the control circuit. The motor should now run and in the correct direction.

Magnetic Motor Starter/Overload

Site voltage is fed to the line side of the motor starter/thermal overload. See voltage placard attached to the starter enclosure for the **as wired** voltage and motor starter circuit drawing number. The feed to the HPU should be controlled from an appropriately sized circuit breaker/disconnect switch and the wires sized properly to prevent excessive voltage drop from the disconnect to the HPU skid. Motors should not be allowed to run at voltages exceeding +/- 10 percent of their ratings. This could lead to tripping of the thermal overloads or substantial damage to the motor and control circuit components.

The thermal overload is calibrated for the anticipated full load amperage of the motor at run voltage, this setting should be confirmed before start up (the amperage dial of the overload should be set for the full load amps labeled on the motor nameplate). The overload should be in the **MANUAL** position, automatic reset could cause equipment failure if a fault is not corrected in a timely manner.

A voltage/phase monitor may optionally be furnished. In addition to protecting the pump against improper rotation, it will shutdown the motor starter circuit if phase loss/reversal or low voltage is detected.

Accumulator

The accumulator is a large cylindrical pressure vessel that provides the high pressure reserve of oil used to move the Barriers and keep them in position. In addition, the oil stored in the accumulator is available to move the Barrier(s) even if the pump/motor should be inoperable. The amount of oil directed out to the Barrier(s) is not limited by the displacement rate of the hydraulic gear pump but by the oil stored in the accumulator.

An accumulator is divided into two sides by a piston (piston accumulator). On the top side, the accumulator contains dry nitrogen gas pre-pressurized (precharged) at the factory at a level determined by the type of Barriers on your order. The fittings and seals on the nitrogen fill connection should be kept tight to prevent loss of this precharge. A special tool is available from Delta Scientific to check the precharge pressure and facilitate recharging if that should become necessary. Precharge should be checked every six months (see **Maintenance** section of this manual). The pump/motor should not be run if there is no precharge, damage to the accumulator could result. Only dry nitrogen should be used for precharge, air or other gases could cause the accumulator vessel to explode. Precharge should only be done at zero hydraulic pressure or an incorrect precharge pressure will result.

The other side of the accumulator contains the system hydraulic oil. At zero hydraulic oil pressure there is little or no oil in the accumulator, the piston is down hard on the oil outlet. As the pump/motor runs, oil accumulates on the oil side at the pressure indicated by the system pressure gage (oil side). This pressure gage will read the precharge indirectly by jumping to the precharge value on motor startup then slowly running up to the shut off pressure. It is important to note that at shut off, only a portion of the accumulator contains oil, the piston has been pushed back to compress the nitrogen gas which is now also at the shutoff pressure. It is the compressed gas that provides the 'spring' to move oil out of the accumulator and to the cylinders of the Barrier.

When performing accumulator maintenance it is necessary to bring the oil side pressure to zero. Large oil loss can occur if fittings are tampered with while under pressure.

Pressure Switch

The pressure at which the oil side is maintained is determined by a pressure switch mounted on the high pressure (pump or accumulator) side of the system. The switch is factory set for the proper shutoff pressure of 1900 psig [131 bar] and has a 500 psig [34 bar] 'dead-band'. This means that the pressure will fall approximately 500 psi [34 bar] after shutoff (about 1400 psig [97 bar]) before the switch closes to restart the pump motor. These settings should be indicated on the motor starter drawing and noted in the pressure log in the **Maintenance** section. The electric side of the switch is terminated on a terminal strip in the motor starter enclosure.

Pressure Gage

A pressure gage is provided to indicate the hydraulic oil pressure of the system. It does not indicate the accumulator precharge except as noted in the **Accumulator** paragraph of this section. The gage is liquid filled with glycol to eliminate needle bounce and a vent is thus provided to allow the case to breath, preventing case blow out. Upon receipt, remove vent seal plug/label.

This gage must read zero when working on the HPU pressure lines and fittings or large oil loss can occur. A gentle tapping on the gage glass will provide the most accurate readings.

Pressure Relief Valve

A pressure relief valve is provided should the high pressure switch fail to shut off the pump motor. The relief valve is typically set 200 to 250 psig [14 to 17 bar] higher than the high pressure switch. When the pressure relief valve opens, oil is allowed to circulate from the pressure side of the

system to the tank/motor suction. The motor horse power is thus being turned to heat across this valve which could cause component damage if allowed to operate uncorrected. The operators or guards should thus report to the person in charge of Barrier maintenance if they note the HPU constantly running.

An open pressure relief valve will cause a hissing sound and if the motor is not running, a falling pressure gage would be noted. See the **Mechanical Trouble Shooting** section if the relief valve does not reseat on pressure reduction.

The pressure relief valve should in no case be set higher than 1.1 times the pressure rating of the minimum rated component in the Barrier system. Please note that most components are designed with a 4 to 1 safety factor, thus the burst pressure of a 2500 psig [172 bar] rated hose would be 10,000 psig [690 bar].

Low Level Switch

As noted above, an oil reservoir low level switch is provided to shut down the pump/motor if the reservoir level drops to the point where the suction of the pump could become uncovered. The gear pump can only run dry for a few seconds before severe wear occurs on the gears and its' housing. Causes of low level are slow system leaks and catastrophic failure of the pressure lines or hoses.

Oil Filter

A return filter element is furnished to filter the oil as it is being returned to the oil reservoir. The oil filter housing is only rated at 150 psig [10 bar] or less as the oil in the return line has only to overcome the pressure drop through the filter itself. If the filter should become clogged with dirt from the system a bypass check valve inside the filter will open and allow the dirty oil to circulate back to the reservoir. For this reason regular filter maintenance is a must. See the **Maintenance** section for details.

Directional Control Valve

A solenoid actuated directional control valve is provided to direct the high pressure oil to the up or down side of the Barrier cylinder(s). One or more (depending on the number of Barriers to be controlled) are mounted on an aluminum manifold bolted to the back plate on the oil reservoir. When the 'up' side is energized, the valve connects the high pressure (P) side of the manifold to the (B) output port of the manifold. The tank return line (T) is simultaneously connected to the (A) output port. When the 'down' side is energized, the manifold (P) side is connected to the (A) port and the (T) side is connected to the (B) port.

The directional valve is equipped with pin extensions mounted on the solenoid ends so that the valve spool can be manually shifted by inserting a pin with a diameter of approximately 0.125 inch [3 mm]. As described above in the **Power Access** paragraph, the valve has spring detents so that it remains in the last commanded position until moved by the electric solenoids or the override pins. See the applicable 'Hydraulic Valve Connection' drawing.

The spool of the valve is designed to provide 'closed center ports' so that if the valve malfunctions and does not fully shift, the ports will be closed to one another. Note that these valves require clearance between the spool and the valve body to properly function, thus some leakage from pressure to tank is to be expected. Excessive valve wear will eventually cause the pump/motor to cycle on and off several times per minute even when the Barriers are not moving. Replacement or rebuilding of the affected valve will then be required.

The convention used on all Delta Barrier systems regarding the directional control solenoid valves is as follows:

Directional Control Solenoid Numbering: Valve one (station one) is the bottom most valve on the manifold with the station number increasing to the top of the valve stack.

Color Codes:

Side/Solenoid	Wire Color	Function
Left/'B'	Black	UP
Right/'A'	Red	DOWN
---	White	COMMON
---	Green	GROUND

The valve is held to the manifold with high tensile cap screws. Buna-N O-rings are used to seal the valve port face to the manifold. It is imperative that the mating faces be clean and all 'O' rings in place and lightly lubricated with hydraulic oil before evenly torquing the cap screws.

Valve mounting screw torque:

NFPA DO1/ISO 03 40 to 50 in-lbs [5 to 6 N-M]

Speed Control Valves

Each directional valve station has speed control valves to control the normal up and down speed of the Barrier. They are located in the B line before the B hose. These large Barriers are furnished with two flow control valves (a flow control valve is a needle valve with and check valve integrally plumbed across the needle) mounted back to back to provide independent control of the up and down speed.

The Delta convention on flow control valves is that the 'up' speed is adjusted on the valve nearest to the directional valve manifold. The 'down' speed is adjusted on the valve nearest the Barrier. Clockwise turning of the adjustment knob is slower (valve closing), faster speed is gained by opening the valve (counter-clockwise). The valve should be locked with the set screw provided after adjustment.

Emergency Fast Operate (EFO) Valve (Optional)

Some systems are equipped with optional emergency fast operate (EFO) bypass valves. These solenoid valves when energized directly connect the high pressure (P) side of the HPU to the up side of the Barrier cylinder(s). This bypasses the normal Barrier speed control valves and allows

the Barrier to rise at its' maximum possible speed. The valve is 'cartridge' style and is mounted in an aluminum body plumbed from the (P) side of the system to the (B) output port immediately before the (B) hose.

Should it become necessary to replace an EFO valve cartridge, the following mounting torques apply:

Solenoid Coil Retaining Nut	60 in-lbs [7 N-M]
Cartridge to Body	420 in-lbs [48 N-M]

Auxiliary Emergency Fast Operate Valve (Optional)

Some systems are equipped with an optional additional accumulator separated from the primary accumulator by an auxiliary emergency fast operate valve. This solenoid valve allows oil to be charged into the auxiliary accumulator and held in reserve until the 'emergency fast operate valve' is actuated. The valve then releases high pressure oil to the P side of the system, even if the primary accumulator has been exhausted. The valve is very similar to the normal EFO valve except that it is equipped with a manual override pin so that the auxiliary accumulator can be bleed down prior to performing maintenance.

Should it become necessary to replace an auxiliary EFO valve cartridge, the following mounting torques apply:

Series 14 - Solenoid Coil Retaining Nut	30 in-lbs [15 N-M]
Cartridge to Body	190 in-lbs [22 N-M]
Series 21 - Solenoid Coil Retaining Nut	30 in-lbs [15 N-M]
Cartridge to Body	475 in-lbs [55 N-M]

Hand Pump

In the event power should be lost to the pump/motor, the Barrier(s) can be raised by working a manual hand pump which is mounted adjacent to the pump/motor on the skid base. The hand pump has its' own internal check valve so no fluid is lost through the hand pump back to tank during normal motor driven pump operation. The suction line to the hand pump is located near the reservoir bottom. In use, the hand pump supplies oil to the pressure (P) side of the hydraulic system. The pump can be operated at anytime.

To raise a Barrier with the hand pump when electricity is out:

1) Check sight gage for proper fluid level, add oil as necessary.

2) Make sure accumulator bypass (bleed down) valve is closed.

3) Shift directional valve spool of Barrier from left (Up) side.

4) Start pumping (each stroke should be productive). Pump until Barrier is fully up.

5) Continue pumping for 10 to 20 strokes after the Barrier is up. This will add some oil to the accumulator to provide for some internal leakage before the Barrier would start to drift down from low pressure.

System Bleed Down Valve

Prior to performing any work on the hydraulic power unit or Barricades it is necessary to bleed down the pressure stored in the accumulator(s). **Note:** It is especially necessary to bleed the power unit down to zero hydraulic pressure before topping off the reservoir with fresh oil; large oil spillage can occur if the unit is not at zero pressure when the reservoir is topped off! This is accomplished with the accumulator bypass or bleed down needle valve located between the high pressure side of the system and the reservoir tank. (Typically this valve is mounted behind the hand pump in a line tied to the hand pump suction line.)

To bleed down the system:

1) Turn off electrical power to the pump/motor.

2) If system is equipped with the optional auxiliary emergency fast operate system, release the auxiliary EFO valve override pin by twisting and pulling to the out position.

3) Release set screw. Crack open the bypass needle valve slightly until hissing sound is heard. Continue to open slowly until pressure on gage reads zero.

4) For added safety, leave valve open while performing maintenance.

To resume operation, close the bypass valve snugly and lock with the set screw. Turn on system power

Hydraulic Interconnect Lines

Delta Scientific uses one of two systems to connect the hydraulic power unit to the Barrier(s). Applicable to both systems is a need to run the lines in the most direct route as possible, keeping bends to a minimum. Long runs will slow the Barrier rise time and must be compensated by increasing the flow diameter. In general, all runs over 50 feet [15 M] should first be cleared with the factory, especially if minimum emergency fast rise times are critical to the installation.

The hydraulic power unit should be mounted at approximately the same or higher elevation as the Barrier(s). Other wise, the oil in the lines may repeatedly drain back to tank and make the Barrier motion erratic.

Cleanliness is the other important requirement for the hydraulic interconnect lines. Dirt or metal chips will find their way into the tight clearances of the components, scoring shafts and spools and wearing seals. Lack of cleanliness will shorten the service life of the system.

Flexible Hydraulic Hose

This system conveys the hydraulic oil from the HPU to the Barrier through flexible hose(s) which in turn are run through a larger conduit, generally a 3 inch [75 mm] PVC tube per hose pair. The PVC conduit should be run to the Barriers in as direct a line as possible, all bends being a radius of at least 6 diameters of the conduit. The burial depth of the conduit should be deeper than the maximum permafrost level in areas subject to freeze. This will prevent excessive pressure drops in the hoses due to high viscosity from the cold. As the hose length changes under pressure, always provide some slack in the hose to allow for shrinkage or expansion.

All joints in the conduit system should be smooth and free from sharp edges and burrs to prevent scoring the hose outer sheathing during pulling and Barrier operation. A hose under pressure is very rigid and tends to bounce when the directional valves are shifted. Sharp edges will quickly cause a hose failure. Where the hose can not be clamped or fixed away from abrasive surfaces, a steel or plastic protective coil or sleeve should be placed over the hose.

Insulate the hose with a heat resistant boot, fire-sleeve or a metal baffle if the hose run passes near an exhaust manifold or other heat source.

Hoses received from the factory have caps on each end and are free from dirt and other contamination. Do not remove caps until hoses are pulled through the conduit and are ready for termination. If caps are not present, reclean the hoses by blowing out with clean compressed air. As an alternate, hose assemblies may be rinsed out with clean mineral spirits, being sure to flow the mineral spirits through from top to bottom without forming any low points which will tend to collect debris.

Before attempting to pull hoses through the conduit first inspect them. Lay the hose out straight and check that the layline of the assembly is not twisted. (Hoses pulled with a twist in them will tend to straighten, causing fitting nuts to loosen.) Check for scoring, cracks, bulging, kinks and dirt in the outer sheath. Check for proper gap between nut and socket or hex and socket; nuts should swivel freely. Be sure hose is capped securely.

If the hose must be stored for a prolonged period prior to installation it should be kept in a dark, dry atmosphere away from electrical equipment. The temperature should not exceed 90°F [32°C]. Storage in straight lengths is preferred. While stored, the hose should be wrapped as necessary with burlap or other suitable material to prevent damage. Hoses should be inspected regularly when in operation, especially where the hose exits the conduit at the power unit and the Barrier. Worn or damaged hose assemblies should be replaced immediately.

Note: Hoses supplied by Delta Scientific are generally supplied in lengths of 50 feet [15 M]. This is adequate for the majority of installations, however, there is generally some left over length. Coil the hose neatly in a circle approximately 20 inches [0.5 M] in diameter at the HPU. Secure the coil with loosely fitting cable ties or similar tying system. Do not allow the hose to rest on the ground or across sharp corners of equipment. If the hose is too short, extension pieces of the correct length can be ordered. As an alternate, hoses can be held back from your shipment and made to exact requirements when the length is determined if desired.

Special field assembly type fittings may be supplied to allow the factory length hoses to be cut and re-terminated to the exact length in the field without the use of special tools.

Steel Pipe Interconnect System

As an alternate to the flexible hose system, steel pipe may be used for the run from the HPU to the Barrier. The same comments above about short, direct runs to the Barrier(s) apply. Typically the pipe run is made up above grade and dropped into a trench for direct burial (below frost level if applicable). If local conditions dictate, the outer portion of the pipe and fittings can be corrosion protected by coating or tape wrapping if desired. Short lengths of hose, typically 3 feet [1 M] long, can be supplied to attach the HPU and Barrier to the pipe system. Or the piping can be plumbed directly to the fittings on HPU or Barrier (for this a union will be required).

The pipe used should be ASTM A-106B seamless (carbon steel) as a minimum. Care should be taken when selecting wall thickness Vs pipe diameter for the system design pressure (Delta can be consulted for proper line sizing, strength calculations and material selection).

Fittings for the pipe run should be forged steel, ASTM A-105 or equal. Malleable iron is not acceptable. All pipe and fittings are to be furnished black, i.e., no galvanizing is permitted; the galvanize can flake off and block or damage hydraulic components.

If desired, stainless steel pipe and fittings can be used, however, do not mix stainless steel pipe with carbon steel fittings or vis-a-vis severe corrosion of the carbon steel components could result. Copper and copper bearing alloys are generally unsuitable for hydraulic oil systems and should be avoided when possible.

Fittings

A variety of fittings are used on a Delta Barrier system; an understanding of how each style seals is important so that leak free operation can be maintained.

Pipe threads are of American National Taper Pipe Thread pattern. As the name implies they seal when the threads pull the tapers together to form a tight joint. These threaded fittings are the only style used by Delta on which Teflon tape or pipe dope may be used. Great care should be taken that pieces of tape or liquid sealant do not end up in the part being sealed as they will eventually find their way into valve seats or other critical parts. Start wrapping the tape one or two threads back from the front of the male fitting and only one or two times around is sufficient. More than twice around is detrimental to a tight joint. Fittings should be brought up snug but not too tight or the female part can be distorted. If orientation of the part is critical, stop on your mark as the part is getting snug instead of trying to force the fitting another complete turn.

SAE (Society of Automotive Engineers) straight threads are used on several fittings where the connection orientation is critical. The male fitting is oriented and a locking nut with washer and O-ring is tightened against the female part. Again, do not over tighten or distortion can occur.

The remaining fittings are SAE 37 degree flare fittings. These have a male nipple to which a compatible female hose or tube/nut can be attached. Most plumbing on the HPU is done with steel hydraulic tubing held to the SAE 37 degree male flare nipple with a ferrule and nut. The tube is not

flared but cut square and deburred. The sealing pressure comes from the nut forcing the ferrule down onto the tube. These fittings can be broken and remade if necessary. Again snug is preferred to overtightened.

Most hoses supplied by Delta are terminated with SAE 37 degree female swivel ends. As the nut swivels on the hose, unions are not necessary. These screw directly onto a companion SAE 37 degree male nipple. To avoid confusion as to a fitting size, use the following table should ordering be necessary:

JIC Size	Hose I.D.	Steel Tube OD	Thread
JIC02	1/8"	1/8"	5/16-24
JIC04	1/4"	1/4"	7/16-20
JIC06	3/8"	3/8"	9/16-18
JIC08	1/2"	1/2"	3/4-16
JIC12	3/4"	3/4"	1-1/16-12
JIC16	1"	1"	1-5/16-12

Note: To repeat, do not use Teflon tape or pipe dope on any straight thread fitting. Only taper pipe threads are to be so sealed.

Cylinders

The Barriers are moved by double acting hydraulic cylinders. These are specified by the bore diameter and length of stroke, such as 2.5" by 8". When the Barrier is commanded to rise, oil is forced into the bottom or 'cap' end of the cylinder, extending the cylinder rod out of the body. The rod end of the cylinder terminates in a clevis and the clevis pin pushes against the Barrier to move it in the up position. When lowering, the cylinder rod retracts into the cylinder body as the oil flows out of the cap end. These heavy Barriers operate single acting. That is, the rod end of the cylinder is allowed to breath air, gravity alone forcing the oil out of the cap end (single acting). The rod end breather plumbed back to a dry location (usually the reservoir tank top) to prevent water from being sucked into the breather fitting.

The cylinders are pre-plumbed to 'headers' at the Delta factory. The headers terminate in the Barrier access area where the customer ties the Barrier to whatever interconnect system is selected. The connection fittings are color coded as noted above in the **Interconnection Convention** paragraph.

Interconnect Convention

So that the Barrier rises when the 'Raise' button is pressed it is necessary to coordinate the interconnect lines with the proper HPU and Barrier connections. The following convention has been established by Delta:

Color Tab	HPU Port	Barrier Cylinder	Function
Red	'B'	Cap (Bottom) End	UP
Yellow	TANK TOP VENT	Rod (Top) End	VENT

Hydraulic Oil

The hydraulic oil selected for the Barrier system is one of the most critical decisions to be made on your installation. The properties of the oil will affect the as new performance of the Barriers as will as the performance in years to come. Delta recommends the use of high grade, inhibited petroleum hydraulic oils for use in its' systems. These oils inhibit or prevent rust, oxidation, foaming and wear. They are readily available just about everywhere in the world.

A viscosity compatible to the expected ambient temperature of the job site should be used. A heavy oil used in snow conditions will tend to slow the Barrier response time down, while light grade oils in desert conditions may not provide lubricity necessary to prevent component wear. Most brands of oils are manufactured in different grades for this purpose.

If required, the new fire-resistant or environmentally friendly fluids can be selected, please consult your fluid dealer for correct selection.

Delta does not recommend the general use of automatic transmission fluid in our systems. While compatible with the seal materials used in all the system components, ATF does not have sufficient viscosity at moderate temperatures and it is generally more expensive than the specially formulated general purpose hydraulic oils. **Under no circumstances** should brake fluid be used. It is not compatible with the seals and will swell and degrade them.

Note: The unit as received from the factory has been tested with Shell Oil Company 'Tellus' 46. Although the unit has been drained after test approximately 1 inch [25 mm] of fluid remains in the reservoir bottom. The hydraulic oils in the following tables should be compatible with this fluid.

Biodegradable Oils

Environmentally friendly oils are also acceptable for use in these systems. These fluids are generally based on naturally occurring vegetable oils and are biodegradable by naturally occurring organisms when spilled or leaked in relatively small quantities. Larger spills will still need to handled similarly to currently accepted methods for conventional mineral oil spills.

Contamination of these oils by other fluids may change the biodegradability, toxicity, or other performance characteristics. Systems should be cleaned as thoroughly as possible before introducing a biodegradable fluid.

Delta has reviewed the data on biodegradable oils manufactured by both Mobil and Texaco. These are summarized below. Other manufacturers' products are acceptable if equal to the performance of these oils or the standard mineral oils listed in the following pages. Consult your local fluid dealer for his recommendation.

	Mobil Oil Corporation	Texaco Lubricants Company
Light	EAL 224H	Code 1607 Biostar Hydraulic 32
Medium	EAL 224H	Code 1616 Biostar Hydraulic 46

Commercial Hydraulic Oil Interchangeability Chart

*	AMOCO Oil Co. (Std. Oil Co)	AMSOIL	Ashland Oil Co. Valvoline Oil Co.
Light	Rycon Oil #15	AWH ISO 32	AW Oil #15
Medium	Rycon Oil #21	AWI ISO 46	AW Oil #20
Heavy	Rycon Oil #31	AWJ ISO 68	AW Oil #30
*	Atlantic Richfield (ARCO)	Chevron USA Inc.	Continental Oil Co
Light	Duro AW S-150	EP Hyd Oil 32	Super Hyd 15
Medium	Duro AW S-215	EP Hyd Oil 46	Super Hyd 21
Heavy	Duro AW S-315	EP Hyd Oil 68	Super Hyd 31
	Exxon USA Inc.	Getty Refining	Gulf Oil Co.
Light	Nuto H 32	Veedol Aturbrio AW 150	Harmony 43 AW
Medium	Nuto H 46	Veedol Aturbrio AW 58	Harmony 48 AW
Heavy	Nuto H 68	Veedol Aturbrio AW 61	Harmony 54 AW
	Mobil Oil Corp.	Phillips Petroleum	Pennzoil Co.
Light	DTE 24	Magnus A 150	Hyd & GP Oil #1
Medium	DTE 25	Magnus A 215	Hyd & GP Oil #2
Heavy	DTE 26	Magnus A 315	Hyd & GP Oil #3
	Shell Oil Company	Std Oil Co of Ohio	Texaco, Inc.
Light	Tellus 32	Industron 44	Rando Oil HD 32
Medium	Tellus 46	Industron 48	Rando Oil HD 46
Heavy	Tellus 68	Industron 53	Rando Oil HD 68
	Union Carbide Corp		
Light	**		
Medium	UCON Hyd Fluid WS34		
Heavy	**		

* Light oils are for cooler climates; medium for temperate zones; heavy for tropical or desert areas.

** No recommendation