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ELECTRICAL CONNECTION CHART

➤ Hydraulic Power Unit and Motor

Reference Drawings: 906x0-1 & 90605

Note: These connections have been made at the factory but are shown here as an aid for troubleshooting.

Hydraulic Power Unit <u>Valve Solenoids</u>		Control Circuit <u>Barrier #1</u>
UP	>>>> Note 1 >>>>	1 CB 17
UP COMMON	>>>> Note 1 >>>>	1 CB 18
DOWN	>>>> Note 1 >>>>	1 CB 19
DOWN COMMON	>>>> Note 1 >>>>	1 CB 20
EMERGENCY OPERATE	>>>> Note 2 >>>>	1 CB 21
EO COMMON	>>>> Note 2 >>>>	1 CB 22
		Motor Control Circuit <u>Barrier #1</u>
LEVEL SWITCH	>>>> Note 3 >>>>	CC 8 (CC 18)
LEVEL / PRESSURE SWITCH	>>>> Note 3 >>>>	CC 9 (CC 19)
PRESSURE SWITCH	>>>> Note 3 >>>>	CC 10 (CC 20)

Note 1: These lines must be sized to carry 30 watts at 24 VDC.

Note 2: These lines must be sized to carry 20 watts at 24 VDC.

Note 3: Starter coil power consumption is less than 100 va inrush, and less than 10 va sealed.

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Control Circuit

The Control Circuit is fed from the customer's local AC control voltage supply (either 100-120/1/50-60 or 200-240/1/50-60). Connection is to terminals CC 1(+) and CC 2(-). Supply should be adequate to provide a minimum of 250 Watts of power.

The control circuit contains a power supply, which reduces the local voltage to 24 VDC for use on the remote control panels. The feed out of the control circuit for these remotes is on terminal CA 1(+) and CA 2(-). Standard power capability is 150 watts. Battery back up power supply/charger and batteries are optionally available.

Note: Use caution when installing the field conduits and wiring to the control circuit enclosure. Shield metal chips and wire fragments from falling on to or in to components. Component failure can be caused by careless installation.

Power Unit Motors

The motor has been ordered and supplied to the actual site voltage. Please confirm before hookup. The motor is factory wired to an automatic starter controlled by the hydraulic power unit pressure switch, oil level switch and (optional) three phase power monitor. Thermal overload protection is integrally provided.

The customer should provide branch circuit protection as required by national and local code. Care should be taken in arriving at the correct wire size for the length of cable provided.

Hydraulic Power Unit Wiring

The three phase power is brought into the HPU terminal box to the line side of the door mounted disconnect switch at L1, L2 and L3.

Verify that the motor runs in the correct direction. Units with phase monitors (three phase only) are factory set to run in the correct direction. If motor does not run, or runs in the wrong direction, reverse any two incoming wires at L1, L2 or L3; motor should now run and in the correct direction.

Power for the starter contactor coil is the same as the primary voltage of the control circuit. Coil voltage legend plates are on the starter so that this can be confirmed. Connection points for the coil power are 'CC 1(+)' and 'CC 2(-)'. Starter coil power consumption is less than 100 va inrush, and less than 10 va sealed.

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Barrier and HPU Heaters

The system is furnished with electric heaters for the purpose of melting snow and ice, which may otherwise freeze the Barrier in either the up or down position.

The hydraulic oil reservoir also is equipped with an immersion heater located within the oil level. It is equipped with a thermostat dial and should be set to a value between 60 to 75°F [15 to 25°C].

The electric feed to the heaters is fused in the control circuit. See appropriate wiring diagram for the connections.

Important: Before energizing the heater circuits at the start of each season, the elements must be megger tested. This is typically done with a megger capable of delivering 500 volts to the circuit. A value in excess of 50,000 ohms to ground is acceptable for energizing the heater circuits. Call the factory if a lower reading is found.

Failure of the elements will in no way cause the Barrier to malfunction unless there is an ice or snow build up inside the machine.



**MECHANICAL
SYSTEM THEORY
VEHICLE ARREST SYSTEM**

MECHANICAL
SYSTEM
THEORY

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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

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'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 well 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 reseal 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:

<u>Side/Solenoid</u>	<u>Wire Color</u>	<u>Function</u>
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.