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# University of Calgary Portable Wind Tunnel Users Manual

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## ➲ Section 1: University of Calgary Portable Tunnel Overview:

Wind tunnels are used to duplicate wind forces on a body. Tunnels range in size from very small units designed to study forces on individual particles to very large like the (80' x 120') wind tunnel at NASA's Ames Research Center used to study full size aircraft. Tunnels may be designed for lab or field use, be portable or stationary. The one thing they all have in common is their applications and range of research opportunities afforded by a tunnel are limited only by the imagination of the user.

The University of Calgary Portable Tunnel (**UCPT**) is designed for research in agricultural fields. Care should be taken when running tests on especially soft surfaces to ensure that the tunnel can be towed without becoming stuck. This unit has been designed to be as versatile as possible and can be used in the field or lab setting. If the tunnel is to be used indoors the user must make certain that proper ventilation is present for the engine exhaust. If adequate ventilation does not exist, an electric motor can be used in place of the gas engine. Portable tunnels are desirable due to the difficulties associated with modelling a natural weathered soil surface. **UCPT** is designed so that a 2 person team can operate the tunnel and conduct field experiments. This unit has been constructed so that it may be adapted to a broad range of applications depending on the resourcefulness of the scientists and the specific objectives of experiments and research.

**UCPT**'s push style design allows for a sample of eroded material to be collected at the discharge end with the remaining material exhausted to the atmosphere. This setup also prevents eroded material from passing through the fan section and possibly damaging the blades. The fan/ transition sections and each of the two test sections utilize a rugged steel frame. Test section walls are constructed of aviation grade T6 hardened aluminum .08" thick. These aluminum sides are fastened to the frame using 10/32 flat head bolts countersunk into the inner wall of the aluminum so that the inside of the test sections is as smooth as possible. Test sections measure (.6m W x .8m H x 7.3m L) and are designed to bolt together. Test section #1 is attached to the fan/ transition of the unit via a heavy pivot pin and can be removed if necessary. **UCPT** is designed so that if desired, tests can be run using only the #1 test section.

A 13 HP gas engine drives the **UCPT**'s 32" fan; wind speeds inside the test section are varied using the engines throttle. Transport in the field is achieved by connecting the hitch to a 2 $^{5/16"}$ ball on a pickup or tractor and lowering the two wheel assemblies so that there is adequate ground clearance beneath the fan/ transition section and the test section(s). Clearance is gained by running the hitch cylinder out via the remote fob and wheel cylinders are controlled from the manual control manifold located on the control side of the tunnel. **UCPT** is essentially a self contained unit and only requires a truck or tractor to tow it from site to site in the field.

Velocity readings and pressure drop down the test section(s) are taken via 2 digital handheld manometers. The manometer located by the tunnel control box reads pressure drop; the second manometer located with the pitot tube at the discharge end of the test section reads differential pressure that can be converted to wind velocity.

Samples of eroded material are collected with a **Vertical Slot Sampler**. The **Vertical Slot Sampler** inlet measures (1cm W x 70 cm H); sample material is drawn into Vertical Slot Sampler using a battery powered vacuum. Sample then passes through a custom **cyclone** where collected material is separated from the wind and deposited into a glass collection jar.

A 24' enclosed car hauler trailer has been modified to house the **UCPT** and is used to transport the tunnel to different test sites. All necessary components, instrumentation, and tools are housed in this **Transport/ Storage Trailer**. Loading and unloading of the **UCPT** once at the test site is done using a 5,000 lbs. capacity winch mounted inside the **UCPT Transport/ Storage Trailer**.

## ➲ Section 2: UCPT Components:

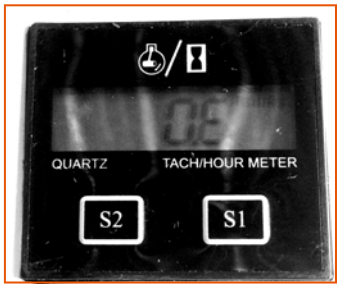
This section covers the main components of the **UCPT** and how to properly use them; operators should familiarize themselves with these items prior to using the **UCPT**.

## 2.1- UCPT Engine:

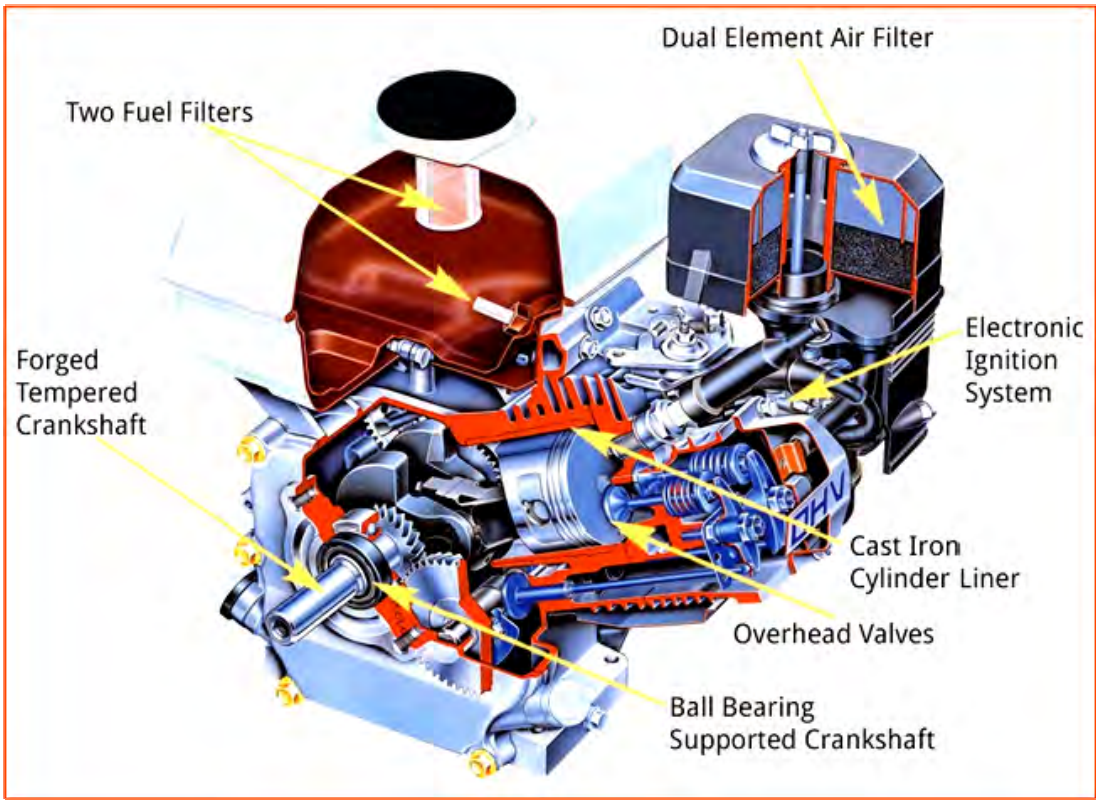
The **UCPT**'s 32" fan is driven via a **Honda GX390** 13 HP engine. Wind speed inside the **Test Section(s)** is varied with the engines throttle control. This engine is equipped with a 10 amp industrial alternator that charges the tunnel's battery while it runs. Care should be taken to minimize the amount of time the hydraulic pump is on or the small winch is being ran and the engine is NOT running as this could deplete the batteries charge; jumper cables and a battery charger are included with the **UCPT** to allow for charging of the units batteries both in the field and when the unit is parked.


**HONDA GX390 13HP Gas Engine Drives the UCPT's 32" Fan.**

**UCPT**'s engine has been wired with a remote push button start. A linkage has been fitted on the engines throttle and choke controls so that all engine functions can be operated remotely. The engine has also been fitted with a tachometer/ hour meter to monitor the engines RPM and keep track of maintenance schedules. For more detailed info on engine specs, maintenance and operation see the manufacturers manual in the appendix.




With proper use and maintenance this engine will run for years to come. Please see the engine user manual in the appendix for more detailed information on operation and



## 2.1.1 UCPT ENGINE OPERATION:

**ALWAYS CHECK ENGINE OIL BEFORE OPERATION. SEE HONDA GX 390 USER MANUAL FOR DETAILED INFORMATION ON ENGINE MAINTENANCE.**

1. Rotate the engine starter switch into the "**ON**" position and check the fuel switch is slid "**ON**"



2. Push the "**Choke**" control all the way in to choke the engine. It is not necessary to use the choke if the engine is already warm.


3. At the **Control Panel**, flip the engine switch into the "**ON**" position; the battery voltage level indicator will light blue. Push and hold the "**Start**" button until the engine turns over and then quickly release it and slide the choke control back in.
   - Be sure to monitor battery voltage levels and charge the battery as needed. If voltage is too low to use the electric start, the manual pull chord can be used to start the engine. Once this is done, the alternator will begin charging the battery.

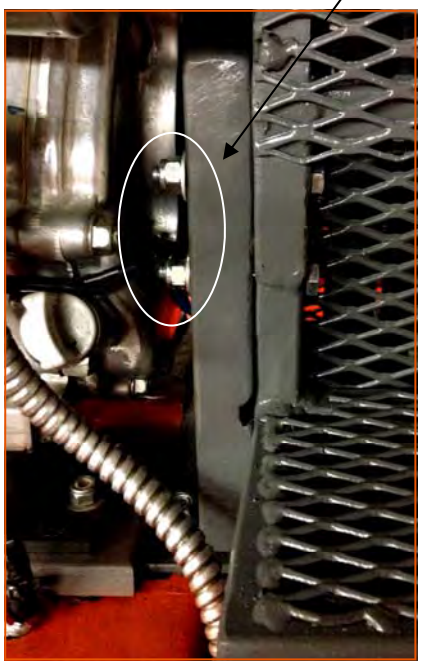

4. Once the engine is started slide the throttle lever to the low position and allow the engine to run for approximately 10 minutes to warm up prior to using the **UCPT**.
   - Engine RPM is displayed on the digital tachometer on the **Control Box**


****ALWAYS USE CAUTION WHEN OPERATING THE ENGINE****

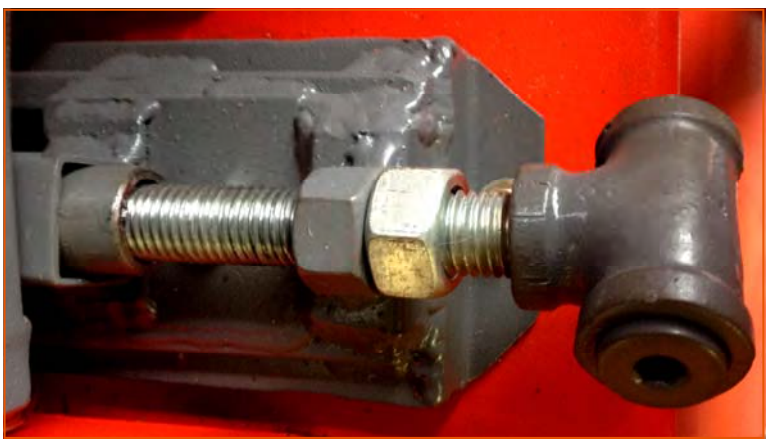
## 2.1.2- Engine Belt Guard:

**UCPT** is a belt driven unit. To protect **UCPT** operators and observers a belt guard has been installed which allows air to circulate around the engine and clutch, but prevents the belt from snagging any surrounding objects or individuals.

To access the two drive belts, the 12V clutch, and other engine components, the belt guard must be removed. The guard is mounted so that this can be quickly and easily removed. To remove the guard simply use the supplied wrenches to remove the 4 mounting bolts which attach the guard to the mounting plate.
**NEVER REMOVE THE BELT GUARD WHILE THE ENGINE IS RUNNING.**



Incorporated into the **Belt Guard** is a **Belt Tensioner**. This tensioner prevents the 2 drive belts from contacting the sides of the belt guard inside the fan housing. The **UCPT** is shipped with proper tension on the belts but if they loosen over time, or new belts are installed, tension can be adjusted by running the tensioning screw in to increase tension and out to decrease. When desired tension is achieved lock the tensioner into place with the lock nut.



## 2.2- UCPT 12V Clutch:

A Warner 12V Clutch is used to engage the fan. The clutch is controlled using the switch found in the UCPT **Control Box.** When engine is running and the switch is flipped up into the "**ON"** position, the clutch will engage and the fan blades will begin to turn. Below is some basic information on the clutch; additional info can be found in the users manual located in the UCPT User Manual Appendix.

**Bearing Mounted Electric Clutch/Brake Assemblies and Operation**
**Components**

An electric clutch/brake or clutch consists of three primary components:

**1. Field Assembly**

The clutch's "power" source contains the coil which generates magnetic force. Most common applications require a 12 volt DC coil, although other voltages are available.

**2. Rotor Assembly**

Generally, the input of the clutch. Includes a keyed hub which mates with the keyway in the drive shaft. The rotor transmits torque from the drive shaft to the output, or armature assembly.

**3. Armature Assembly**

Generally, the output of the clutch. Also contains the mechanical brake in a clutch/brake assembly. The armature transmits torque from the rotor to the driven load.

The sleeve is a secondary component. This sleeve serves as a spacer between the rotor and the field assembly, and is also a support for the field assembly bearing.

## 2.3- Fan/ Transition Section:

**UCPT** moves air through the test section(s) via a Hartzell 32" tube axial fan. Connection of the fans round housing to the rectangular test sections requires a transition section. The **Fan/ Transition** section is where the **UCPT** engine, hydraulics, transport wheels, and other controls are mounted and is where the tunnel is operated from.

## 2.4- Air Straightening Section:

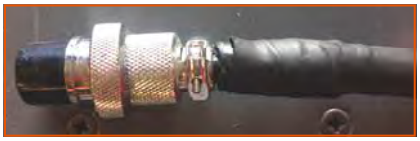
Air flow within the test section(s) of the **UCPT** has been screened to produce uniform air flow and establish a good wind profile. These adjustments are made by screening the air as it enters the section on the upwind side travels through the **Air Straightening** section of the tunnel. The **UCPT** has been extensively tested and dozens of calibration tests have been run in order to ensure that the unit is ready for field deployment upon its arrival at the University of Calgary, however, additional adjustments can be made by adding/ removing screen to the **Air Straightening** section. Access to this section is gained by removing the 5" steel caster on the hitch side of the tunnel, and opening the access door by unscrewing the small gray clamping knob. Once this knob is removed the access door can be opened and the desired adjustments can be made or possible obstructions to air flow can be removed.

## 2.5- Sand Feeder:


The **Sand Feeder** is located on the discharge side of the **Air Straightening** section. This apparatus utilizes 6 drop tubes to introduce sand into the test section(s). Flow of material from the hopper into the test section is controlled by moving a feed control strip into or out of line with the drop tubes. Alignment is controlled using the momentary toggle switch on the **UCPT Control Box**. To use the **Sand Feeder**, follow these steps:

### SAND FEEDER OPERATING PROCEDURE:

1. Plug in the orange chord coming from the **Sand Feeder** into the **Control Box.** When this connection is made the green or red indicator will light to show the current position of the sand feeder.



2. Flip the **Sand Feeder** toggle switch up into the "ON" position; the blue LED indicator will light showing that the **Sand Feeder** solenoid now has power. The position of the **Sand Feeder** (ON/ OFF) can now be toggled using the momentary toggle switch. Ensure that the **Sand Feeder** is in the "OFF" position and load the hopper.


3. A green light indicates that the **Sand Feeder** is "ON" and that sand will flow out of the hopper; conversely, a red light indicates that the **Sand Feeder** is in the "OFF" position and will not allow sand to begin feeding down the drop tubes. The **Sand Feeder** should be closed when preparing for a test; use the toggle switch to move the feed strip to "OFF".


Sand will feed from hopper

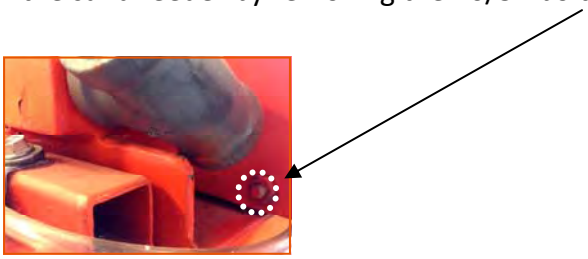

No Sand Feeding

The Sand Feeder is now ready for use. When the time comes to begin feeding sand into the test section move the toggle switch to the right to turn the **Sand Feeder** "ON"; the green LED will light indicating that sand is now feeding.

## 2.5.1- Changing Sand Feed Rate:

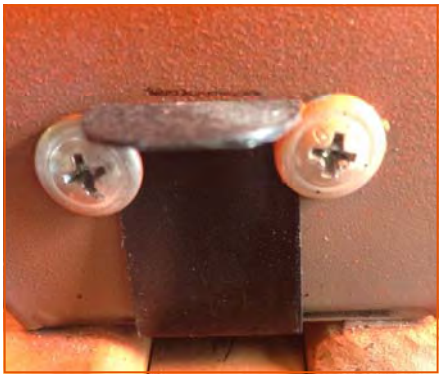
The **UCPT Sand Feeder** is designed so that the rate at which sand if fed into the test section(s) can be easily changed. Feed rate is controlled via steel control strips that are slid into place in a track located underneath the **Sand Feeder** hopper. To change the rate control strip, follow these steps:

1. Remove the metal cover from the label side of the sand feeder by removing the 10/32 bolt.

2. With the cover off you are now able to access the control strip. Remove the steel strip by removing one of the two alignment screws holding the strip in place.

3. Once the alignment screw is removed, slide out the old strip and then replace with the new one. The new control strip will slide in on TOP of the main control strip



**NOTE:**

**Be certain that the alignment screws are snugly tightened after replacing the feed rate control strip.**

Feed rate of the **Sand Feeder** can be checked by placing a container under one of the six drop tubes and then feeding sand for a set time period. Once this time has elapsed you can divide the quantity collected by the time the sand was fed over and get a quantity per unit of time feed rate.

## 2.5.2- Mini Sand Feeder & Checking Feed Rate:

The **Sand Feeder** has 6 control strips that allow for 6 different feed rates. Hole size and feed rates for these six strips are shown in the table below.

| Hole Size (mm): | Feed Rate in g/min |
|---|---|
| 2.381 | 32.52 |
| 2.778 | 42.78 |
| 3.969 | 124.57 |
| 4.366 | 154.14 |
| 5.556 | 326.92 |
| 8.731 | 1103.64 |

**Hole size & feed rates for the 6 Sand Feeder control strips**

A "**Mini Sand Feeder"** has been shipped with the **UCPT** that allows additional hole sizes to be tested and their feed rate determined. To test various hole sizes and determine the rate at which they will feed sand remove on of the blank metal tabs from the **Mini Sand Feeder** and drill the desired hole size into the piece. Once the hole is drilled load place the tab in the **Mini Sand Feeder** so that the hole is NOT aligned with the hopper and sand will NOT feed out. Next place material into the hopper on top of the **Mini Sand Feeder.** Now use a timer or stop watch and begin timing as you slide the tab in so that it lines up with the hole from the hopper and sand begins feeding into the collection jar. Stop the test as soon as about 2/3's of the material has fed out of the hopper.

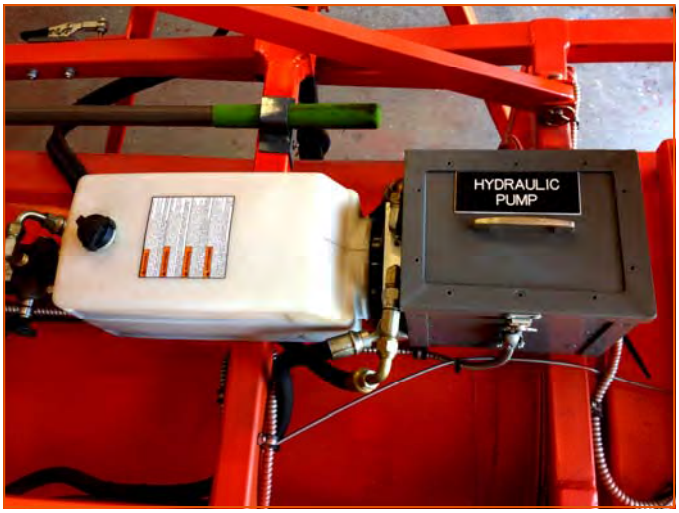

You should now have a known quantity and the time it took for this quantity to feed out of the hopper. Using this information a feed rate in grams per minute/ second/ etc. can be calculated. For example:

- About 30 g of sand is loaded in the hopper of the **Mini Sand Feeder**.
- After about 25 g of material has fed though the hole, say after maybe 100 seconds stop the feed out of the hopper. Using this info it an be determined that:

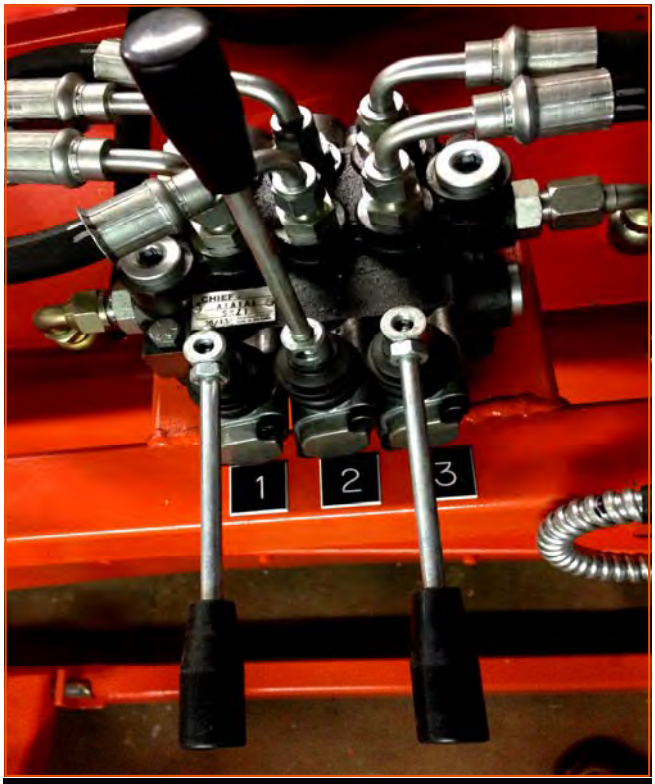
**25g / 100 seconds= 1g/ 4 seconds = 15g/ minute**

## 2.6- Hydraulic System:

The **UCPT** utilizes a 12V hydraulic pump and 4 industrial hydraulic cylinders to raise/ lower the transport wheels (x2), test section(s), and the hitch assembly. The hydraulic pump is mounted on the **Fan/ Transition** section of the **UCPT** (right). The pump itself is housed inside the gray enclosure with the black and white label on its top to protect the unit from damage and to cover the electrical connections.




Three of the four cylinders in this system are controlled via a 3 valve manifold located on the control side of the tunnel; the fourth cylinder on the hitch assembly can be controlled using a remote to allow for easier alignment with the transport vehicle. This fourth cylinder also has a manual control housed in the "**Remote Hydraulic Control Box".**

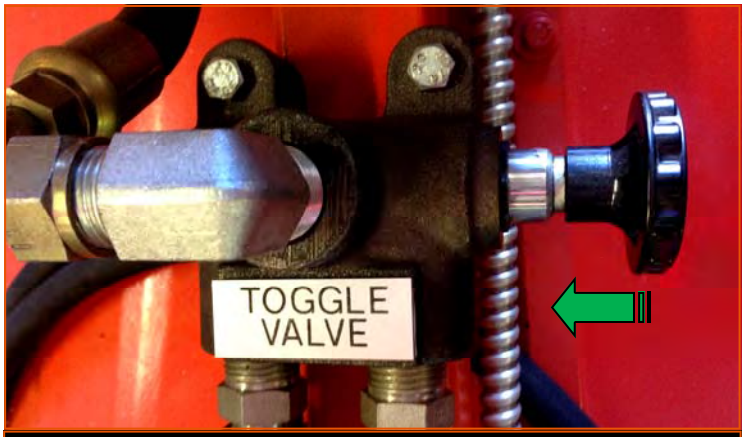



**Control Manifold for Cylinders 1-3**


**Manual Controls for the 4th cylinder on the hitch assembly.**

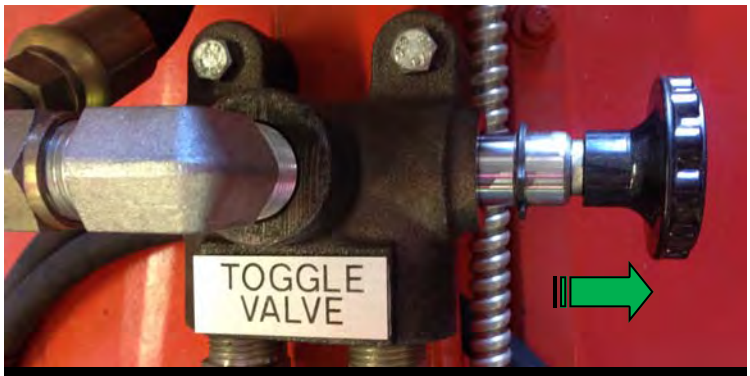
## 2.6.1- Toggle Valve:

In addition to these controls there is a **Toggle Valve** mounted on the central portion of the **Fan/ Transition** section. This valve toggles between the 3 hydraulic cylinders controlled from the 3 valve manifold and the fourth cylinder on the hitch assembly. When this valve is pushed toward the hitch assembly so that the snap ring is flush with the valve housing (see photo below) the hitch cylinder can be retracted/ extended as needed, however, the other 3 cylinders will not be "energized".




**Toggle Valve pushed in to activate the hitch cylinder**

To control the other 3 cylinders in the hydraulic system simply pull the **Toggle Valve** away from the housing. Once this is done hydraulic fluid will be routed to the other 3 cylinders and this portion of the system is now activated.



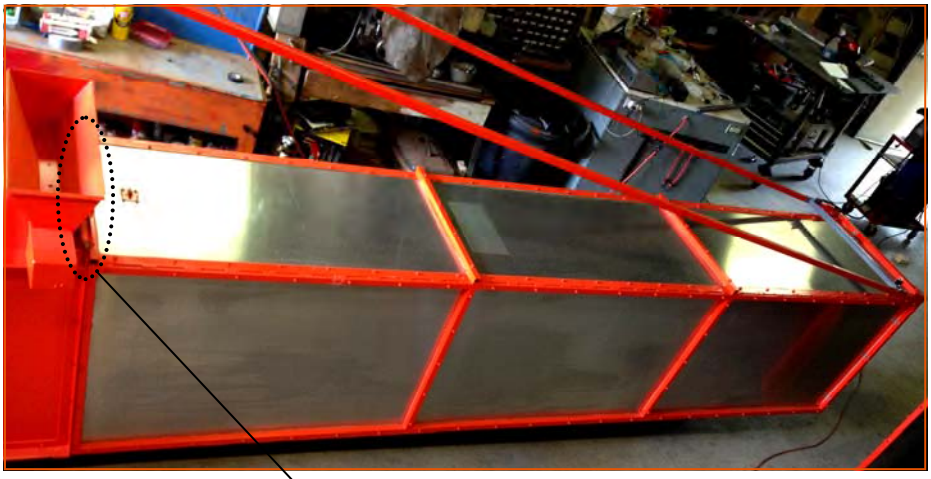

**Toggle valve pulled away from housing, activates other 3 cyl.**

**A good rule of thumb is to move the Toggle Valve towards whatever components you wish to control. Pull the valve towards the control side for wheels and test section and push away towards the hitch side to control the hitch.**

## 2.7- Test Sections:

**UCPT** has two 12' test sections made of aviation grade T6 hardened aluminum. The frame of the test sections is welded 1" 12G square tubing. The aluminum is fastened to the steel frame via 10/32 flat head bolts countersunk into the inside of the test sections so that the inner portion of the test sections is smooth. **Test Section #1** is attached to the discharge end of the **Sand Feeder/ Air Straightening** section with 3/4" solid steel pin. **Test section #2** bolts onto the discharge end of **Test Section #1** with (5/16" x 2 1/2") bolts (x8).

Each test section is constructed with an open bottom so that it can be lowered onto a surface in the field.

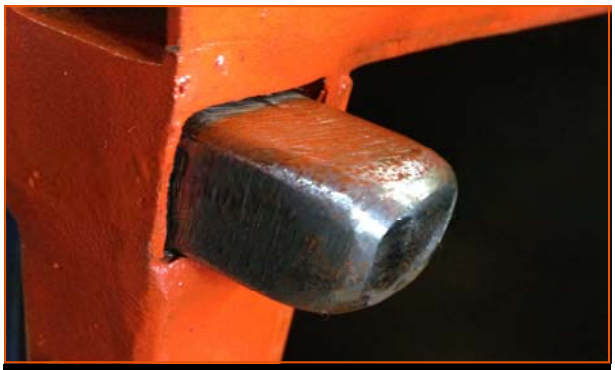



Test Section #1 is attached to the **UCPT** via a heavy hinge pin located at the intake end of the section. If necessary this pin can be driven out to remove the **#1 Test Section.**

## 2.7.1- Attaching the #2 Test Section:

Running tests with a single test section is possible and may be adequate for certain experiments. If both test sections are to be used the #2 Test section is attached by aligning the two test sections and sliding them together. 3/4" alignment pins have been installed to help align the two sections. The pins on the top corners are shorter than those on the bottom; this allows the two bottom corners to be aligned first as it may be necessary to push in on the two sides of the **#2 Test Section** to achieve proper alignment. Once each of the bottom corners is properly oriented, push on the discharge end of the **#2 Test Section** so that the two halves slide together. Once the two test sections are slid together, slide the 5/16" mounting bolts through the eight mounting holes and snuggly tighten each one. Wrenches have been supplied for bolting/ unbolting the two test sections; the 5/16" nuts/bolts require a 1/2" drive.

**Bottom alignment pins will be inserted 1st**



**Top, shorter, alignment pin**

The two test sections normally slide together with relative ease, a set of ratchet straps can be used to aide in this process if necessary. To use the straps to help pull the two sections together wrap each one around the top corners as shown in picture below. Once in place, alternate tightening one and then the other so that the test sections stay in line as they are drawn together. Continue tightening until the test sections are flush against one another, or close enough that the bolts can be slide in and tightened; firmly tightening the bolts will suck the two halves completely together if a small gap is still present.

## 2.7.2- Test Section Stabilizing Arms:

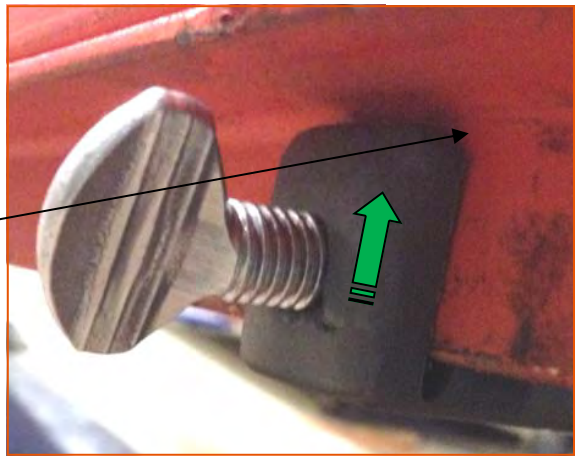
While the test sections have been made to be as rugged as possible, **Stabilizing Arms** should be placed across this open side when storing or transporting the test sections to prevent spreading or bending.

**Stabilizing Arms** are stored on mounts at the discharge end of the #1 test section and at each end of the #2 test section. To mount these arms onto the test sections or back onto their mounts back out each of the 3/8" thumb screws located on either end of the arm so that they do not protrude into the slots, and then slide the arm onto the flange of the angle iron on the bottom edge of the test section roughly 6-10" from the end of the test section making certain the arm slides onto the flange completely (see photo below), then tighten the two thumb screws to lock the **Stabilizing Arm** in place. Remove the arms by loosening each of the two thumb screws and lightly tapping the arm downward.

**Spacer Bar** setting in mount on top of test section

**Spacer Bar** installed on bottom of test section

Be sure **Stabilizing Arms** slide completely onto the 1" angle iron on the bottom side of the test sections before tightening the lock screw.

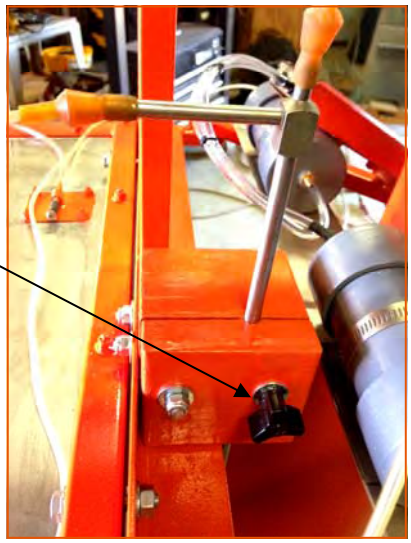


## 2.8- Vertical Slot Sampler:


The **Vertical Slot Sampler** is constructed of 28 gauge galvanized steel. The inlet of the sampler measures (1cm W x 70cm H) and is divided into 4 sections; all 4 sections are connected to a single vacuum hose that draws material from the sampler to the cyclone. A pitot tube has been incorporated into the **Vertical Slot Sampler** mounting so that wind speed at the inlet can be recorded. Height of the pitot tube can be adjusted by loosening the wing nut (see below). Eroded material is drawn into the inlet by the Green Works vacuum and then passed through a cyclone and into a sample collection jar. The sampler bolts onto the discharge end of the #1 or #2 test section and can be left in place when travelling short distances in the field; if travelling very far or over relatively rough ground it is recommended that the **Vertical Slot Sampler** be removed to avoid damage to the sampler or the test section. Below is the procedure for mounting the **Vertical Slot Sampler** onto the discharge end of either test section.

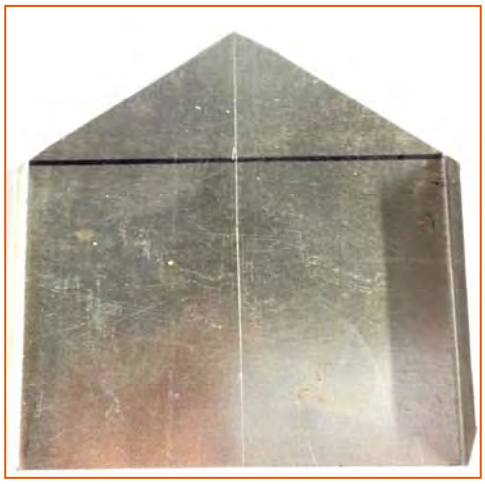
- **Mounting the Vertical Slot Sampler:**

1. Ensure that the **Vertical Slot Sampler's** height adjustment knob is tightened to prevent the sampler from sliding up or down.
2. Slide the 3/4" alignment pins on the **Vertical Slot Sampler** into the open 1" square tubing on the discharge end of test section #1 or #2.
3. Once the sampler is slid completely into the 1" square tubing, slide the 1/4" bolts (x2) through the holes in the top of the test section and the angle iron and then place washers onto the bolts and screw on the nuts. Tighten.
4. Once the **Vertical Slot Sampler** is mounted it can be raised/ lowered via the height adjustment knob. Height of the pitot tube is also adjustable by loosening the wing nut on the pitot tube clamp, sliding the pitot tube to the desired height, and re-tightening the clamp.



## 2.8.1- Vertical Slot Sampler Efficiency Tests:

Custom Products conducted over 50 efficiency tests on the **Vertical Slot Sampler** system to determine its sampling efficiency. These tests were conducted by placing a known quantity of sand onto a tray 10 cm wide. This tray was then placed on the test section perpendicular to the **Vertical Slot Sampler** inlet. The inlet of the **Vertical Slot Sampler** is 1 cm wide, therefore it should collect 10% of the material off of the 10cm wide tray (10% of 10cm = 1cm).



Once the everything was in place the vacuum was turned on and the fan would be engaged and allowed to run until there was no sand remaining on the 10 cm tray.

**Efficiency Tests Conclusions:**

- The **Vertical Slot Sampler's** efficiency is not impacted by the velocity of air within the test section. Sampling efficiency remained constant over a broad range of RPM.
- Sampling efficiency **IS** impacted by the speed the vacuum is ran at. Running the vacuum at 5 (the highest available setting) resulted in the most efficient sampling.
- Efficiency of the sampler is not extremely high, however, it is consistent. Sampling efficiency over a vast range of air speeds remained virtually constant. **Vertical Slot Sampler** efficiency for the 3 highest vacuum settings is:
    - **Vacuum Setting of 5 = 47.6%**
    - **Vacuum Setting of 4 = 28.5%**
    - **Vacuum Setting of 3 = 8.2%**

## 2.8.2- Vertical Slot Correction Factors:

Since these efficiencies were reproduced multiple times under varying conditions, a correction factor can be applied to each to account for the remainder of the material that was not collected. Correction factors for each of these 3 settings are given below. Multiplying the amount of material collected by these values will result in the total material loss from the test section. Correction factors are as follows:

- **Vacuum Setting of 5 = 128.3**
- **Vacuum Setting of 4 = 213.9**
- **Vacuum Setting of 3 = 743.4**

For example, if a test was ran with a vacuum setting of 3 and 1.06g of material was collected from the cyclone collection jar, this value will then be multiplied by the correction factor to calculate material loss across the test section.

**1.06g x 743.4 = 788.004g**

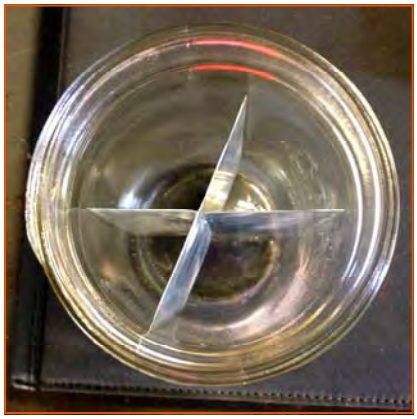
## 2.9- Cyclone:


The **UCPT Cyclone** is used in conjunction with the **Vertical Slot Sampler**. Design of this **Cyclone** is unique as it utilizes a longer funnel than standard cyclones to allow for a higher percentage of fine material to settle out of the air flow and into the **Cyclone** collection Jar. To draw air from the **Vertical Slot Sampler**, the **Cyclone** utilizes a 40V Lithium ion powered Green Works vacuum. The **Cyclone** is connected to the vacuum source with 2" clear tubing (see below) that is reinforced so that it does not collapse when it encounters the vacuum but still allows the operator to observe collected material as it flows through the tube.

This tube connects to the cyclone with an industrial air tight connector. To connect the tube push both of the locking tabs forward, to remove pull each tab back towards the tubing.

Once material has been drawn through the tubing it enters the cyclone where it then rides along the outter walls. The centrifugal force of the material coupled with the design of the **Cyclone** cause the material to remain against the outer wall of the cyclone as it progresses downward until it eventually settles out of the air flow and into the **Cyclone** collection jar.

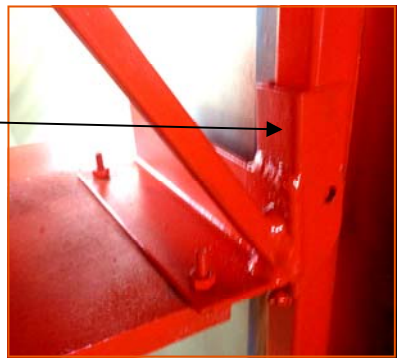
The **Cyclone's** collection jar has a set of galvanized vanes that help prevent collected material from being abraded or drawn back out and exhausted by the vacuum.



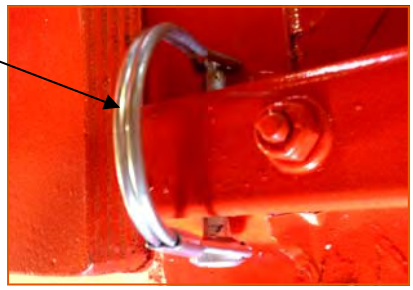
## 2.9.1- Mounting the Cyclone:

The **Cyclone** is stored in the **Transport/ Storage Trailer** and should not be mounted until the **UCPT** has been unloaded. Once the unloading process is complete, follow these steps to mount the cyclone onto the end of the **#2 Test Section**:

1. Remove the **Cyclone** from its mount in the **Transport/ Storage Trailer** and carry to the discharge end of the #2 test section.
2. Locate the 1" square tubing that has a hold drilled in through the sides (the first one inside of the discharge end) and align the 3/4" pin on the **Cyclone** frame .



3. Move the bottom portion of the **Cyclone** frame in towards the test section so that the 1 1/4" squared tubing on the mounting foot slides onto the 1" square tubing frame of the test section.
3. Raise or lower the unit as needed so that the 3/4" alignment pin mentioned in step 2 slides into the 1" square tubing and then slide the 1/4" pin through the hole and close the pin.



4. Align the hole in the **Cyclone** frame with the hold on the 1" square tubing frame of the test section and slide the 1/4" mounting bolt through. Place the 1/4" nut on the bottom side and tighten.
5. Once the **Cyclone** is securely mounted the vacuum can now be placed on top. Prepare the vacuum for mounting by removing the adapter from the top of the cyclone and attaching it to the bottom/ intake portion of the vacuum. To attach the vacuum pull back the black flap covering the inlet and slide the ear of the adapter into slot located just in front of the pivot. Next lower the opposite side so that it sits flat against the inlet and slide the gray latch over to hold the adapter in place.

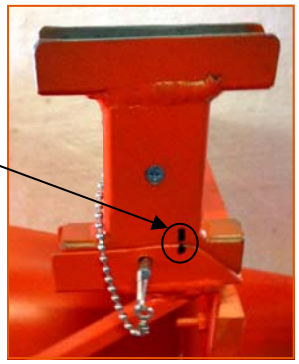
6. One the vacuum adapter is in place, simply slide the galvanized tube down into the opening at the top of the cyclone and the cyclone is now ready for use.

## 2.9.2- Mounting the Cyclone on the #1 Test Section:

The **UCPT** has been constructed so that test can be run using one or both of the test sections. If tests are to be ran using on the #1 test section the **Cyclone** will mount in the same location as it did on the **#2 Test Section**, the only difference will that the following 3 adapters are added. To mount the cyclone onto the discharge end of the **#1 Test Section** follow these steps:


**1) 3/4" to 1" Adapter:**

This adapter slides into the 1" square tubing located on top of the second upright in from the discharge side of the test section. The adapter is marked with a "T" for "TOP"; orient the piece so that this "T" is facing up and slide it into the 1" so that they holes align and slide the 1/4" pin in and lock into place.

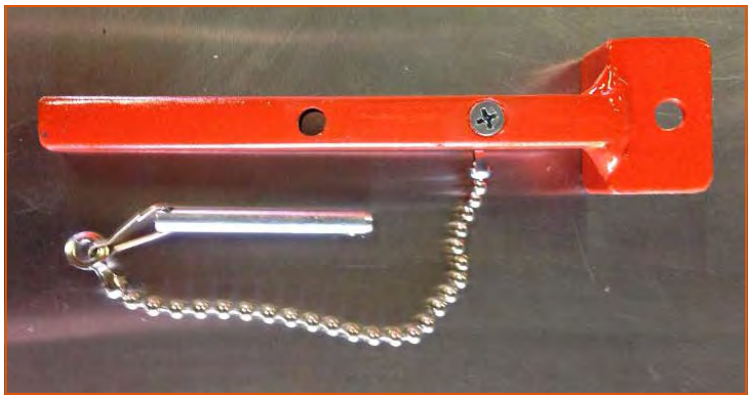


**2) 1 1/4" Adapter:**

The second adapter mounts inside of the 1 1/4" square tubing that slides onto the 1" upright of the #2 test section. Notice the black alignment mark on the adapter and the square tubing; insert the adapter so that the marks align as seen in the photo and slide the 1/4" pin through the hole.

3) 1/2" Adapter:

The final adapter required is a small piece of 1/2" square tubing. This connects the left side of the cyclone to the #1 test section.



## 2.10- UCPT Control Box:


All electrical controls for the **UCPT** are housed in the tunnels **Control Box.** The panel housed inside the box is divided into 4 sections:

1) Engine
2) Hydraulics
3) Clutch
4) Sand Feeder

The switch located in each of these 4 sections will supply power to the respective component. All but the engine have a blue indicator light that will turn on when the switch is flipped up into the "ON" position. The engine has a battery voltage indicator installed in place of an LED.


Also housed in the **Control Box** is a 15A slow-blow fuse that protects the switches and other HW from being damaged. If switches on the panel inside the **Control Box** are unresponsive and nothing is getting power, this fuse is probably blown and will need to be replaced. To change the fuse simply unscrew the cap on the fuse holder, remove the blown fuse and replace with a new one, and screw the holder back into the **Control Box.** Blowing this fuse should by no means be a common occurrence, but in the event one is needed, additional fuses have been supplied with the **UCPT** and can be found in the aluminum case.

## 2.10.1- Remote Hydraulic Control Box:

A smaller secondary control box to the right of the main **Control Box** is the **Remote Hydraulic Control Box**. This control box houses the transmitter receiver and electronics for the remote hydraulic cylinder on the hitch assembly. Like the main **Control Box**, this enclosure also has a fuse to protect the electronics for the remote cylinder. The fuse holder is mounted on the right hand side of the box and uses a spade style 7.5A fuse. In case they are needed, additional fuses for the **Remote Hydraulic Control Box** have been included in the aluminum case.

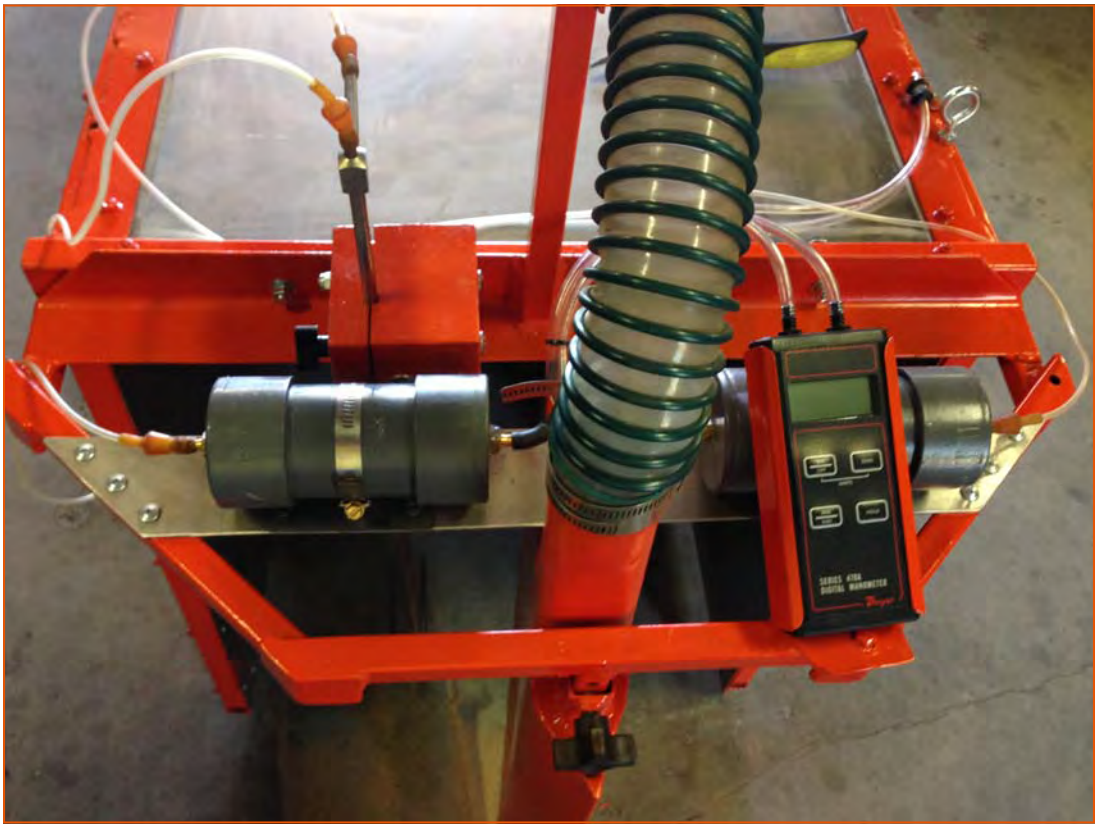

## 2.11- Digital Manometers:


A Set of Dwyer 478 A Handheld **Digital Manometers** has been supplied with the **UCPT**. Each manometer has a mount that it slides into at its respective location. Manometers can be left in these mounts but can be slid out if needed by firmly pushing up on the bottom edge.

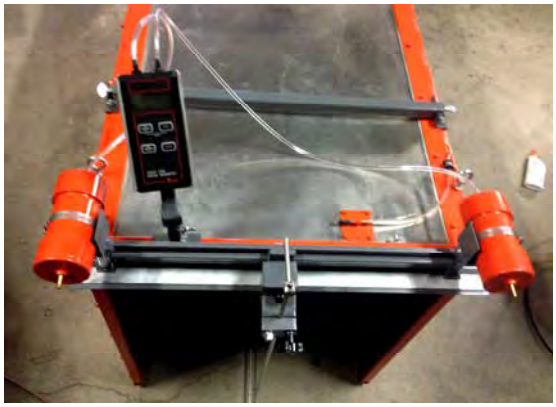
One of the two **Digital Manometers** is mounted on the **Vertical Slot Sampler** and is used to take velocity readings within the test section; the other is mounted on the **Fan/ Transition** section and is used to read pressure drop down the test section(s).

- **Velocity Readings:**

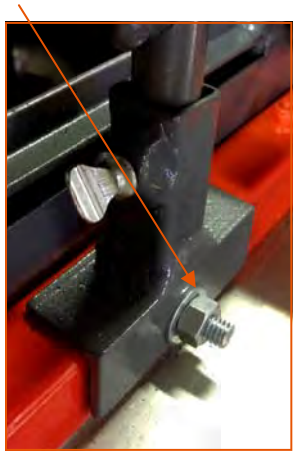
This manometer reads on a scale of 0-4" of water to the hundredth decimal place. As you can see, prior to bringing the lines into the **Digital Manometer** it first passes through a set of 2" diffusion chambers. These chambers help to minimize fluctuations in the velocity readings. If desired, these chambers can be bypassed and the leads connected straight from the pitot tube to the manometer.



## 2.11.1- Digital Manometer Mount:



If tests are to be ran without using the **Vertical Slot Sampler** then a separate pitot tube mount will need to be used. This mount uses the same 5/16" holes as the **Vertical Slot Sampler** to fasten to the discharge end of the #1 or #2 test sections. To use this mount first remove the pitot tube from the mount on the **Vertical Slot Sampler** by loosening the two bolts running perpendicular to the tube and carefully sliding it out. Set the pitot tube aside and mount the pitot tube holder onto the discharge end of either test section by aligning the 5/16" holes on the 2" angle of the pitot tube mount with those on the 1" square tubing running across the top of the discharge end of either test section. If the user prefers the digital manometer on the left hand side of the mount as seen in the above photo, place the nut onto the right hand bolt. Support the left hand side of the mount as needed and slide the digital manometer holder onto the bolt left hand mounting bolt followed by the nut and tighten (for right hand mount follow same procedure but use opposite side).

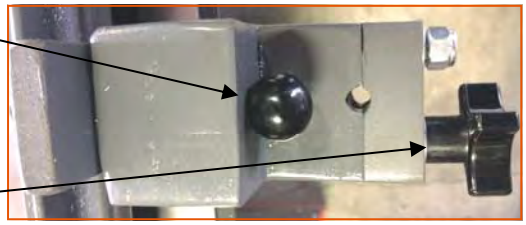


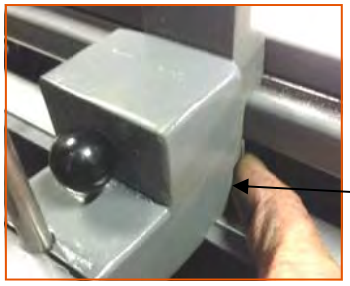
With the base of the pitot tube holder and digital manometer mount in place slide the digital manometer into the holder by firmly pushing it in from the top. Next slide the steel rod on the bottom of the manometer mount down into the socket on the holder seen in the photo to the left, orient the manometer as desired, and then tighten the 1/4" lock screw to hold it in place.

Lastly, mount the pitot tube clamp and pitot tube onto the holder. Do this by sliding the 1/4" alignment bolt through the gap between the 1/2" angle and the pitot tube holder frame as shown below. Slide the pitot tube mount onto the bolt followed by the clamping knob. Next loosen the black clamping knob and nut on the back side of the mount and slide the pitot tube through the hole; retighten once the pitot tube is in place. The pitot tube is now mounted and can adjusted horizontally and vertically by loosening the respective clamping knob.

Horizontal Adjustment Knob

Vertical Adjustment knob





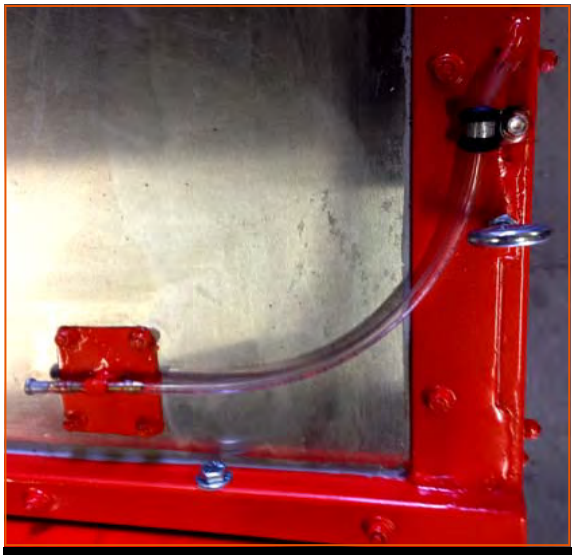
Sliding the clamp horizontally is much easier when pressure is applied towards the base of the clamp as seen in the photo to the left.

- **Reading Pressure Drop:**

Static port on test section #1

The second 478 A **Digital Manometer** is mounted on the **Fan/ Transition Section** and is used to read pressure drop down the **UCPT** test section. Diffusion chambers are used on these lines just like on those used to read velocity; again, they are not necessary and can be bypassed if desired. To read pressure drop one side of the **Digital Manometer** is connected a static port mounted on the on the upwind edge of the #1 test section; this port is always connected when reading pressure drop. The second line will come from the end of the #1 or #2 test section. This line is ran through the 1" square tubing frame of each test sections so that is protected and out of the way. If only the #1 test section is to be used the clear 1/4" line protruding from the 1" square tubing will be connected to the port on the discharge end of the first test section; the opposite side of this port is capped.

If both test sections are being used then the line on the upwind end of the #2 test section will need to be connected to the line on the discharge end of the #1 test section (same line that was previously connected to static port on #1 test section). Once this connection is made connect the line on the discharge end of the #2 test section to the static port to read pressure drop through both test sections.



Static port in discharge end of #2 test section

Lines from test section #1 and #2 spliced

## 2.11.2- Digital Manometer Conversion Table:

The **Digital Manometers** utilized by the **UCPT** take readings in inches of water column. These readings can be recorded and then easily converted to more practical units like meters per second. Below is a table which can be used to make this conversion from inches of water to meters per second:

**Inches of Water to Meters per Second Conversion Table:**

| | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 2.85 | 3.51 | 4.05 | 4.54 | 4.97 | 5.37 | 5.75 | 6.10 |
| 0.1 | **6.43** | **6.75** | **7.05** | **7.34** | **7.62** | **7.89** | **8.15** | **8.40** | **8.64** | **8.88** |
| 0.2 | 9.12 | 9.34 | 9.56 | 9.78 | 9.99 | 10.20 | 10.40 | 10.60 | 10.80 | 10.99 |
| 0.3 | **11.18** | **11.37** | **11.55** | **11.73** | **11.91** | **12.08** | **12.26** | **12.43** | **12.59** | **12.76** |
| 0.4 | 12.92 | 13.09 | 13.25 | 13.40 | 13.56 | 13.71 | 13.87 | 14.02 | 14.17 | 14.31 |
| 0.5 | **14.46** | **14.61** | **14.75** | **14.89** | **15.03** | **15.17** | **15.31** | **15.45** | **15.58** | **15.72** |
| 0.6 | 15.85 | 15.98 | 16.11 | 16.24 | 16.37 | 16.50 | 16.63 | 16.76 | 16.88 | 17.01 |
| 0.7 | **17.13** | **17.25** | **17.37** | **17.50** | **17.62** | **17.74** | **17.85** | **17.97** | **18.09** | **18.21** |
| 0.8 | 18.32 | 18.44 | 18.55 | 18.66 | 18.78 | 18.89 | 19.00 | 19.11 | 19.22 | 19.33 |
| 0.9 | **19.44** | **19.55** | **19.66** | **19.77** | **19.77** | **19.98** | **20.08** | **20.19** | **20.29** | **20.40** |

For example, if the **Digital Manometer** mounted on the discharge end of the test section reads .42 this reading would be converted to **9.99 meters/ second** using the above table. Make this conversion by starting on the Y axis with the first number (.4), then follow on that row over to the second number (.02), the row and column will intersect at the meters per second conversion, or, 9.99 meters per second.

Additional Examples:

- Reading of .17 inches of water = 8.40 meters/ second
- Reading of .39 inches of water = 12.76 meters/ second
- Reading of .54 inches of water = 15.03 meters/ second

**Additional copies of this table can be found in the appendix. A digital copy is provided on the smart stick included with this manual.**

## 2.12- 12 V Winch:


Unloading/ loading of the **UCPT** is accomplished using a 12V, 5,000 lbs. capacity SuperWinch. This winch has more than enough power to easily pull the UCPT into and out of the **Transport/ Storage Trailer**. The winch is mounted opposite the trailers gate on a 1/4" steel plate which is bolted into the steel frame of the trailer. The UCPT winch is controlled via the remote which has 30' of cable to allow the user to walk up and down the length of the trailer as needed. The winch remote plugs into the receptacle seen in the bottom right of the above picture. When not in use, the cable should be rolled up and wrapped on its hanger.

A separate battery supplies the winch with power. While the battery holds more than enough charge to load and unload the tunnel multiple times, users should keep an eye on its charge level and connect the battery charger mounted above it as needed. The supplied battery charger has a built in "overcharge detector" that shuts off the unit once the battery is fully charged, so it will not harm the battery or the charger to plug this in after each use to ensure the battery is fully charged for the next set of tests. Additional information on this charger can be found in the appendix of this manual.

The UCPT battery charger in the **Transport/ Storage Trailer** runs on 110 VAC. A waterproof exterior outlet has been mounted on the front end of the UCPT so that power can be easily supplied to the unit. An extension cord has been modified so that it has a male plug on either end to allow this outlet to plugged in.

****CAUTION****

**ALWAYS plug the cord into the Transport/ Storage Trailer FIRST and THEN into a 110VAC outlet. Plugging the cord into the outlet before the opposite end is plugged into the trailer means that the exposed prongs of the male plug on the opposite end will be electrically hot and can result in electrical shock. When unplugging the cord ALWAYS unplug the cord from the 110VAC outlet FIRST and THEN from the Transport/ Storage Trailer.**

## 2.13- Transport/ Storage Trailer:

A 24' enclosed "car hauler" trailer purchased from BigTex Trailer in Odessa, TX is used to house and transport the UCPT. The trailer has been modified to hold everything required for UCPT tests. Specs for the trailer are given below. Additional information and contact info for the dealership can be found in the **Transport/ Storage Trailer** section of the appendix.

Additionally, locks have been provided for the trailer gate and door, as well as for the ball hitch receiver of the trailer.

| Transport/ Storage Trailer Specs: |
|---|
| V-NOSE |
| 8'6" WIDE |
| 6'6" TALL |
| 24' LONG |
| 2/5200# AXLES |
| G.V.W.R. 10,000# |
| EMPTY WEIGHT 3,560# |
| CARRYING CAPACITY 6,440# |
| SILVER MOD 6 HOLE WHEELS |
| 36" SIDE ACCESS DOOR W/FLUSH LOCK & CAMBER BARLOCK |
| REAR RAMP DOOR 76" TALL x 88" WIDE |

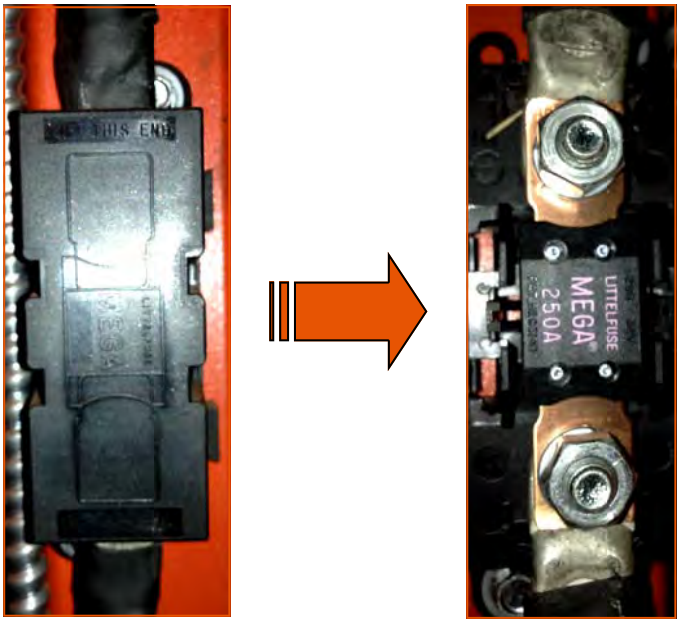
## 2.14- UCPT 12V Battery:


An industrial 12V battery supplies power to the various components of the UCPT. Most components do not have very high current draw and therefore do not drain the battery very quickly at all, however, the hydraulic pumps current draw is substantial and can deplete the battery's charge in a short time. As soon as the engine is started the battery is charged by a heavy duty 10 amp alternator on the engine. So long as caution is used to minimize the amount of time the hydraulic pump is running and the engine is not, keeping the UCPT battery charged should not be a problem. The UCPT battery is held in place by a heavy duty mount can be easily removed if necessary. To do so disconnect the lead going to ground, and then remove the two 5/16" bolts located on the ends of the bar running across the top of the battery. Once the bolts are removed the bar can be lifted off and the battery can be disconnected and removed.


The current charge level of the battery can always be seen by flipping the switch located next to the push button start inside the **Control Box**. If the voltage level indicated by this meter is too low for the battery to run the UCPT components it can be charged by doing one of the following:

1) Manually starting the engine using the pull chord start (**easiest option)
2) Plugging in the battery charger and connecting the leads to the battery's fuse holder and to the ground lug

Power from the battery goes out on the (+) lead and directly to an industrial grade fuse. If access to the (+) lead of the battery is needed simply pop the cover off the fuse housing to expose the fuse and the line. ALWAYS use caution when working around the battery and ALWAYS replace housings and covers if they are removed.



## 2.15- Ground Cover/ Intake Reducer:

The **UCPT** utilizes a **Ground Cover/ Intake Reducer** for a number of reasons. First, this apparatus prevents any debris and other foreign objects or material from being drawn into the fan. Second, it is used to allow lower wind speeds inside the test section to be achieved by limiting the amount of air that can be moved. Two different **Ground Cover/ Intake Reducers** have been shipped with the **UCPT**; details for using and storing each are as follows:

### #1- Steel Ground Cover/ Intake Reducer:

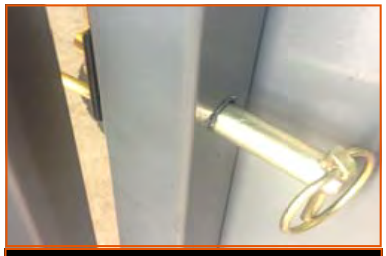
**UCPT's** Steel **Ground Cover/ Intake Reducer** serves as a counter weight in addition to the functions listed above. Due to its weight a small 12V winch is used to raise/ lower the cover. Normally the steel **Ground Cover/ Intake Reducer** will be in the upright and locked position during field transport, however, if necessary it can be left partially raised so that is extends further away from the intake end of the tunnel and offers extra counter weight. To use the steel cover follow these steps:

**If the steel cover is to be used as an intake reducer it is now in the proper position and no further steps are required.**

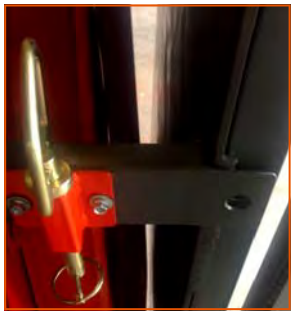
1. When transporting/ storing the **UCPT** or during normal field transport, the steel **Ground Cover/ Intake Reducer** will be in the upright and locked position with both of the smaller sections folded in. Once the user has arrived at the test site unfold the "flap" shown on the left side of the photo to the right (control side of tunnel) and allow is to hinge partially open so that the 1/2" lock pin can be accessed. Remove the 3/16" keeper pin from the lock pin and slide it out of the locking pin hole and place it in its holder on the stop as seen below.

**Steel Ground Cover** in the upright and locked position

When this 3/8" pin is removed the side it was holding will hinge out allowing access to the lock pin located behind the flap.



Lock pin in place



❷ Once the lock pin is removed use the winch control to lower the steel cover a few inches away from the fan and tunnel so that the side that is currently free can be hinged out and locked into place by sliding the half inch lock pin that was hanging from the 3/8" hitch pin through the holes in the frame of the two sections as seen below. Repeat for the opposite side


Steel Ground Cover winch control

Return the two 3/8" pins to the angle iron ears once the sides have been unlocked and folded out.

Insert the half inch pin through the frame of the central and outer sections to lock the flap OUT

❸ Once the two smaller sides are hinged out and locked into place the steel cover can be lowered the rest of the way by running the winch OUT until it is roughly parallel with the frame of the **UCPT**. **DO NOT RUN THE COVER DOWN PAST PARALLEL WITH THE (2"x3") RAILS ON THE BOTTOM OF THE TUNNEL FRAME AS THIS MAY MAKE LIFTING THE COVER DIFFICULT FOR THE WINCH.**

Steel cover lowered and in the OUT position

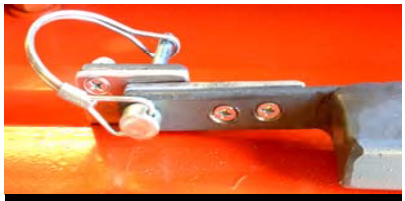
If the operator decides that the steel ground cover needs to be removed it is recommended that it be separated into the 3 separate pieces rather than attempting to move it assembled. Remove the two smaller sides by driving the hinges up and out. USE CAUTION AS EACH PIECE OF THE COVER IS EXTREMELY HEAVY.

**Always return the steel ground cover to its upright and locked position when storing/ loading/ unloading the UCPT.**

## #2- Wooden Ground Cover/ Intake Reducer:

The alternative to the heavier steel ground cover is the lighter wooden cover which stores in the **Transport/ Storage Trailer.** If this cover is to be used the steel cover will need to be removed first. Once this is done mount the wooden cover by laying it on the ground, aligning the pivot holes with the holes on the angle iron ears on the (2"x3") rails on the **UCPT** frame, and sliding the pins through. Additional instructions are as follows:

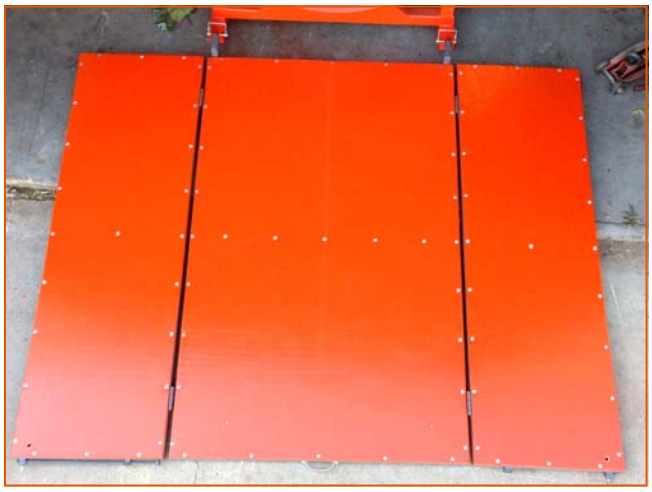
Pin holding Ground Cover Upright



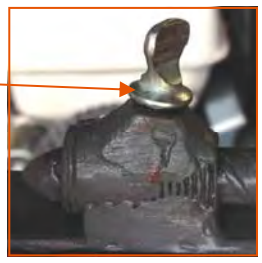
Ground Cover pin replaced in

Ground Cover keeper pivoted to the opposite position

Use caution once the keeper pin is removed to ensure that the **Ground Cover** does not fall as it is substantially heavy and could harm an operator or observer. Use the nylon strap to lower the cover and then hinge the two smaller sides out as seen in the photo below. If necessary, two rebar stakes have been included to stake down the two smaller covers. Leave the cover in place for the duration of the test; when finished, return the cover to its original position.



To free the rebar stakes from the **Ground Cover** frame loosen the two 1/4" lock screws. Backing them out 1/4 to 1/2 turn should allow the rebar to slide out of the mounting brackets.



## ➲ Section 3- Unloading the UCPT:

****CAUTION SHOULD ALWAYS BE USED WHEN UNLOADING THE UCPT.****

### UNLOADING PREFACE:

The UCPT has been designed so that unloading of the unit is as safe and simple as possible, however, users should ALWAYS be aware of what is going on during the unloading process. Consider the following before beginning to unload:

- ⇒ **Operators should always have an "escape plan" in mind just in case things go wrong.**
- ⇒ **NEVER climb, reach, or get underneath the UCPT in ANY WAY when it is elevated.**
- ⇒ **ALWAYS monitor UCPT clearance from themselves, the Loading/ Unloading Trailer, the ground, and any other objects that might come into contact with the UCPT.**
- ⇒ **Take your time. Run the winch SLOWLY so that if something is caught or hung you can loosen the cable and take care of the problem BEFORE any damage is done.**
- ⇒ **Operators should keep an eye out for their counterparts and help to ensure that all users are clear of any possible danger.**
- ⇒ **Unloading should be done SLOWLY so that operators can listen for possible snags or binding that might occur. If these are detected early enough they can be easily solved before any damage is done.**

This short list in no way covers ALL things that users should be cautious of when unloading the UCPT. So long as operators are mindful of their surroundings and watching for any potential hazards to themselves, their fellow operators, and the UCPT/ **Transport Storage Trailer** unloading of the tunnel should be no problem whatsoever.

Upon arriving at the test site the first thing that needs to be done is to unload the UCPT. Whenever possible, park the **Transport/ Storage Trailer** on level ground (or as close to level as is available). Prior to beginning to unload the UCPT, run through the check list below and ensure everything is ready to go and the site is suitable for unloading:

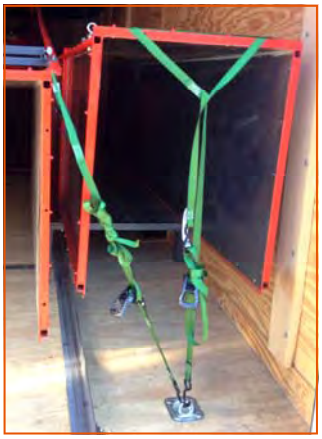
- **Ensure that the Transport/ Storage Trailer is securely hooked onto the ball hitch of the tow vehicle**
- **Confirm that the UCPT has adequate clearance from any potential obstructions BEFORE beginning to unload**
- **Make certain the UCPT is has not shifted during transport and is sitting inside of the (2"x3") unloading rails mounted to the Transport/ Storage Trailer floor**
- **Check that each of the 3" rigid casters mounted on either side of the Air Straightening Section are dropped all the way down to allow maximum ground clearance.**

The unloading process is broken down into 4 main steps each of which is covered in more detail in the following section. These 4 main steps are:

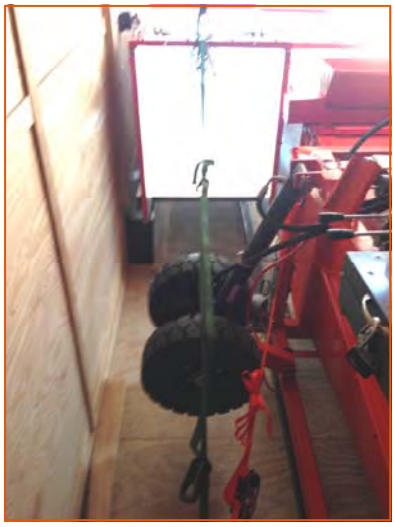
| UCPT Unloading Steps: |
| --- |
| 1) Remove the #2 Test Section/ Ratchet Straps |
| 2) Mount the Loading/ Unloading Ramp |
| 3) Attach the winch to the Snatch Block |
| 4) Winch the UCPT out of the Transport/ Storage Trailer |

## ⇒ Unloading Step 1- Remove the #2 Test Section/ Ratchet Straps:

1. Unhook the green ratchet straps holding the #2 and #1 test sections in place. There are a total of 3 straps to remove: 2 from the top corners of the **#1 Test Section** and 1 from the middle of the **#2 Test Section.**



- Once all the straps from the gate end of the trailer have been removed, enter the opposite end through the side door and remove the single green strap and 2 orange straps.



**3 tie downs attach to a single "eye" just inside trailer side door.**

2. With the **#2 Test Section** free from its tie downs on both ends, lift up on the end of the test section that is attached to the rope hoist; as you lift with one hand, use your other hand to pull the slack out of the rope. You will hear a clicking sound as the ratchet in the rope hoist works. Lift the section as high as the hoist will allow (see video clip included on UCPT smart stick).

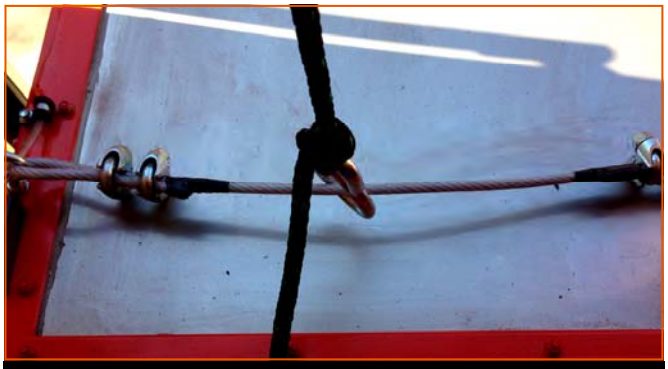
**DO NOT ATTEMPT TO LIFT THE SECTION BY SIMPLY PULLING DOWN ON THE ROPE. THIS MAY PLACE EXCESSIVE STRAIN ON THE TRAILER WALLS AND CEILING AND COULD CAUSE SERIOUS DAMGE TO THE TRAILER. ALWAYS AIDE THE HOIST BY LIFTING UP ON THE TEST SECTION AS YOU RAISE IT.**

## ⇒ Unloading Step 1- Remove the #2 Test Section/ Ratchet Straps (cont.)

3. With the far end of the **#2 Test Section** elevated by the rope hoist begin to slide the test section towards the trailer gate by lifting the end opposite the rope hoist and slowly sliding the section out of the trailer. One of the two operators should stay inside the trailer to help guide the **#2 Test Section** as it moves towards the exit end of the trailer while the other carries the other end. If necessary, the operator inside the trailer may step on the loading platform but must be certain and stay towards the hinge side of the apparatus, or the left side if facing the unloading gate(capacity of the platform estimated at 230 lbs.).

4. Once the **#2 Test Section** has gone reached the end of the overhead track and is as far out of the trailer as it can go while still attached to the rope hoist, set the free end down and pick up on the opposite end to get some slack in the rope and then press the release on the rope hoist UP and gently lower the end of the test section down.

Rope hoist release. Pressing up on this lever will disengage the ratchet and allow the end of the test section to be lowered.



**Gently lower the #2 Test Section after releasing the rope hoist**

5. The **#2 Test Section** should now be free of the rope hoist and can be picked up on either end and carried off to the side where it will not interfere the rest of the unloading process.

6. Remove the 3/8" thumb screws holding each of the 2 legs on the test section storage platform (the wheel well of the trailer will support the platform without any weight on it). Hinge the platform back up against the wall and allow each leg to hinge downward and lock the apparatus back into place with the 2 toggle clamps.

## ⇒ Unloading Step 2- Mounting the Loading/ Unloading Ramps:

1. Remove the **Loading/ Unloading Ramp** from the wall of the **Transport/ Storage Trailer** by releasing the two toggle clamps holding in place against the wall.

2. Remove the 3/4" Alignment pins from the sockets at the end of the (2"x3") guide rails on the trailer floor by flipping the ring on the hitch pin up and sliding them out of the socket; keep within reach as they will be re-inserted shortly.

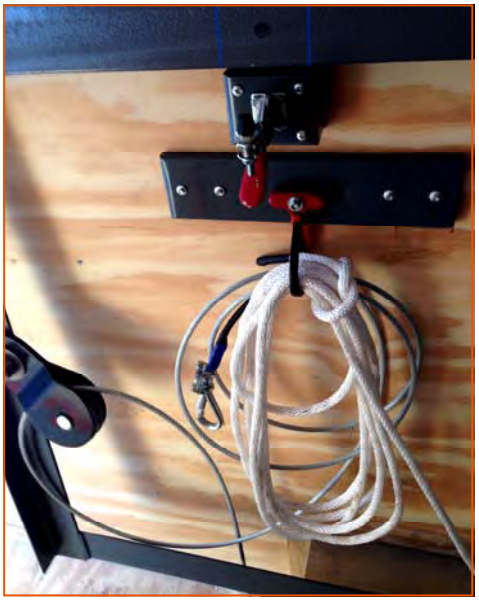
3. Lay the ramp down on top of the gate of the trailer so that the flanges of the angle match the angle bolted to the trailer floor. An ear extends just beyond the leading edge of the ramp which slides outside the rails inside the trailer. Position the ramp so that is in line with the guide rails and slide a 3/4" pin into the socket located on either side. Once in place, slide the 3/16" hitch pin through the keeper hole.

**3/4" Alignment pin slide back into socket**

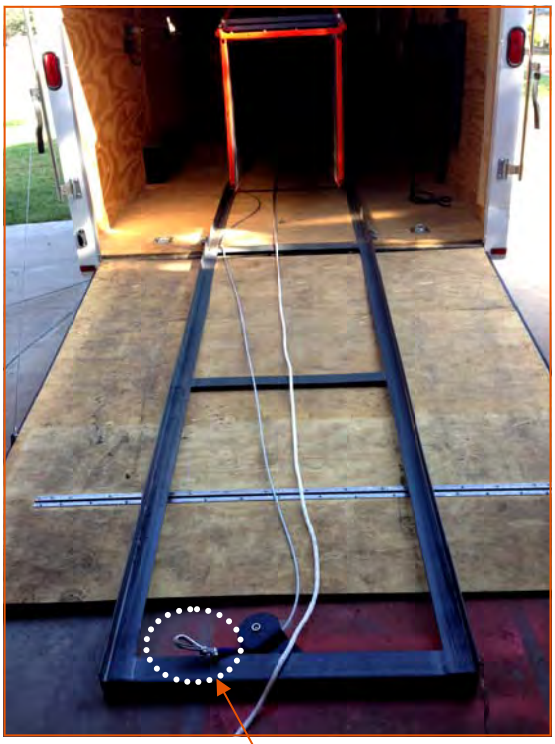
**Load/ Unload Ramp mounted**

## ⇒ Unloading Step 2- Mount the Loading/ Unloading Ramps (cont.)

Take note of the photos below as this is how the setup should look prior to proceeding to **Step #3**. Notice the rope and cable both running down the central portion of the tunnel (this will be important in the next step). Also notice the appearance of the alignment pin at the seam between the **Load/ Unload Ramp** and the trailers gate. Pins will need to inserted in this fashion each time; flipping the pin the opposite direction will result in the pivot bolt being sheared off.



Be certain to insert the alignment pin for the Loading/ Unloading ramp as seen in the photo above to avoid shearing one of the pivot bolts.



Hook from the winch will eventually attach to this look in the cable from the snatch block.

## ⇒ Unloading Step 3- Attaching the Winch to the Snatch Block:

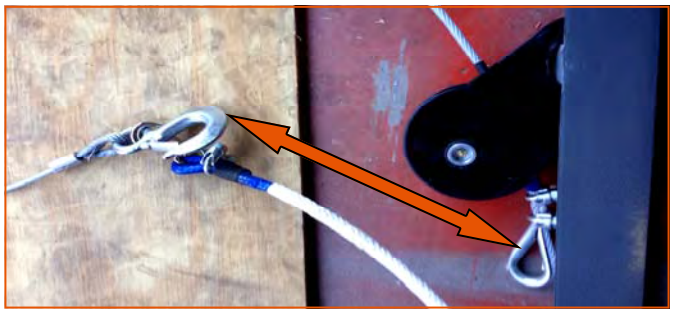
Once the **Loading/ Unloading Ramp** is in place the winch cable can now be attached to the **Snatch Block** located on the end the ramp. To connect the winch to the **Snatch Block** follow these steps:

1. Disengage the clutch located on the top of the wind so that it can spin freely by flipping the clutch control UP


2. With the winch "free spooling", disconnect the winch hook from the **Loading Eye** (on right in photo below) and use the rope that is attached to it to pull the hook under the tunnel and out the back of the trailer; be certain to run the cable UNDER the 2" square tubing NOT over the top.


It is strongly recommended that the rope hook be left attached to the winch hook as this does not interfere with loading/ unloading the **UCPT.**

3. Once the cable has been pulled under the **UCPT** using the white 1/2" rope, connect the winch hook to the eye on the cable from the snatch block



Once this connection is made the operator should perform a quick check to ensure that the cable is not going to catch on the trailer, tunnel frame, etc. Once this inspection is made the **UCPT** is ready to be winched out of the **Transport/ Storage Trailer**

## ⇒ Unloading Step 4- Winching the UCPT out of the Transport/ Storage Trailer:

Before the operator begins to winch the **UCPT** out of the **Transport/ Storage Trailer**, the following checks should be made:

- ⇒ Is the winch cable ran UNDERNEATH the **UCPT** frame?
- ⇒ Are the cables from the winch and snatch block crossed? If so, undo the connection and reconnect so that they no longer do so.
- ⇒ Is there anything else that might be a problem while winching the **UCPT** out of the trailer?

After completing these checks, winch the **UCPT** out of the **Transport/ Storage Trailer** by completing these steps:

1. Remove the winch remote control from the trailer wall and plug it into the receptacle on the front of the winch; a white mark on the receptacle and plug indicate proper alignment.
2. Position one operator inside of the **Transport/ Storage Trailer** to control the winch. The second operator will stand at the end of the **Loading/ Unloading Ramp** to monitor the **UCPT** as it is pulled out of the trailer.
3. Ensure that the winch remote control cable is clear of the **Loading/ Unloading Ramp** and will not be damaged as the tunnel is winched out. Once clearance is confirmed begin winching the **UCPT** out by tapping the control lever on the remote DOWN until all slack has been removed from the cable. As slack is removed the operator on the opposite end of the tunnel should be watching the ramps and cable to ensure they stay in place as the slack is removed.

**Winch Remote**

4. Once there is tension on the cable continue to SLOWLY winch the **UCPT** out of the **Transport/ Storage Trailer**. The operator controlling the winch should be positioned between the 2 sets of transport wheels and walk along side the **UCPT** as it moves out of the trailer. Both operators should be watching and listening for ANY sign of a snag, an indication that the tunnel is in a bind. If everything is progressing as it should the **UCPT** should be sliding inside of the guide rails and moving relatively easy towards the unloading ramp.

**Pressing the control lever DOWN on the winch remote will retract the winch cable and pull the UCPT out of the trailer. TAP this lever down to begin unloading and then hold for a few seconds at a time, stopping periodically to ensure everything is moving smoothly out of the trailer.**

## ⇒ Unloading Step 4- Winching the UCPT out of the Transport/ Storage Trailer (cont.):

5. Continue to slowly winch the **UCPT** out and monitor the position of the two lifting arms connected to hydraulic cylinder #2. As soon as these arms are clear of the tunnel ceiling the operator inside the trailer will need to open the **Control Box,** turn the hydraulic pump ON, and raise this cylinder to make sure the **#1 Test Section** has adequate clearance from the ground.

It is **EXTREMELY** important that the operator controlling the winch and hydraulics monitor the position of these arms and begin raising the **#1 Test Section** as soon as the arms clear the roof of the trailer.

6. Winch the **UCPT** out of trailer until the back set of transport wheel on the inlet side of the tunnel clear the trailer gate. At this point the winch operator can extend the winch cable so that there is some slack in the line and disconnect the winch hook from the snatch block cable.

Once the field transport wheels mounted in front of the fan are clear of the trailers gate the **UCPT** has been winched far enough out of the **Transport/ Storage Trailer.**

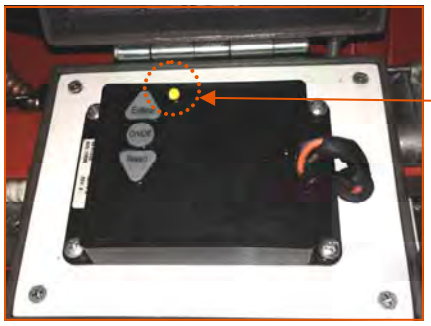
At this point the **UCPT** may still be resting on the **Load/ Unload Ramp**. This is not a concern as the ramp can be removed once the **UCPT** is connected to the tow vehicle.

Once the tunnel and **#2 Test Section** are unloaded additional items such as **Vertical Slot Sampler, Cyclone,** etc. can be removed from the **Transport/ Storage Trailer**.

## ➲ Section 4: Hooking the Tow Vehicle to UCPT-

Once the tunnel is unloaded from the trailer it will need to be hooked up to the truck or tractor that will transport the unit from site to site in the field. Carefully back up the truck or tractor so that the ball of the vehicle and the hitch assembly are aligned and complete the following steps:

1. Turn on the remote hydraulic pump by pressing the "ON/OFF" button on the manual control housed in the "Remote Hydraulic Control Box".

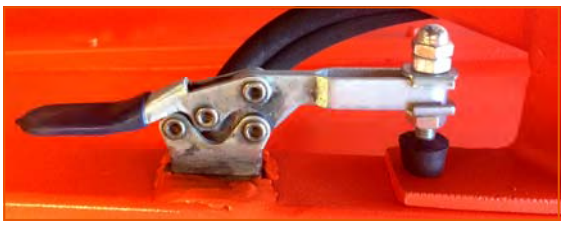



An amber LED will come on when the remote hydraulic unit is turned on.

2. Turn on the remote fob for the cylinder with the "ON/OFF" button; a blue LED indicator will light indicating the remote is ready to use.



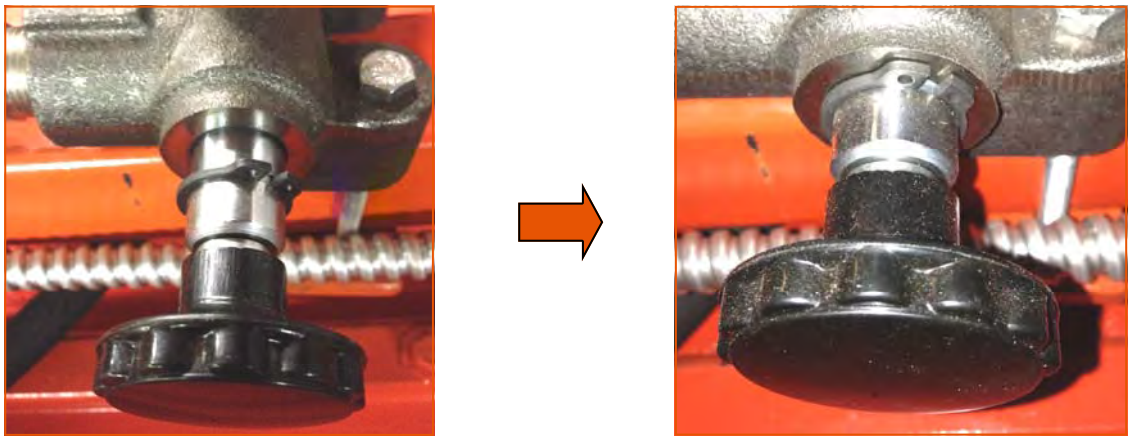
3. Release the hitch cylinder and hitch assembly by moving the toggle clamp into the open position and carefully lowering hitch assembly and allow rest it on the ground.



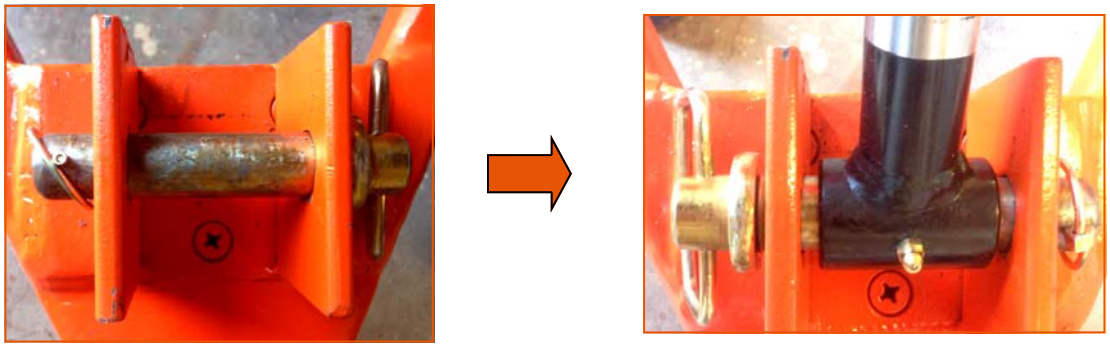
4. Turn on the **Hydraulic Pump** by flipping the switch on the **Control Panel** into the up position; a blue indicator will light when the pump is on.

***CAUTION: Minimize the time that the Hydraulic Pump is on and the engine is not running as this can draw down the units battery.**

5. With the **Hydraulic Pump** and the **Remote Hydraulic Control** each turned on, push the **Toggle Valve** towards the hitch side of the tunnel to engage the remote cylinder system; the keeper ring on the valve will be flush with its housing when it is fully engaged.

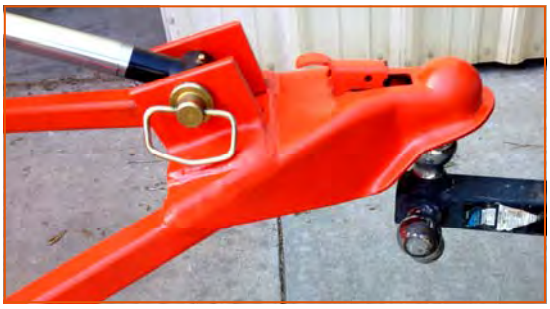


6. Remove the 1" pin from the hitch assembly by pulling the 3/16" keeper pin and use the remote control to extend the hitch cylinder so that it can be aligned with the mounting ears on the hitch assembly and re-insert pin and keeper as shown below.



**Hitch assembly connected to the cylinder #4 and ready to connect to the tow vehicle.**

7. Raise/ Lower the hitch assembly as needed so that the ball hitch on the tow vehicle is directly below the ball hitch receiver on the hitch assembly. Ensure that the ball hitch and hitch assembly receiver are properly aligned and lower the hitch assembly onto the ball. The ball will slide completely up into the hitch assembly receive when correct orientation is achieved. Once this happens lock the hitch assembly onto the ball.



8. Once the ball hitch receiver is securely locked onto the ball of the tow vehicle, lower the field transport wheels and extend the hydraulic cylinder on the hitch assembly so that the **UCPT** is clear of the **Load/ Unload Ramp**. Turn off the hydraulic pump as soon as clearance is gained and slide the **Load/ Unload Ramp** out from underneath the **UCPT.** Once the ramp is out of the way double check that the tunnel will clear the **Tranpsort/ Storage Trailer** and any other obstacles and that the rigid casters used for unloading are all the way UP. After clearance has been confirmed the tunnel can be pulled to the test site.

## ➲ Section 5: Vertical Slot Sampler Test Procedure-

To run a test with the **Vertical Slot Sampler** it must first be mounted onto the discharge end of the test section (see section 1.8 for mounting procedure); the **Cyclone** and the vacuum must also be mounted onto the same test section. Once these units are mounted, follow these steps to conduct a test using the **Vertical Slot Sampler**.

1. Connect the 2" flexible tubing from the **Vertical Slot Sampler** to the inlet port of **Cyclone**. Be certain that a good connection is made and that the locking ears on the connector are all the way down.
2. Set the **Vertical Slot Sampler** so that it sets flat against the soil surface in the center of the test section and then re-tighten the clamping knob to lock the sampler into place.
3. Start the engine and set the desired RPM. Allow the engine to warm up if this has not already been done.
4. Zero both digital manometers.
5. Turn on the vacuum and set to the suction to the desired level.

   **NOTE:**

   **The Vacuum used in conjunction with the Vertical Slot Sampler has the longest runtime currently available, however, it may still not be able to run continuously for more than a few minutes at a time with the vacuum set to maximum suction (5). Trial and error will allow a better feel for exactly how long the vacuum can run on different settings. A charge level indicator on the battery can be used to monitor the charge level of the vacuum battery.**


6. Engage the clutch and begin the test. Make a note of note of time or start timer to determine the length of the test.
7. Once the required time has elapsed, disengage the clutch and throttle down the engine. **DO NOT TURN OFF THE ENGINE IMMEDIATELY; ALLOW ENGINE TO COOL FOR AT LEAST 5-10 MIN AFTER RUNNING WITH A LOAD.**
8. Turn off the vacuum and tap the sides of the Cyclone to ensure that all collected material settles into the collection jar.
9. Unscrew the collection jar from the bottom of the cyclone. A lid can now be placed on the jar or, if additional test will be ran, transfer the material to another container and replace the **Cyclone** collection jar.

## ➲ Section 6: UCPT Field Test Procedure-

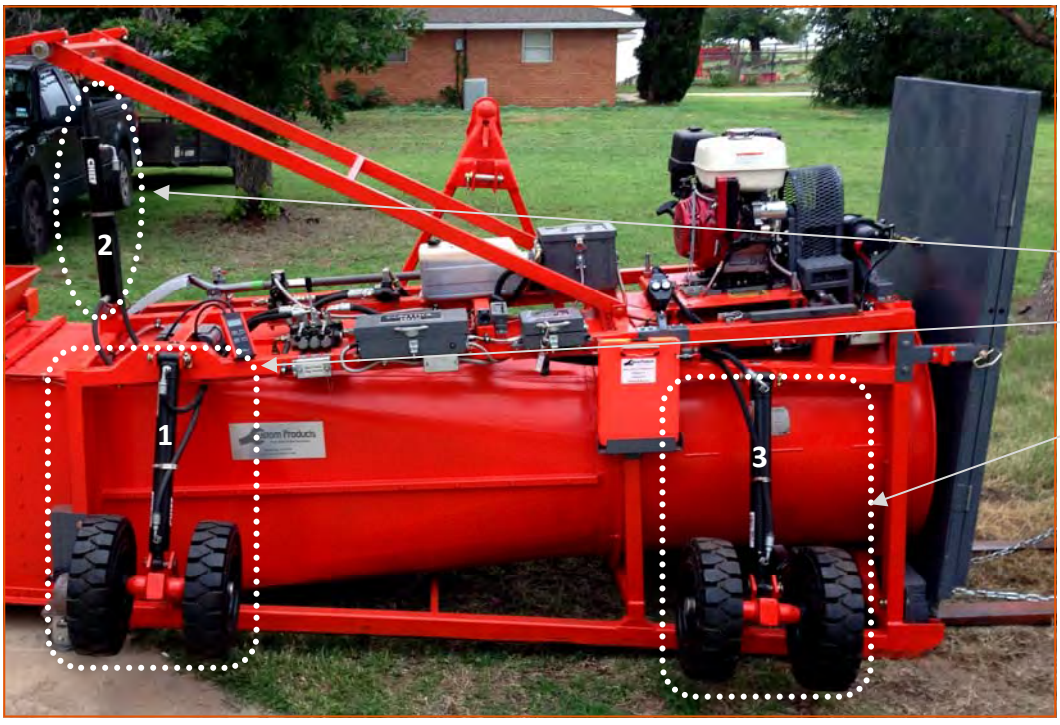
After the UCPT is hooked up to the tow vehicle and transported to a test site, conduct a field test by following these steps:

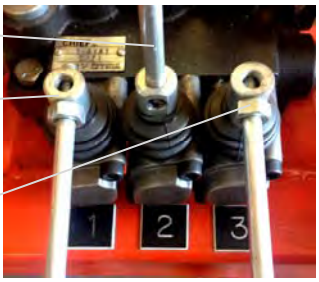
1. Once the test site is located orient the **UCPT** so that it is parallel with the site but STOP when you are approximately 3 feet from the site. At this point turn on the engine so that it can be warming up and remove the shovel from its mount on the tunnel and dig out where the plate on the bottom of the **Sand Feeder/ Air Straightening Section** will sit during the test. This allows the tunnel to sit slightly lower so that the test sections can run parallel with the surface and minimizes the amount of "filling" needed to close any gaps between the bottom of the test sections and soil surface.

**This plate measures approx. (24"W x 20"L)**

2. Remove the spacer bars from the bottom of the test section(s) and pull forward so that the raised test section(s) are directly above the test site.

3. Once proper alignment and placement are achieved turn on the **Hydraulic Pump** from the **Control Panel** and raise/ lower the wheel assemblies and hitch so that the fan/ transition section is level and as close to the soil surface as possible. After leveling the **Fan/ Transition Section** lower the **Test Section(s)** until flat against the soil surface; any remaining gaps will need to be filled in with dirt from outside the test area. Use caution when filling to not disturb the area inside the test section.



4. Now that the **Test Section(s)** have been lowered and any gaps between the bottom edge and the soil surface are filled the **Vertical Slot Sampler** can be lowered into position by loosening the height adjustment knob and re-tightening when at the desired height. (more detailed info on running a **Vertical Slot Sampler Test** is available in the previous section)

5. Double check that the **Cyclone** battery has a full charge and a collection jar is in place. Replace battery or mount jar if necessary.

6. Lower the **Ground Cover/ Intake Reducer** (unless doing threshold work or wanting lower wind speeds inside of **Test Section(s).**

7. Turn on and zero both manometers. Identify date, operator and test location on data sheet and collection tin.

8. Turn on the vacuum mounted on the **Cyclone** and adjust suction level as needed. Set the engine RPM or wind speed (determined from pitot tube reading at the discharge end of the test section) to approximate level for test as they will change once the clutch is engaged.

After operators have run a few tests using the **UCPT** they will find that you can estimate with a fairly high degree of accuracy how much the engine RPM/ reading from pitot tube will drop after the clutch is engaged. Operators will need to set the RPM or velocity so that it is roughly where they would like it to be for the test, engage the clutch, and then make their final adjustments using the engines throttle.

9. Take vertical velocity readings and record on data sheet and check pressure drop reading on the manometer mounted to the left of the **Control Box.**

10. Double check engine RPM/ velocity readings one final time.

The **UCPT Vertical Slot Sampler** test for this particular site is now complete.

See the following page for post-test protocol.

The above procedure assumes that the **Vertical Slot Sampler** is being used. For alternative experiments such as threshold tests, etc. that may not use the **Vertical Slot Sampler** simply follow virtually the exact same procedure and omit any reference to this unit.

## ➲ Section 6.1: UCPT Post Test Protocol-

Once a test is finished operators will need to ensure that everything has been returned to its original position and is safely stored for transportation to the next test site or back to the **Transport/ Storage Trailer.** Complete the following steps after completing a **UCPT** test:

1. Once desired exposure time has elapsed disengage the clutch and throttle down the engine.

**DO NOT TURN OFF THE ENGINE AFTER IT RAN WITH A LOAD FOR MORE THAN A FEW MINUTES. ALWAYS ALLOW THE ENGINE TO COOL PRIOR TO SHUTTING OFF.**

2. Once fan has stopped turn OFF the vacuum on the **Cyclone.**
3. Record exposure time on data sheet.
4. Remove the collection jar from the **Cyclone** and carefully empty the contents into the collection tin and label.
5. Raise the **Vertical Slot Sampler** and lock into place by tightening the height adjustment knob.
6. If it has been lowered, raise the **Ground Cover/ Intake Reducer** and lock back into the UP position.
7. Turn on the hydraulic pump and raise the **Test Section(s).** If only travelling a short distance it is not necessary to re-attach the stabilizer bars, however, if the tunnel will be towed a relatively long ways or if the ground is very rough these should be placed back on the bottom side and locked into place.
8. Lower the field transport wheels and hitch assembly as needed to gain adequate ground clearance for transport.
9. Once the engine has had cooled down by running at low RPM with no load for 5-10 min it can be safely turned off.

Prior to placing the tow vehicle into drive and moving the **UCPT** to its next destination, we recommend that the operators each take a quick walk around the tunnel to ensure everything is in a safe position for transport. Operators should pay special attention to clearance under the test section(s) and **Vertical Slot Sampler**. Following this inspection the **UCPT** is ready for field transport.

## ➲ Section 7: Loading the UCPT-

Before beginning to load the **UCPT** operators will first need to remove any equipment that has been mounted onto the tunnel during use (**Vertical Slot, Cyclone, Pitot Tube Mount**, etc.)

Operators should remember when loading the **UCPT** that, just like when unloading, the most important thing is to take it slow and use caution as you winch the unit into the **Transport/ Storage Trailer**. During the loading the process one operator will be inside the trailer operating the winch and will monitor clearance to ensure no unwanted contact is not made. The second operator will be outside of the trailer facing the trailer's gate and will watch for any potential alignment issues and guide the cable and rope as they are pulled into the trailer with the **UCPT** (we'll cover this in more detail shortly). Similarly to the unloading process, loading the **UCPT** is broken down into 5 major steps:

| UCPT Loading Steps: |
| --- |
| **1) Positioning the UCPT** |
| **2) Prepping the UCPT for loading** |
| **3) Winching the UCPT into the trailer** |
| **4) Loading the #2 Test Section** |
| **5) Securing the UCPT for Transport** |

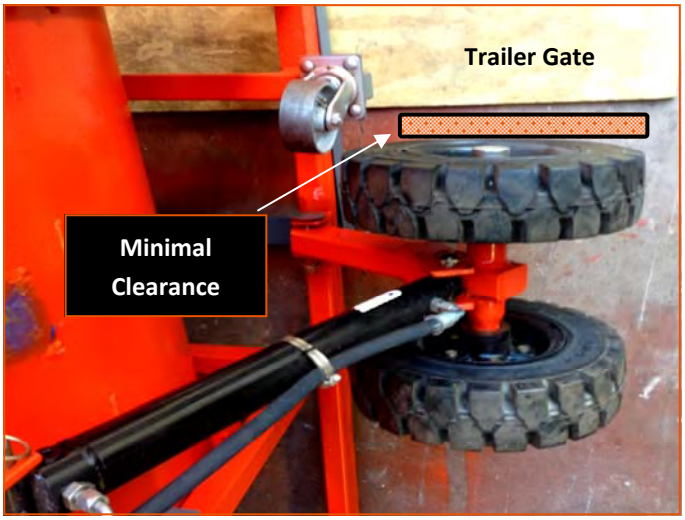
**ALWAYS USE CAUTION WHEN LOADING THE UCPT**

## ⇒ Loading the UCPT Step 1- Positioning the UCPT

1. Tow the **UCPT** back to the **Transport/ Storage Trailer** and unbolt the #2 test section and set it out of the way. Next lay the loading/ unloading ramps into place. Be sure each of the two alignment pins are slid into either side of the rails.

2. Carefully tow the **UCPT** so that the field transport wheels on the intake side of the tunnel are approximately 6" from the gate of the trailer as seen in the photo below. **USE CAUTION TO NOT CONTACT THE TRAILER GATE OR THE LOAD/ UNLOAD RAMP.**

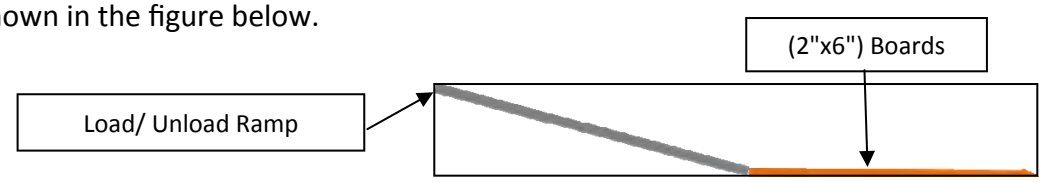
Towing the **UCPT** so that the field transport wheels just clear the gate allows for the tunnel to be setting inside of the angle iron on the **Load/ Unload Ramp** so that when the field transport wheels are raised and the hitch disconnected, the tunnel is properly positioned inside the ramp.




3. Use the tow vehicle to orient the **UCPT** so that it is in line with the **load/ unload ramp** as possible. The operator not driving the tow vehicle will need to keep an eye on the clearance between the field transport wheels and the trailer gate to ensure proper clearance is maintained while positioning.

Ideally, the **UCPT** will sit very close to what is shown in the figure above. Notice that the (2"x3") rails are inside the flange of the **load/ unload ramp** and riding straight along its edge. The winch can pull the **UCPT** into alignment if it is slightly off, but efforts should be made to get this as close as possible.

4. If necessary, lay the 2 (2"x6") boards down to prevent the rigid casters from sinking into the ground when they are lowered in the following step. These boards butt up against the **Load/ Unload Ramp** as shown in the figure below.



## ⇒ Loading the UCPT Step 2- Prepping the UCPT for Loading

At this point the **UCPT** should be directly behind the **Transport/ Storage Trailer** with the **Load/ Unload Ramp** in place. The **UCPT** should still be connected to the tow vehicle with the field transport wheels down. Begin prepping the tunnel for loading completing the following:

1. Lower the 5" rigid casters (x2) located on the discharge end of the **Air Straightening/ Sand Feeder** section of the **UCPT** to their lowest position as shown below and replace the large pin and the smaller keeper pin.

Rigid casters will be in the UP position during field use. These casters **MUST** be lowered to load the **UCPT**. Drop each rigid caster to its lowest position, or so that 2 holes are exposed as seen to the left.

2. Once the 2 rigid casters are lowered and locked in place the **UCPT** can be lowered so that it rests on the ground. Do this by raising the 2 sets of field transport wheels to their highest position. As you raise the two sets of wheels the tunnel will start to lower; as it does make certain that the (2"x3") rails along the bottom of the frame are setting inside of the **Load/ Unload Ramp** as shown in the photo below.

3. After the proper alignment has been verified and the field transport wheels are raised to their highest position remove the pin from the hitch assembly, retract the hitch cylinder completely and return the hitch assembly to its upright, locked position.

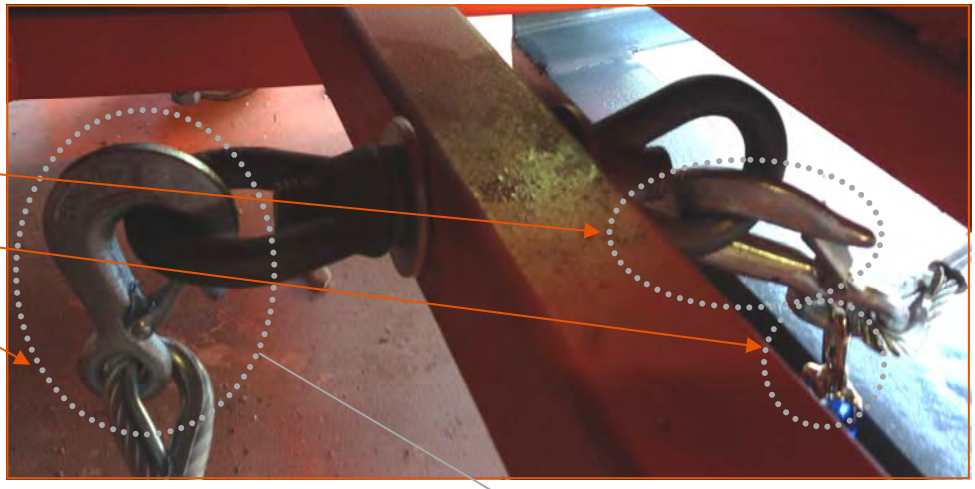
4. Connect the tow vehicle to the **Transport/ Storage Trailer** to stabilize the trailer during the loading process.

## ⇒ Loading the UCPT Step 2- Prepping the UCPT for Loading (cont.)

5. Disengage the clutch on the winch at the front of the **Transport/ Storage Trailer** and spool out enough cable to connect the hook on the winch cable to the loading eye on the underside of the **UCPT** frame.

6. Once the winch hook is connected to the loading eye connect the rope to the winch hook and connect the hook coming from the cable on the snatch block to the unloading eye on the opposite side of the 2" square tubing. After completing this step you will have a total of 3 connections made as seen in the photo below.

| | |
|---|---|
| 1) | Hook from winch |
| 2) | Rope hook |
| 3) | Hook from snatch block |



If desired, the rope can be connected to the winch hook before connecting it to the loading eye.

The cable from the snatch block will be connected to the unloading eye as seen in the photo to the right. The operator not running the winch will need to watch this cable as the tunnel is loaded to ensure it does not catch as it moves into the **Transport/ Storage Trailer**

Making these connections BEFORE loading the **UCPT** makes unloading the unit MUCH simpler. When making the connections from the snatch block and rope be certain to run each UNDERNEATH the middle of the **UCPT** frame. The operator not running the winch from inside the trailer will need to monitor each as the tunnel is loaded to ensure they do not catch on **Load/ Unload Ramps** or trailer floor.

7. Raise the #1 test section to its peak height to provide ground clearance and the tunnel is ready to load.

## ⇒ Loading the UCPT Step 3- Winching the UCPT into the Transport/ Storage Trailer

At this point the **UCPT** is ready to be winched into the **Transport/ Storage Trailer**. Before beginning this process, go over the following check list:

| |
|---|
| ⇒ Are both rigid casters in the DOWN position to give maximum clearance? |
| ⇒ Is the rope connected to the winch hook? |
| ⇒ Is the hook from the snatch block connected to the **Unloading Eye**? |
| ⇒ Is the rope and cable ran centrally UNDERNEATH the **UCPT** frame? |
| ⇒ Does the tunnel have a clear path into the trailer? |
| ⇒ Is the tunnel adequately aligned with the **Load/ Unload Ramp**? |
| ⇒ Have all other items (except the #2 test section) that will need to be stored in the trailer been loaded? |

If the answer to all these questions is "yes", perform one last inspection and proceed with loading by completing these steps:

1. Engage the clutch on the winch by flipping black tab located on the top of the winch DOWN.
2. Plug in the remote control for the winch and walk to the gate end of the trailer laying out the cable as you go so that it is clear from the load rails on the floor of the trailer.
3. Confirm that both operators are ready and begin winching the **UCPT** into the trailer. Use short "taps" on the IN button of the remote at first and watch the **UCPT** to ensure that the tunnel is not hung on something and is progressing forward as the winch is pulling.

Once both operators have confirmed that the tunnel is starting up the ramps, maintaining proper alignment, and is not hung on anything, the operator controlling the winch can begin to hold down the "IN" control on the winch as opposed to pulsing it. As the loading process continues remember that SLOW and STEADY is the preferred approach. Operators should take their time loading the tunnel and continuously watch and listen for any sign of a snag or other trouble. Problems spotted early on are normally very easily fixed.

## ⇒ Loading the UCPT Step 3- Winching the UCPT into the Transport/ Storage Trailer (cont.)

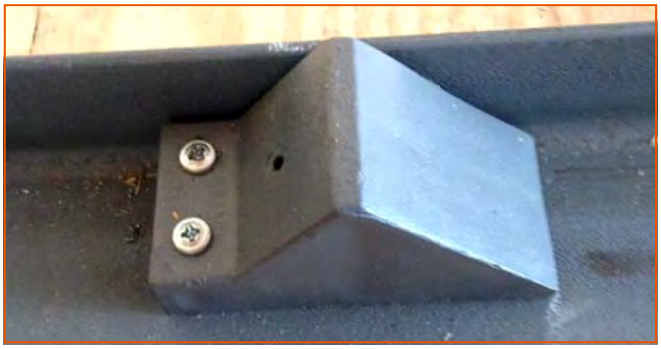
4. The operator controlling the winch will need to remain close to the gate of the trailer and watch the highest point of the lifting arms as the tunnel continues inward. Leave the #2 cylinder extended (i.e. #1 test section in the RAISED position) until just before it enters the trailer. When the lifting arms are approximately 6" from entering the trailer gently press the #2 hydraulic control lever forward BRIEFLY so that the cylinder retracts and the #1 test section is lowered a few inches. When this is done the tunnel can be winched into the trailer a few more inches. Repeat this process until the other operator confirms that there is ample ground clearance for the #1 test section to be lowered completely.

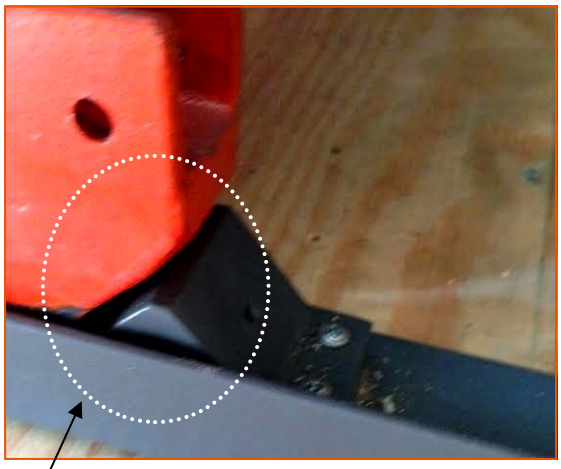

This is the clearance referred to above. The operator controlling the winch will need to stay by the 3 valve hydraulic control manifold so that they can easily reach the #2 control lever to lower the arms as needed. Lowering the arms can be done with the hydraulic pump OFF.

**The operator controlling the winch MUST remember to carefully watch this clearance as the lifting arms WILL HIT THE TRAILER if they are not lowered and the #1 test section WILL CONTACT THE GROUND if it is lowered too soon.**

## ⇒ Loading the UCPT Step 3- Winching the UCPT into the Transport/ Storage Trailer (cont.)

5. Once the **UCPT** has been winched far enough into the trailer that the lifting arms can be safely lowered and have cleared the trailer gate the operator running the winch can begin to hold the winch control in the "IN" almost continuously, but both operators need to continue to observe the tunnel as it comes into the trailer. Continue to winch the **UCPT** in until you reach the 2 stops (or are within an inch or two of these)





Once the **UCPT** is barely touching these stops the tunnel is far enough into the **Transport/ Storage Trailer**. Operators should get the tunnel as close as they can as leaving the tunnel too far from the stops will not allow the #2 test section to be loaded without contacting the tunnel.

6. Remove the pins from the **Load/ Unload Ramp** and return it to its mount on the wall of the trailer; place the alignment the pins back into their sockets so they are ready when the time comes to unload. The **UCPT** is now loaded!

## ⇒ Loading the UCPT Step 4 - Loading the #2 Test Section:

The **#2 Test Section** is the last thing that will be loaded into the **Transport/ Storage Trailer.** The section must be carried by hand with one person on either end to get it into position to begin loading. Complete the final portion of loading the **UCPT** by following these steps:

1. Release the 2 toggle clamps holding the platform located on the wall opposite from the loading ramp and let it hinge down. DO NOT EXTEND THE LEGS OF THE PLATFORM UNTIL AFTER IT HAS BEEN RELEASED AND LOWERED. Once the platform is down fold the 2 support legs out and lock them in place by screwing the thumb bolts in until snug.

Lock the 2 legs into place by threading these bolts in until snug AFTER the platform has been folded down

2. With the platform lowered so that it is now parallel with the trailer floor and the 2 legs locked into position, carry the **#2 Test Section** to the trailer and orient it so that the end with the steel cable ran across the top side will enter the trailer first (check that a spacer bar has been placed roughly 6" in from either end of the section before handling). Carry this section up the ramp until the end with the lift cable is sticking into the trailer a few inches and set the **#2 Test Section** down.

The end of the **#2 Test Section** with the cable seen to the right will enter the trailer FIRST.

3. Next the operator that is on the end of the test section with the cable that is protruding into the trailer slightly will release the ratchet on the rope hoist by pushing the tab UP. Once released pull enough slack in the rope so that it can be hooked onto the lift cable on the end of the **#2 Test Section**.

Rope hoist release tab. Push UP to disengage.

## ⇒ Loading the UCPT Step 4 - Loading the #2 Test Section (cont.):

4. Once the hook from the rope hoist has been connected to the lift cable on the **#2 Test Section** the operator on that end of the section will raise it by lifting UP on the test section with one hand and taking the slack out of the rope with the other until the section is as raised high enough to clear the top of the platform. If necessary, another operator can assist in the lifting of the **#2 Test Section**.

Attach the rope hoist to the **#2 Test Section** as shown in the photo to the right.

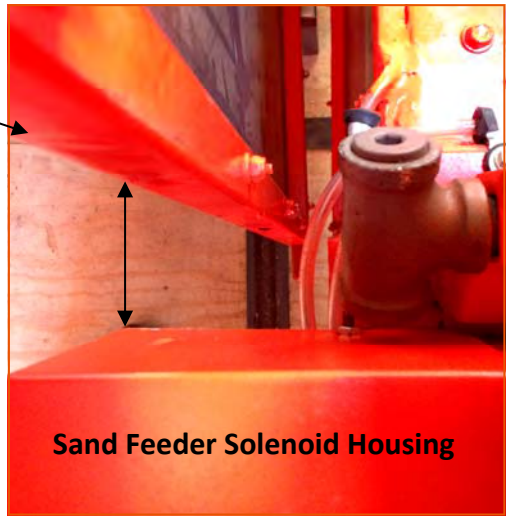
**DO NOT ATTEMPT TO LIFT THE TEST SECTION BY SIMPLY PULLING DOWN ON THE ROPE HOIST. THIS MAY CAUSE SEVERE DAMAGE TO THE TRAILER ROOF.**

5. Once the **#2 Test Section** has been raised the operator on the opposite end can begin pushing the section into the trailer by lifting up on it and SLOWLY pushing it inwards. The operator on the end supported by the rope hoist will need to guide this end and watch that it does not catch on the toggle clamps, trailer frame or gate cable, etc. Operators may need to walk on the top of the test section loading platform during this process, if so, be sure and stay as close to the trailer wall as possible and use caution.

6. Carefully slide the **#2 Test Section** in until the end opposite of the rope hoist is clear of the trailer gate. The operator inside of the trailer will need to monitor clearance between the tunnel and the test section as it progresses inward. The first point of contact will be between the **Sand Feeder** and the **#2 Test Section**. The operator inside the trailer should keep an eye on the solenoid housing of the **Sand Feeder** and make certain that the test section does not come too far into the trailer and contact this housing.

Leading edge of **#2 Test Section**

Clearance between the **#2 Test Section** and the **Sand Feeder** will need to be carefully monitored as the test section WILL CONTACT this housing if not stopped in time.



**Sand Feeder Solenoid Housing**

## ⇒ Loading the UCPT Step 4 - Loading the #2 Test Section (cont.):

7. Once the **#2 Test Section** is far enough into the trailer that it will not interfere with closing the gate there is no need to push it in any further. At this point the operator in the rope hoist end of the section will lift up on the test section so that there is some slack in the rope and with their other hand push UP on the release tab on the rope hoist to disengage it and then SLOWLY lower the end of the test section so that it rests on the platform.

**USE CAUTION WHEN REMOVING THE ROPE HOIST. AS SOON AS THE RELEASE TAB IS MOVED UP THE HOIST WILL NO LONGER SUPPORT THE LOAD; THE OPERATOR SHOULD BE PREPARED TO HANDLE THE WEIGHT AND GENTLY SET IT DOWN.**

8. Now that the **#2 Test Section** is far enough into the trailer so that the gate can be shut and is not contact the solenoid housing on the **Sand Feeder** all that remains to complete the loading the test section is to properly position it on the test section platform. When looking in from either end of the test section operators will notice two pieces of 1" square tubing mounted on top of the test section platform. The 1" angle iron on the bottom edge of the test section will need to slid INSIDE the 1" square tubing. The simplest way to accomplish this is to pick up one side of the section and slide it inside the square tubing. Then the operators can pick up the opposite side and push/ pull against the side that is already been sitting down against the 1" square tubing and lower the other side down so that each side sits as shown in the figure below.

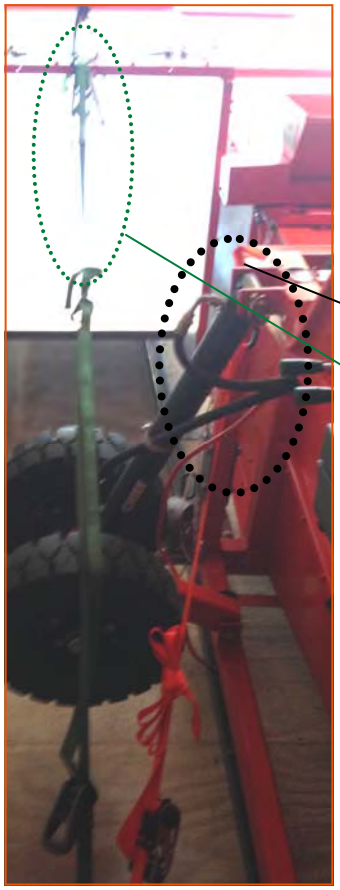

The two alignment rails on the test section platform (shown in blue above for visibility) prevent the sides for the **#2 Test Section** from spreading during transport. The 1" angle should rest on top and inside of each rail as shown above.

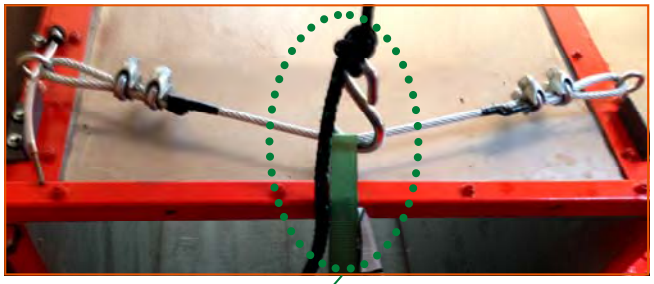
9. Once the **#2 Test Section** is properly seated inside the alignment rails the test section is loaded and ready to be secured.

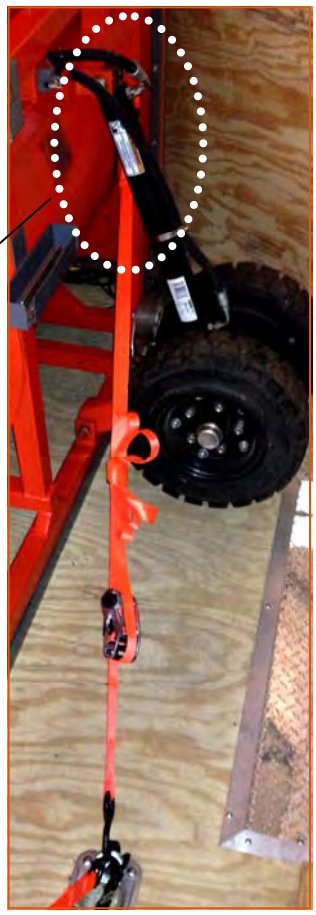
## ⇒ Loading the UCPT Step 5 - Securing the UCPT for Transport/ Storage

Once the **UCPT** is completely loaded all that remains is to secure the tunnel and test section using the ratchets straps (x8) provided. 4 of these 8 straps are **ORANGE**; these have a higher weight rating and should be used to strap down the **Fan/ Transition Section** of the tunnel. The remaining 4 are **GREEN** and have a slightly lower capacity; these will be used to secure the test sections. When securing the tunnel ALWAYS make sure that the straps are ran from the tunnel frame back to the steel "eye" without contacting any of the **UCPT** components or looped around something that might be damaged. Instructions for tying the **UCPT** are as follows:

1. Enter the **Transport Storage Trailer** through the side access door. Once inside secure a total of 3 straps all to the same "eye" as shown below:
   I. **ORANGE** strap from the upper corner of the **UCPT** frame on the intake side
   II. **ORANGE** strap from the upper corner of the **UCPT** frame on the discharge side
   III. **GREEN** Strap from the lift cable on the **#2 Test Section**







Total of **3** straps to be tied just inside the trailer door. 1 from either end of the 2" steel frame of the **UCPT**, the other from the end of the **#2 Test Section**. The green strap from the test section will connect to the lift cable. Orange straps should be wrapped around **UCPT** frame so they have a solid hold and will not slip during transport.

## ⇒ Loading the UCPT Step 5 - Securing the UCPT for Transport/ Storage (cont.)

❷ Once the first 3 tie points are secured proceed to the opposite side of the **UCPT** and locate the steel eye on the trailer floor directly across from the eye that was used in the previous step. Loop a strap around the upper corner of the 2" square tubing frame at either end of the tunnel and back to this "eye" and tighten (shown below).

At this point the **UCPT** should be tied at **5** points: 2 **ORANGE** straps from either of the upper corners of the frame on the control side. 1 **GREEN** strap ran from the lift cable of the **#2 Test Section** back to this same eye, and 2 **ORANGE** straps ran on the opposite upper corners of the **UCPT** frame on the opposite side.

❸ Three tie points remain; each will use one of the remaining green straps. One strap will run from either corner of the discharge end of **Test Section #1** back to the tie point on the trailer floor. The third and final strap will run from the 2 "eye" bolts on the top of **Test Section #2** back to the same eye as right hand side of the test section as shown below.

## Preparing the UCPT for Long Distance Transport/ Rough Terrain Transport

When transporting the **UCPT** a relatively short distance over normal type roads or stable surfaces the unit can be loaded into the **Transport/ Storage Trailer** with the 5" rigid casters used in the loading process left in the DOWN position. Under normal conditions the stops incorporated into the (2"x3") guide rails along with the winch and ratchet straps will have no problem holding the tunnel in place, however, if the **UCPT** is to be hauled over long distances or pulled across rough ground, it is recommended that that these casters be raised and a **Test Section Stabilizer Foot** be added at the discharge end of the **#1 Test Section** to help stabilize the tunnel. To prep the tunnel follow these instructions:

1. To raise the 5" rigid casters the weight of the tunnel will first have to be removed from them. Remove the load from the caster on the control side of the tunnel first by turning on the hydraulic pump and lowering the set of field transport wheels closest to the caster until it is slightly off the trailer floor. Once it is free slide the 3/4" pin out and raise the caster to its highest position. Re-insert the pin and keeper and raise the field transport wheels to their highest position.

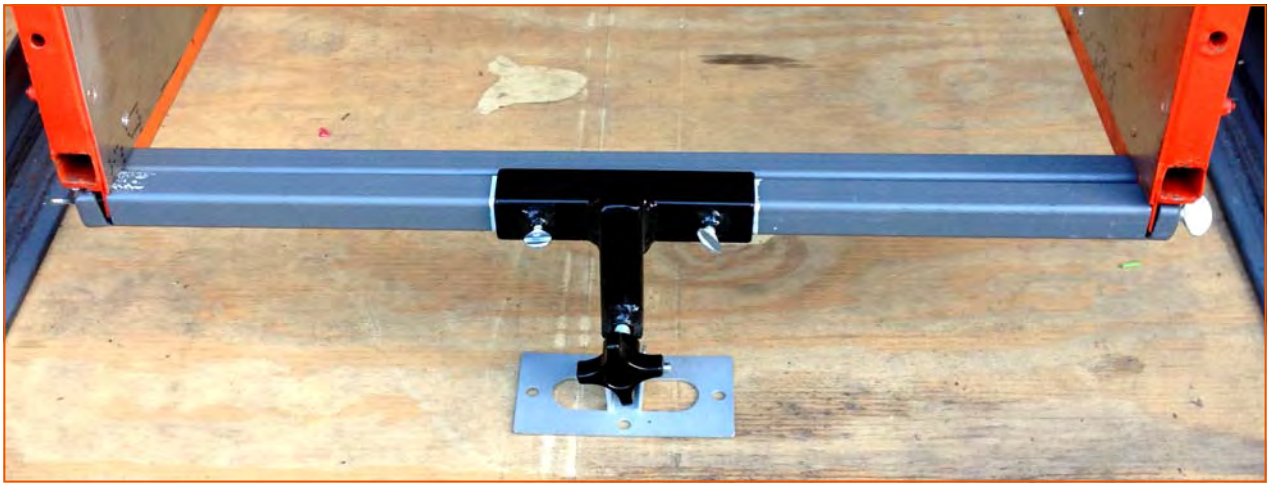
Each caster will be raised to its highest position and locked in place before lowering the tunnel. Be sure and do this ONE SIDE AT A TIME

2. Next the caster on the opposite side must be raised. A similar procedure is used only this time the hitch cylinder will be used to lift the hitch side of the tunnel so that the caster can be raised. BEFORE turning on the hydraulic pump and extending the hitch cylinder BE SURE AND PLACE THE **HITCH CYLINDER BLOCK** (shown below) underneath the cylinder so it will not damage the trailer floor. Once the block is in place extend the cylinder so that the caster just clears the trailer floor, raise the caster, lower the tunnel and turn OFF the hydraulic pump.


Position the wood block so that it butts up against the (2"x3") guide rails on the trailer floor directly below the hitch cylinder BEFORE extending it.

## ⇒ Loading the UCPT Step 5 - Securing the UCPT for Transport/ Storage (cont.)

❸ Lastly, the **Test Section Stablizer Foot** will need to be added to the discharge end of **#1 Test Section** just inside of the gate. Remove the foot from its mount on the trailer wall and slide it onto the extra spacer bar so that the foot runs in the opposite direction of the slot that will slide onto the 1" angle along the bottom edge of the test section. Center the foot between the alignment marks on the stabilizer and use the 1/4" thumb screws (x2) to lock the foot into place. Next slide the foot onto the 1" angle 2-3" in from the end of the test section. Make certain the stabilizer arm seats all the way UP onto the angle and use the 3/8" thumb screw on either end to lock the arm into place, lower the foot down as far as possible, and then use the 3/8" locking knob to lock the stabilizer foot in the DOWN position.



Once the casters are raised and the **Stabilizer Foot** is in place, strap the **UCPT** down as described in the previous section and proceed with transport.

## ➲ Section 8: Appendix:

The UCPT consists of a number of unique components. All information shipped with each item was either copied, or the hard copy included in the appendix of the respective item.

# Appendix #1: Honda GX390 Engine

**Basic info for fan is provided below; user's manual begins on the following page. Additional info on engine can be found on the UCPT smart stick or online.**

Fuel Efficient, High Output Operation
- Digital CDI ignition system with variable timing

Increased compression ratio | Learn More
- Precision camshaft design offers precise valve timing and optimal valve overlap for better fuel efficency

OHV design for increased efficiency and optimal power transfer

Smooth Performance
- Precision engineered components result in lower vibration
- Ball bearing supported crankshaft for greater stability
- Heavy duty balancer shaft

Improved piston design

Exceptionally Quiet
- Large capacity, multi-chamber exhaust system
- Improved camshaft and muffler reduce overall engine noise by up to 5 dB
- Forged steel crankshaft and rigid crankcase
- Helical cut gears

Sophisticated air intake system

Proven Reliability
Oil Alert | Learn More
- Cast iron cylinder sleeve
- High quality materials, fit, and finish
- Dual element air cleaner
- Fuel Valve

3-Year Limited Warranty

Easy to Use and Maintain
- Simple throttle control
- Large fuel tanks
- Large automotive type fuel cap
- Dual oil drains and fill
- Easy, convenient, heavy duty control box

Easily accessible spark plug

Easy Starting
- Heavy duty recoil starter

Automatic mechanical de-compression system | Learn More
Variable ignition timing

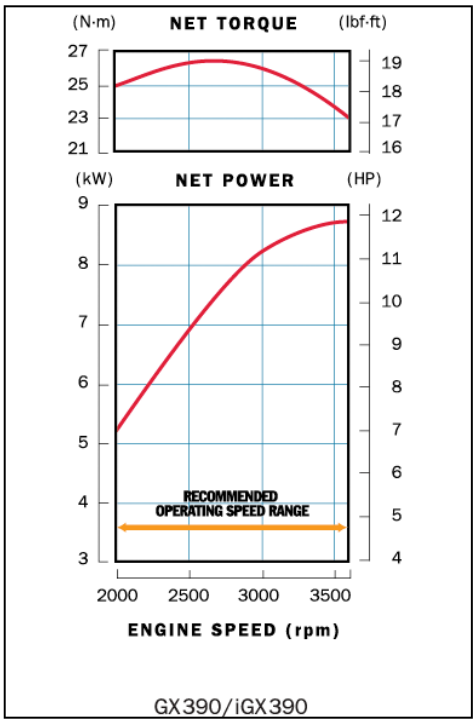
Emissions Compliant
- CARB and EPA certified

No catalyst necessary

Available Options
- Low profile versions
- Gear reduction options
- Electic start
- Spark arrester available
- Charge and lamp coils with multiple output options available

Cyclone Air Cleaner available

| Honda GX 390 Specs: | |
|---|---|
| Engine Type | Air-cooled 4-stroke OHV |
| Bore x Stroke | 88 X 64 mm |
| Displacement | 389 cm3 |
| Net Power Output* | 11.7 HP (8.7 kW) @ 3,600 rpm |
| Net Torque | 19.5 lb-ft (26.4 Nm) @ 2,500 rpm |
| PTO Shaft Rotation | Counterclockwise (from PTO shaft side) |
| Compression Ratio | 8.2:1 |
| Lamp/Charge coil options | 25W, 50W / 1A, 3A, 10A, 18A |
| Carburetor | Butterfly Float Type |
| Ignition System | Digital CDI with variable timing |
| Starting System | Recoil/electric |
| Lubrication System | Splash |
| Governor System | Centrifugal Mass Type |
| Air cleaner | Dual element |
| Oil Capacity | 1.16 US qt (1.1 L) |
| Fuel Tank Capacity | 6.4 U.S. qts (6.1 liters) |
| Fuel | Unleaded 86 octane or higher |
| Dry Weight | 69 lb (31.5 kg) |
| Dimensions | |
| Length (min) | 16.0" (407 mm) |
| Width (min) | 19.1" (485 mm) |
| Height (min) | 17.7" (449 mm) |
| PTO Shaft Options | |
| E type | Tapered shaft |
| H type | Reduction type PTO |
| L type | Reduction type PTO |
| P type | Threaded type (SAE) |
| Q type | Straight shaft |
| R type | Reduction type PTO |
| V type | Tapered shaft |



# Appendix #2: Warner 12V Clutch


User Manual begins on following page.

See UCPT Smart Stick for detailed info on clutch

# Appendix #3: Hartzell 32" Belt Drive Tube Axial Fan

**Custom Products has a long a very positive relationship with Hartzell and uses their fans on all our tunnels. Hartzells user's manual begins on the following page.**

Additional info on fan and transition included on the UCPT smart stick

# V-Belt, Cogged, 5VX750

## Details

Use this belt for medium/high HP industrial applications that require single or multiple V-belt drives. It's oil - and heat-resistant, and static-conductive. It's interchangeable with brands like Browning™, Goodyear®, Carlisle®, Gates®, and Dayco®.

| Technical Specs | |
|---|---|
| Item | V-Belt |
| Material | Rubber Body w/Polyester Cords |
| Belt Type | 5VX |
| Top Width | 5/8" |
| Thickness | 17/32" |
| Industry Number | 5VX750 |
| Outside Length | 75" |
| Construction | Raw Edge, Cogged |

## Appendix #5: 9" Pulley

# V-Belt Pulley, Detachable, 2Groove, 9"OD

## Technical Specs

Item: V-Belt Pulley

Bore Type: Quick Detachable Bushed Bore

Material: Cast Iron

Number of Grooves2

Outside Dia.9"

5V Belt Pitch Dia.8.9"

Fits Shaft Dia.1/2" to 2-5/8"

Bushing Required: SK

Construction: Web

Industry Number: QD2/5V9.00

Set Screw Included: Yes

For Use With 5V or 5VX Single or Joined Type V-Belts

Standards: RMA and MPTA

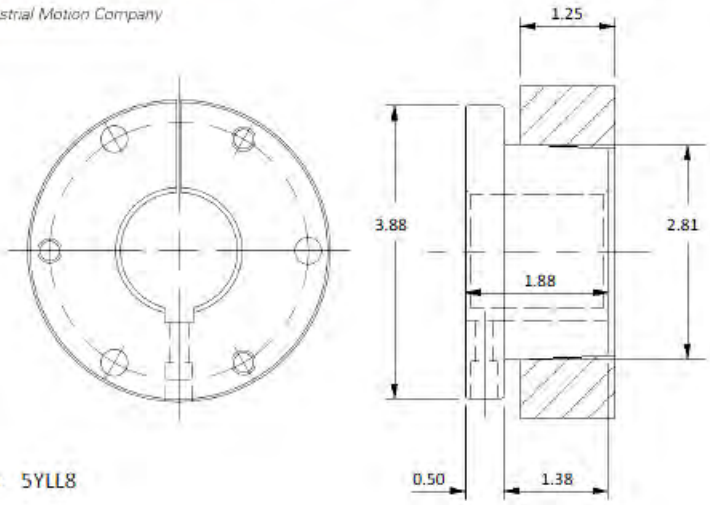
## Appendix #6: Bushing

# QD Bushing, Series SK- Bore 1-7/16"

TB Wood's Incorporated

An Altra Industrial Motion Company

**Product Specification Sheet**




**Material Number:** 5YLL8

**Product Number:** SK1716

**Part Description:** SKx1 7/16

**Product Type:** Sure-Grip Bushing

**Bushing Size:** SK

| Properties and Performance | |
|---|---|
| Bore: | 1 7/16 in |
| Keyway: | 3/8 x 3/16; Standard |
| Torque Rating: | 7000 in·lbs |
| Material Type: | Cast Iron |
| Product Weight: | 2.9 lbs |
| Installation Torque: | 15 ft·lbs |
| Capscrew Size: | 3X 5/16-18 x 2; Grade 5 |
| Setscrew Size: | 5/16-18 |
| Mounting: | Standard or Reverse |

*Special key is included for all shallow keyways

www.tbwoods.com 1-888-829-6637 mechanical@tbwoods.com

# Appendix #7: Tires


## "We Build The World's Toughest Forklift Tire"

Made in Houston, TX Since 1968 | 713-697-0633

Tires used on the 2 sets of dual field transport wheels were purchased through road runner rubber. These solid rubber tires require virtually no maintenance and are EXTREMELY durable and heavy duty. Damaging the tires and/ or wheel assemblies should be very difficult, but in case it does occur, Road Runner's contact info is provided below.

**Phone:** 713-697-0633
**Fax:** 713-697-6233
**Email:** info@roadrunnertires.com

# Appendix #8: Field Transport Wheel Hubs

**UCPT's** wheel hubs can be purchased at most any tractor or trailer retailer. The units are heavy duty with a weight rating of 1,750 lbs. and have been greased prior to sealing them by Custom Products at the time of assembly so there should be no need for maintenance.

| Specification | Description |
|---|---|
| Product Type: | Repair Kits |
| Inner Bearing Size (ID): | 1-3/8 in. |
| Number of Studs: | 5 |
| Outer Bearing Size (ID): | 1-1/16 in. |
| Seal Size (ID): | 1-3/8 in. |
| Spindle Diameter: | 1-3/8 in. |
| Spindle Length: | 4-1/4 in. |
| Warranty: | 90-Day Limited Warranty |
| GardenHoses-WeightCapacity: | 1,750 lb. |
| Bolt Circle Pattern: | 4-1/2 in. |
| Brand: | Martin Wheel |
| Center Hole Size: | 2-3/8 in. |
| Manufacturer Part Number | H-545UHI-B |

# Appendix #9: Hydraulic Pump

The entire **UCPT** hydraulic system was purchased through **Florida Hydraulics**. They are an extremely well known and reputable company that can offer quality technical support if needed. Contact information for Florida Hydraulics is:

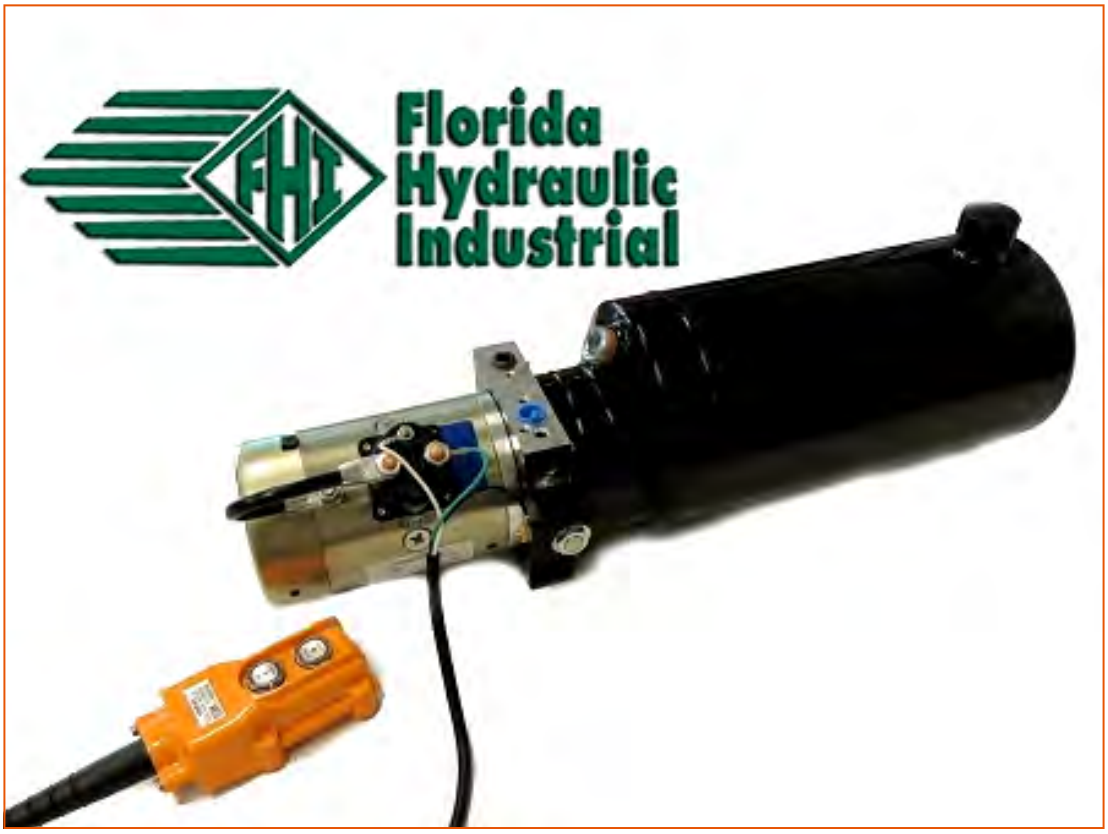
**www.floridahydraulic.com**

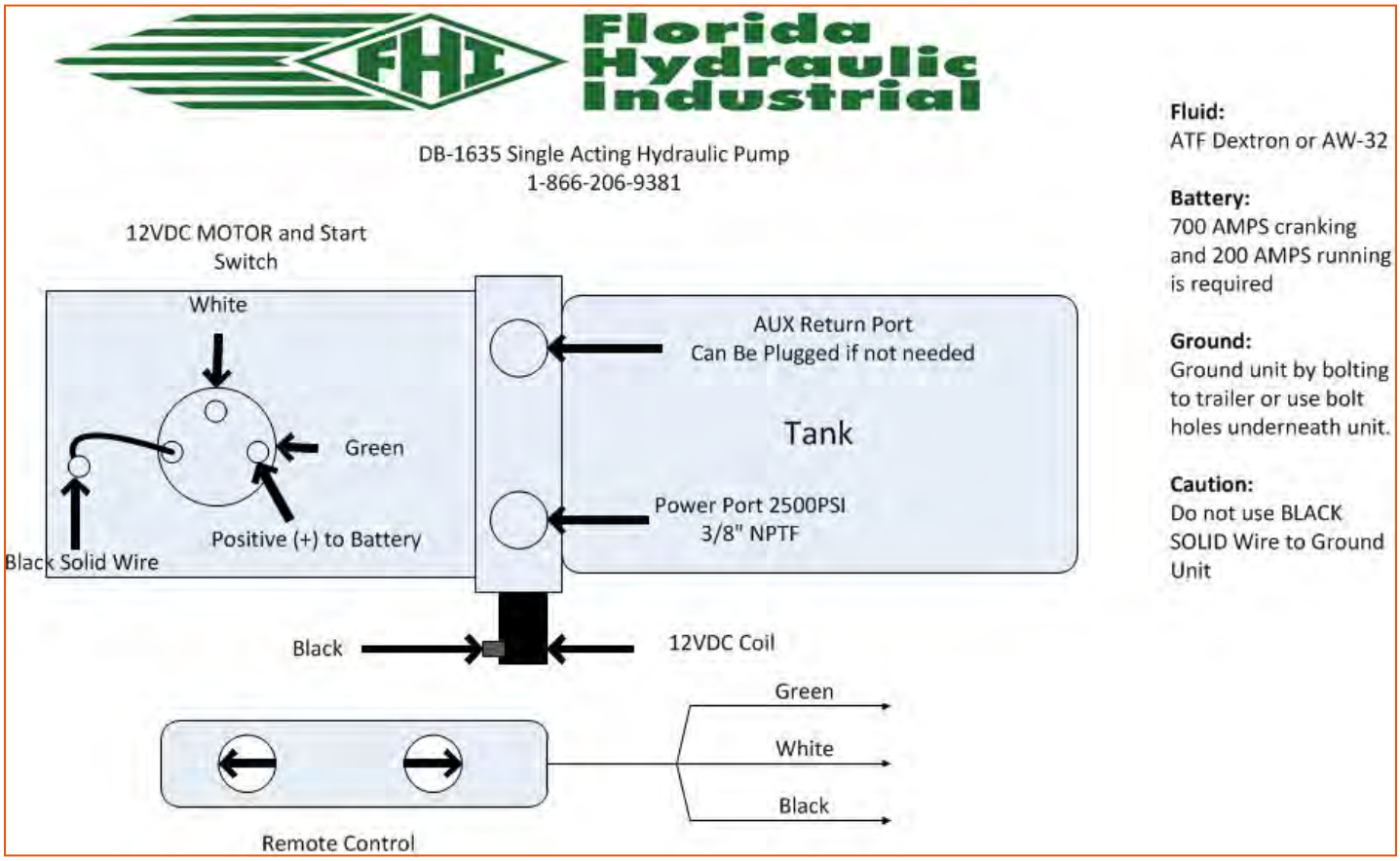
**Florida Hydraulic Industrial**

**4130 SW 13th St, Unit 1**

**Ocala, FL. 34474, USA**

**Phone: (352)291-0160/ 1-866-206-9381**






| DB 1635 Hydraulic Pump Specs: |
|---|
| Motor - 12 Volts D.C., 1 Terminal, Standard Duty |
| Pump - A.F.C. 2.5 CC/REV. (.153 CU.IN./REV.) |
| Relief - Adjustable Relief set at 2500 PSI |
| Endhead - 3/8 NPTF Pressure-Return Port 3/8 NPTF Auxiliary Return Port (2) 3/8-16 TAP X .38 DEEP MTG. HOLES |
| Tank - 2 gal |
| Valving - Check Valve 10VDC 2P2W N.C. RELEASE VALVE |
| Wiring - 12 VOLT DC TO MOTOR, START SWITCH & COIL |
| Unit Performance - 1.3 GPM AT 2000 PSI AT 11.7 VOLTS DC & 183 AMPS AT 45 CENTISTOKES (200 SSU) |
| This is not a continuous duty unit. |

# Appendix #10: 12 V Remote Hydraulic Pump

**Model: D035-2C-12D-35**

**Hydraulic Pump Wireless Remote Control System**

- This remote control system operates one 12-volt dc hydraulic application (single or dual valve).
- Many customers are installing this remote control on their hydraulic pump to operate their dump trailers, trailer jacks, boat lifts, snow plows and many more!
- Raise and lower your application from 50-100 feet away or even while staying inside your vehicle!
- This remote is a "life saver" for those less mobile customers, and for the ones that simply love the convenience!
- Simply hold down a button on the key fob and let the remote control operate your existing 12-volt dc hydraulic pump.
- Now there is no need to be restricted to one area to operate your application.
- This convenient wireless system lets you move around and monitor the area while operating your application.
- This is a safe one person operation and contains an on/off switch on the top of the receiver box.
- This system is also engineered so you can continue to use the tethered (wired) remote that came with your hydraulic pump. Although, after you use the wireless controller we bet you never use the tethered (wired) remote again!

GS-HYO-01

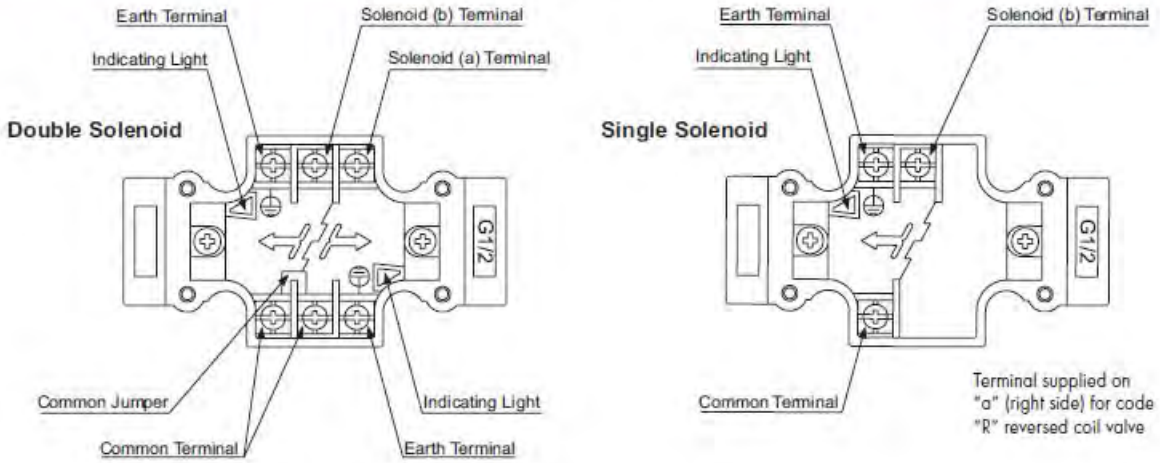
## Specifications

NFPA SIZE: D03 & D05

| | | | D03 | | | D05 | | |
|---|---|---|---|---|---|---|---|---|
| | | | AC solenoid | DC solenoid | | AC solenoid | DC solenoid | |
| | | | | Built-in rectifier | | | Built-in rectifier | |
| | | | AC | RAC | DC | AC | RAC | DC |
| Max. operating pressure | P, A, B ports | | 5070 psi (35 Mpa) | | | Note: Less for some valve types such as hyd. shockless and tandem spool | | |
| Maximum permissible back pressure | T port | | 3040 psi (35:21 MPa) | | | 2320 psi (16 MPa) | | |
| Changeover frequency (cycles/min) | | Standard type | 300 | 120 | 300 | 300 | 120 | 240 |
| | | Shockless type | — | | 120 | — | | 120 |
| Mounting Surface | Nfpa, (ISO) | | T3.5.1.MR1-D03, (4401-03) | | | T3.5.1.MR1-D05, (4401-05) | | |
| Internal Leakage | cu-in/min, (ml/min) | | 0.18, (3) | | | 0.22, (3.5) | | |
| Mass lbs (kg) | Double solenoids | | 4 (1.8) | 4.4 (2.0) | | 9.2 (4.2) | 11 (5.0)-35 | |
| | Single solenoid | | 3.1 (1.4) | 3.3 (1.5) | | 7.9 (3.6) | 8.6 (3.9)-35 | |
| Recommended operating conditions | Operating temperature range | | -4 ~ 158°F (-20 ~ 70°C) | | | 41 ~ 140°F (5 ~ 60°C) | | |
| | Operating viscosity | | 80 ~ 1400 SUS (15 ~ 300 mm/s²) | | | | | |
| | Viscosity index | | 90 or above | | | | | |
| | Filtration | | 25 μm or less | | | | | |

# Wiring Diagram for Remote Hydraulic Pump:

## Electrical Box Wiring

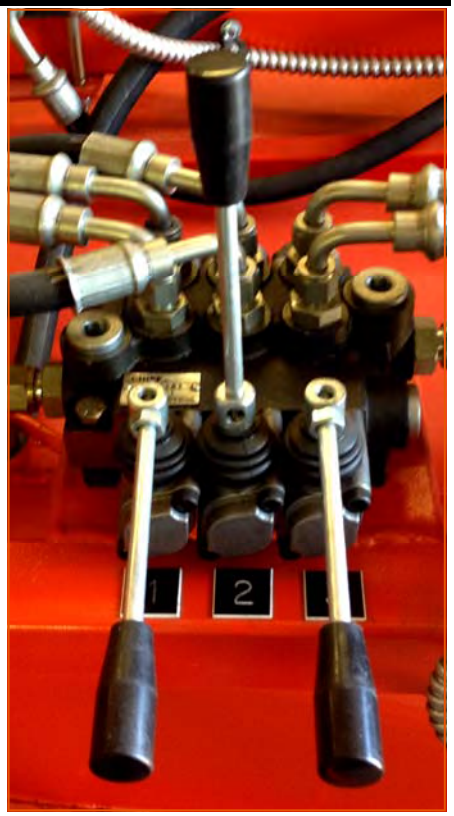


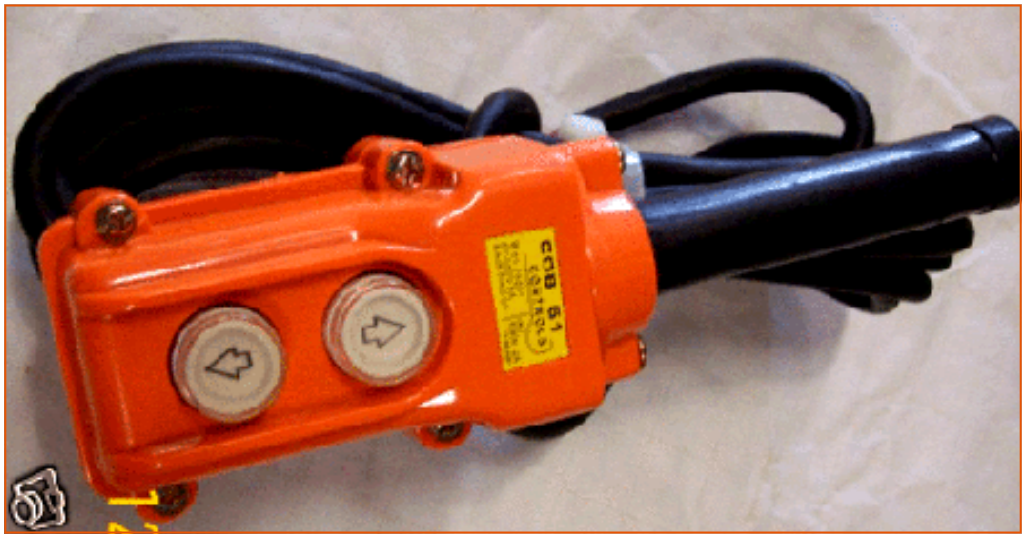

Notes:

- DIN Coils manufactured to accept standard 3 pin DIN 43 650 and ISO 4400 connectors.
- AC Coils are rated for both 50/60Hz (rewiring not required)
- DC coils are not polarity sensitive
- Rectifier is supplied: in the electrical box- D03S, in the coil (internal)- D03SD
- Hydraulic shockless AC valves are always supplied with rectifier.
- Hydraulic shockless valves will not operate as shockless until the tank line has become filled with oil- occurs automatically after the first few cycles. Mounting valve below the reservoir oil level or using check valve ensures that the tank line remains filled.
- Do not supply electrical power to the AC coils unless the coil is mounted on the valve.
- Do not exceed voltage specifications shown above.
- Electrical power should be maintained on detented valves (spool code 3A). Detent only maintains start-up position of the valve.

# Appendix #11: 3 Valve Control Manifold

Also through Florida Hydraulics. An additional remote control unit has been included in the plastic storage container that can be hard wired to the larger hydraulic pump with the reservoir attached to it. Info for wiring in this controller is found in **Appendix #9.**



# Appendix #12: Hydraulic Cylinders

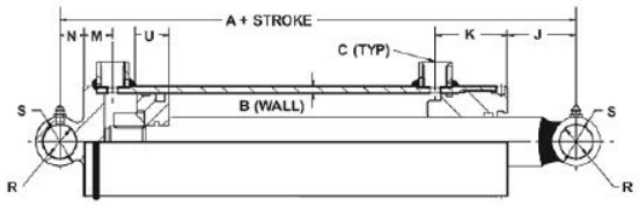
## Product Specifications:

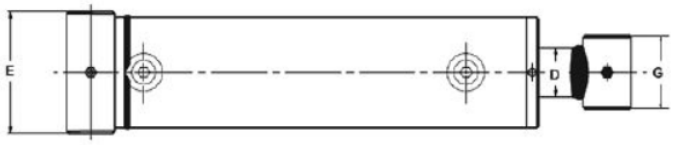
This MAXIM™ WT 3000 PSI welded cylinder is crosstube mounted, and exceeds the highest standards.

These cylinders are designed for demanding applications and are built to ensure maximum reliability and performance. Painted black.

| UCPT Hydraulic Cylinder Specs: |
|---|
| **Designed For**: Double-acting applications |
| **Piston**: Ductile iron ASTM A536 65-45-12 for excellent life |
| **Piston Lock Nut**: Grade 8, high tensile zinc-plated |
| **Gland**: Ductile iron ASTM A536 65-45-12 |
| **Tube**: Precision honed steel |
| **Tube seal**: Nitrile O-ring with Polytemp hytrel back-up |
| **Rod**: High tensile ground & polished hard chrome plated rod |
| **Rod seal**: Std PolyPak with B lip design (Polyurethane U-cup with nitrile O-ring expander) |
| **Wiper**: Polyurethane |
| **End Mounts**: Cross Tubes |
| **Pin and Pin Clip**: High tensile zinc-plated steel |
| **Piston ID Seal**: O-ring |
| **Piston OD seal**: Hallite 755 piston seal with wear ring |
| **Ports**: SAE O-rings |
| **All Seals**: Manufactured to US specifications |
| **Testing**: 100% hydro-pressure tested |

# Additional Hydraulic Cylinder Specs:




## Dimensional Data in Inches (Millimeters)

| BORE | DIMENSIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | G | J | K | M | N | R | S | U |
| 1.500 (38.1) | 8.000 (203.2) | 0.188 (4.8) | SAE 4 | 1.000 (25.4) | 2.250 (57.2) | 2.000 (50.8) | 2.913 (73.99) | 2.129 (54.1) | 0.929 (23.6) | 0.625 (15.9) | 0.764 (19.4) | 1.250 (31.8) | 0.945 (24) |
| 2.000 (51) | 8.000 (203.2) | 0.188 (4.8) | SAE 6 | 1.250 (31.8) | 2.750 (69.85) | 2.250 (57.15) | 2.844 (72.24) | 1.937 (49.2) | 0.894 (22.7) | 0.750 (19.1) | 1.015 (25.8) | 1.500 (38.1) | 1.000 (25.4) |
| 2.500 (64) | 8.000 (203.2) | 0.188 (4.8) | SAE 8 | 1.500 (38.1) | 3.250 (82.55) | 2.250 (57.15) | 2.654 (67.41) | 1.925 (48.9) | 0.894 (22.7) | 0.750 (19.1) | 1.015 (25.8) | 1.500 (38.1) | 1.000 (25.4) |
| 3.000 (76) | 8.000 (203.2) | 0.197 (5.0) | SAE 8 | 1.500 (38.1) | 3.750 (95.25) | 2.250 (57.15) | 2.301 (58.45) | 2.244 (57) | 1.012 (25.7) | 0.750 (19.1) | 1.015 (25.8) | 1.500 (38.1) | 1.000 (25.4) |
| 3.500 (89) | 10.000 (254) | 0.219 (5.563) | SAE 8 | 1.750 (44.5) | 4.250 (107.95) | 2.250 (57.15) | 3.98 (101.09) | 2.248 (57.1) | 1.012 (25.7) | 1.000 (25.4) | 1.265 (32.1) | 2.000 (50.8) | 1.000 (25.4) |
| 4.000 (102) | 10.000 (254) | 0.250 (6.350) | SAE 8 | 2.000 (50.8) | 4.750 (120.65) | 2.500 (63.5) | 3.934 (99.92) | 2.244 (57) | 1.012 (25.7) | 1.126 (28.6) | 1.515 (38.5) | 2.252 (57.2) | 1.000 (25.4) |
| 5.000 (102) | 11.000 (279.4) | 0.250 (6.350) | 3/4 NPT | 2.500 (63.5) | 5.750 (171.5 | 4.000 (101.6) | 2.750 (69.9) | 2.272 (57.7) | 1.500 (38.1) | 0.787 (19.99) | 1.515 (38.5) | 2.500 (63.5) | 1.626 (41.3) |

# Appendix #13: Cyclone Collection Jar

The **Cyclone** utilizes a standard ball jar that can be bought in a variety of sizes. The only constraint on the size of jar will be that it is not too tall and that the mouth of the jar be the same size as the ring that is fixed onto bottom of the **Cyclone.**

**Specs/ Info on Collection Jars:**

Their manufacturing facility in Muncie, Indiana produces each lid with pride. Using their custom, time-tested sealing compound so you get a quality seal. And they also use an underside coating on each lid so that the natural acids in your food will not react with the lid.
The canning jars and lids have been made here in the U.S. for more than 125 years. So you can trust that each jar is every bit as genuine as the creation inside it.

For over 125 years, Ball fresh preserving products have been a staple in American kitchens, helping preserve freshness, healthy nutrients and delicious creations.

8 oz (Half Pint) Regular Mouth Mason Jars x 12 Ball

# Appendix #14: Cyclone Vacuum

## G-MAX 40V 185MPH Digipro Blower/Vac


**Model 24312: DigiPro™ G-MAX 40V Leaf Blower/Vacuum (Battery and Charger Not Included)**
**What's in the Box:** Brushless Blower/Vacuum, Blower Tube, Concentrator Tip, Vacuum Tube, Collection Bag and Owner's Manual


Features & Benefits

- High Performance G-MAX 40V Lithium-Ion Battery
- Powerful DigiPro™ brushless motor offers greater torque and performance to breeze through wet/dry leaves
- Max speed of up to 185MPH/340CFM
- Variable speed dial along with a turbo button for enhanced speed
- Ideal for heavy duty projects either on hard surfaces or lawn
- Quick and easy tool-less transition from blowing to vacuum mode when the need arises
- Mulch Ratio 10:1
- Hassle free push button start eliminates the hassle of gas pull cords and hazardous fumes
- Zero gas, Zero Fumes, Zero Maitenance
- Less fatigue and less vibration than gas leaf blowers
- Lightweight at only 7.8 lbs without battery
- 2Ah battery charges within 1 hr.
- 4Ah battery charges within 2 hrs.

**Compatible only with GreenWorks G-MAX 40V Battery Models 29462, 29472 and Charger 29482**

Additional Info can be found online at:

**http://www.greenworkstools.com/gmax-40v-lawn-and-garden-tools/cordless-leaf-blowers/185mph-blower-vacuum/#product-tabs2**

# Appendix #15: Digital Manometers (x2)

2 Dwyer 478 A series digital manometers are used for reading velocity and pressure drop. Specs for these units are given below. Additional literature on the following pages.

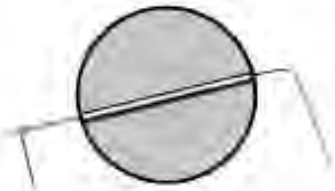
| 478A Specifications: |
|---|
| Service: |
| Air and compatible gases. |
| Wetted Materials: |
| Consult factory. |
| Accuracy: |
| ±1.5% Full Scale @ 72°F (22.2°C). Includes linearity and repeatability. |
| Pressure Hysteresis: |
| ±0.1% of Full Scale. |
| Pressure Limits: |
| 5 psig (.34 bar). |
| Temperature Limits: |
| 0 to 140°F (-17.8 to 60°C). |
| Compensated Temperature Limits: |
| 32 to 104°F (0 to 40°C). |
| Thermal Effect: |
| 0.05% F.S./°F. |
| Display: |
| 4 digit LCD (.425"H x .234"W digits). |
| Power Requirements: |
| 9 V alkaline battery, installed non-functional, user replaceable. |
| Process Connections: |
| Barbed connection for use with 3/16" or 1/4" I.D. tubing. |
| Weight: |
| 10.8 oz (306 g). |
| Agency Approvals: |
| CE. |

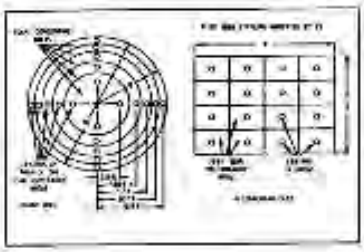
# Appendix #16: Pitot Tube

Bulletin H-11

## Series 160 Stainless Steel Pitot Tubes

### Specifications - Installation and Operating Instructions





The total pressure of an air stream flowing in a duct is the sum of the static or bursting pressure exerted upon the sidewalls of the duct and the impact or velocity pressure of the moving air. Through the use of a pitot tube connected differentially to a manometer, the velocity pressure alone is indicated and the corresponding air velocity determined.

For accuracy of plus or minus 2%, as in laboratory applications, extreme care is required and the following precautions should be observed:

1. Duct diameter to be 30 times pitot tube diameter, or greater.
2. Make an accurate traverse per sketch at right, calculate the velocities and average the readings.
3. Provide smooth, straight duct sections a minimum of 8 1/2 diameters in length upstream and 1 1/2 diameters downstream from the pitot tube.
4. Provide an egg crate type straightener upstream from the pitot tube.

In making an air velocity check select a location as suggested above, connect tubing leads from both pitot tube connections to the manometer and insert in the duct with the tip directed into the air stream. If the manometer shows a minus indication reverse the tubes. With a direct reading manometer, air velocities will now be shown in feet per minute. In other types, the manometer will read velocity pressure in inches of water and the corresponding velocity will be found from the curves in this bulletin. If circumstances do not permit an accurate traverse, center the pitot tube in the duct, determine the center velocity and multiply by a factor of .9 for the approximate average velocity. Field tests run in this manner should be accurate within plus or minus 5%.

The velocity indicated is for dry air at 70°F., 29.9" Barometric Pressure and a resulting density of .075#/cu. ft. For air at a temperature other than 70°F. refer to the curves in this bulletin. For other variations from these conditions, corrections may be based upon the following data:

$$\text{Air Velocity} = 1096.2\sqrt{\frac{Pv}{D}}$$

where Pv = velocity pressure in inches of water
D = Air density in #/cu. ft.

$$\text{Air Density} = 1.325 \times \frac{P_B}{T}$$

where $P_B$ = Barometric Pressure in inches of mercury
T = Absolute Temperature (indicated temperature °F plus 460)
Flow in cu. ft. per min. = Duct area in square feet x air velocity in ft. per min.

**AIR VELOCITY CALCULATOR**
Computes velocity based on air density corrected for conditions of temperature and pressure. Eliminates tedious calculations. Ranges from .01 to 10" water corresponding to 400 to 20,000 FPM. Furnished with each pitot tube.

**STAINLESS STEEL PITOT TUBES**
Test confirmed unity coefficient and lifetime construction of No. 304 stainless steel. Inch graduations show depth of insertion for traversing. Model 160 is designed to meet ASME "Fluid Meters" 6th Ed, ANSI/AMCA 210-99, ANSI/ASHRAE 51-1999, and British Standard 1042. Sizes 12" to 60" long. Hand or fixed mounting types.

**DWYER INSTRUMENTS, INC.**
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
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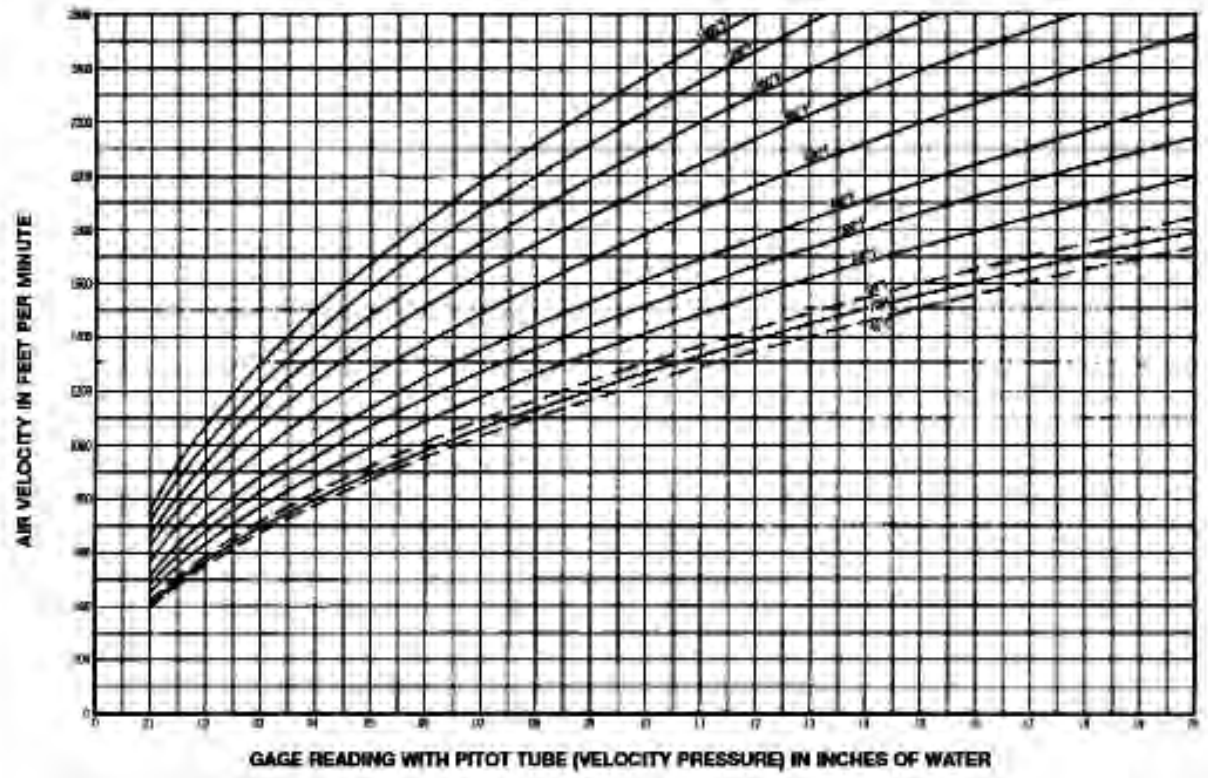


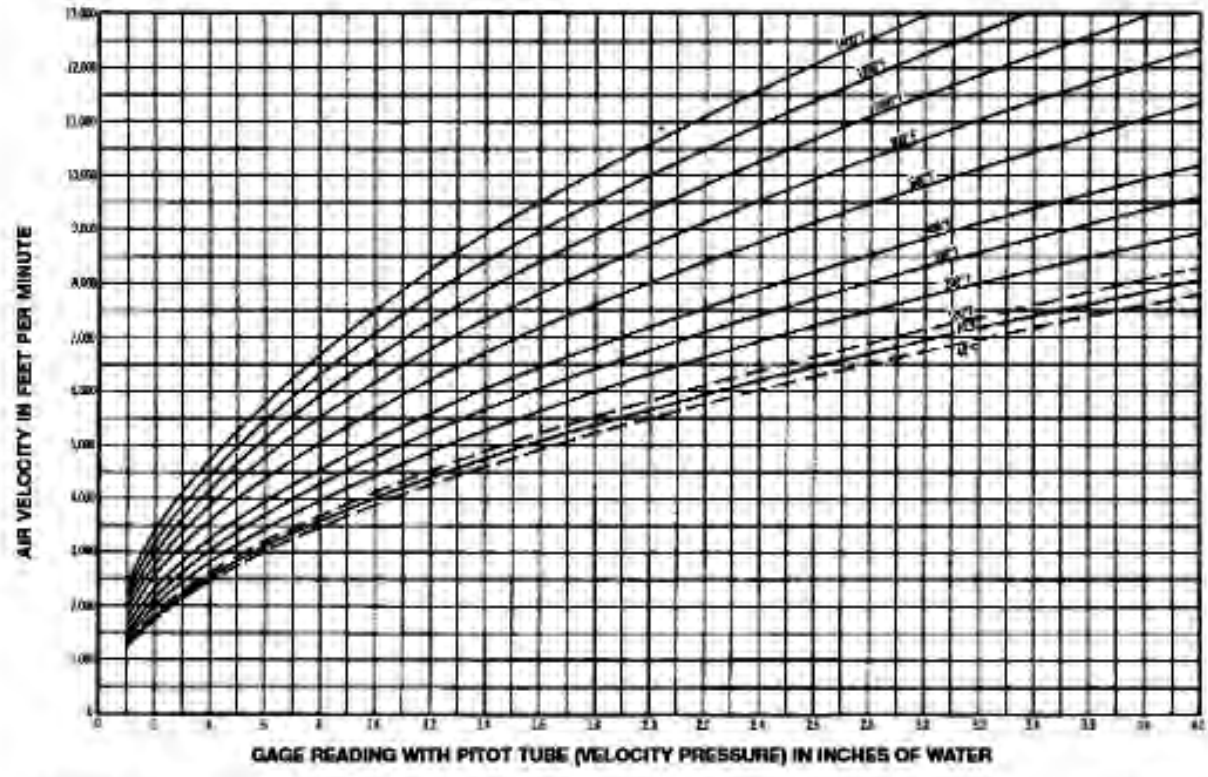


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# Appendix #16: Battery Charger

The Stanley 15A Battery Charger is fully automatic. Vehicle won't start? Battery needs maintenance? Just connect the battery charger clamps to the battery terminal and press charge. The unit automatically selects charge rate and adjusts from rapid charge to trickle charge to maximize battery life. The 15-amp charger features 40-amp patented engine start to jump start a vehicle in 90 seconds, alternator check to indicate potential alternator issues and battery reconditioning to improve charge carrying capability and extend battery life. One of the most advanced chargers on the market, the 15-amp charger features a digital LCD screen that displays charging status and battery status with easy-to-understand icons.

**Stanley 15A Battery Charger with 40A Engine Start:**

- 3/15/40A battery charger and maintainer
- Automatically selects charge rate and adjusts from rapid charge to trickle charge to maximize battery life
- 40A patented engine start to jump start a vehicle in 90 seconds
- Alternator check to to indicate potential alternator issues
- Battery reconditioning technology can help reverse sulfate build-up on battery plates to improve charging carrying capability and extend battery life
- Microprocessor and LCD screen with easy-to-read icons
- Reverse polarity protection

# Appendix #17: Super Winch

This winch is an extremely dependable unit and can easily pull the **UCPT** into and out of the trailer. Additional documentation and info on following pages.


| | |
|---|---|
| **Rated Line Pull** | 5,000 lbs (2,268 kgs) |
| **Motor** | 2.1 hp Series Wound |
| **Gearing** | Differential Planetary |
| **Gear Ratio** | 159:1 |
| **Solenoid** | S3™ Sealed Submersible Solenoid (3 Yr. Warranty) and Circuit Breaker Protected |
| **Clutch** | Free-Spooling, Lever Action |
| **Brake** | Mechanical and Dynamic |
| **Rope** | Wire Rope 1/4" x 50' (6.4mm x 15.2m) |
| **Hook** | Latched |
| **Fairlead** | Roller |
| **Remote** | 30' Hand-held |
| **Dimensions** | 15.1" L x 8.7" D x 6.0" H (383mm L x 221mm D x 152mm H) |
| **Drum Diameter** | 1.625" (41.3mm) |
| **Drum Length** | 3.0" (76.2mm) |
| **Mounting Bolt Pattern** | 2 Hole, 3.69” (93.7mm) on Center |
| **Installed Weight** | 38.9 lbs (17.6 kgs) |
| **Shipping Weight** | 40 lbs (18.1 kgs) |
| **Warranty** | Limited Lifetime Warranty/3 Year on Solenoid |
| **UPC** | 0 22705 00035 2 |
| **Line Pull: 0 lbs** | 36 Amps Motor Draw / 31.0 FPM (9.4 MPM) Line Speed |
| **Line Pull: 5,000 lbs** | 350 Amps Motor Draw / 4.5 FPM ( 1.4 MPM) Line Speed |

# Appendix #18: 3500 lbs. Winch

This Traveller 12V ATV Electric Winch works with ATVs, boats, and snowplows.

- Permanent magnet DC 12V Motor with 1.4hp output
- Maximum Load Capacity: 3500 lb.
- Automatic braking action
- Remote switch with handlebar mount
- Roller fairlead minimizes damage to wire when pulling from different angles
- Universal flat bed winch mounting plate
- Comes with 3/16 in. x 46 ft. of galvanized aircraft cable
- 1 year limited warranty


| Specification: | Description: |
|---|---|
| Brand: | Traveller |
| Brake Type: | Automatic |
| Clutch: | Freespooling |
| Drum Capacity - | 46 ft. of 3/16 in. rope |
| Fairlead | Yes |
| Gear Ratio: | 6.375694444 |
| Horsepower: | 3.5 HP/1.4 HP |
| Line Pull: | 3,500 lb. |
| Line Speed: | No-load: 10-1/4 ft./min Full |
| Mounting Bolt | 2-3-1/8 in. |
| Mounting | Yes |
| Power Type: | DC |
| Product Height: | 4-1/4 in. |
| Product Length: | 12-3/4 in. |
| Product Type: | Electric Winches |
| Product Width: | 4-1/2 in. |
| Rope Diameter: | 3/16 in. |
| Rope Length: | 46 ft. |
| Rope Type: | Galvanized |
| Warranty: | 1-Year Limited |
| Manufacturer | EWX3500D |

# Appendix #19: UCPT Paint

Orange touch up paint has been included in the plastic storage containers. Paint is shipped in a small glass jar that be screwed onto the **Valspar Touch Up Sprayer** that has also been provided so that paint can be sprayed for touch ups as needed. Additional orange paint can be purchased through **Sherwin Williams** using the following info:


The only other color used for the **UCPT** is a dark gray. This paint is a **Rustoleum** product. If needed, additional gray paint can be purchased at most any hardware store. Specs for the dark gray paint are as follows:

**Gloss Dark Gray, Sku #: 249115 - 12 oz. Spray**

The breakthrough technology of Painter's Touch® Ultra Cover 2x means you'll get twice the coverage in a single pass—which means your project will be done in half the time at half the cost of competitive brands. All of that, plus a smooth, glossy finish with dozens of popular color options. Enjoy!

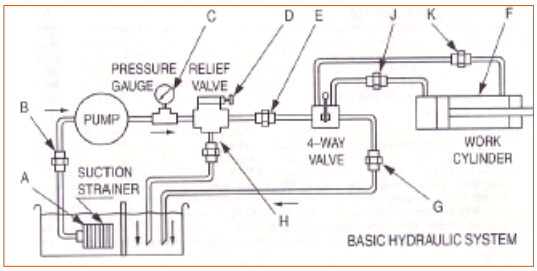
- Ultimate Coverage
- Smooth, durable finish
- Any-angle spray with comfort spray tip
- For Best Results apply 2 or more light coats a few minutes apart. Spray in a steady back-and-forth motion.

## ➲ Section 9: Hydraulic Trouble Shooting Guide

# Hydraulic Troubleshooting Guide

## Hydraulic Troubleshooting

Many of the failures in a hydraulic system show similar symptoms: a gradual or sudden loss of high pressure, resulting in loss of power or speed in the cylinders. In fact, the cylinders may stall under light loads or may not move at all. Often the loss of power is accompanied by an increase in pump noise, especially as the pump tries to build up pressure. Any major component (pump, relief valve, directional valve, or cylinder) could be at fault. In a sophisticated system, other components could also be at fault, but this would require the services of an experienced technician. By following an organized step-by-step testing procedure in the order given here, the problem can be traced to a general area, then if necessary, each component in that area can be tested or replaced.




**STEP 1 - Pump Suction Strainer ...** Probably the trouble encountered most often is cavitation of the hydraulic pump inlet caused by restriction due to a dirt build-up on the suction strainer. This can happen on a new as well as an olde system. It produces the symptoms described above: increased pump noise, loss of high pressure and/or speed. If the strainer is not located in the pump suction line it will be found immersed below the oil level in the reservoir (point A). Some operators of hydraulic equipment never give the equipment any attention or maintenance until it fails. Under these conditions, sooner or later, the suction strainer will probably become sufficiently restricted to cause a breakdown of the whole system and damage to the pump. The suction strainer should be removed for inspection and should be cleaned before re-installation. Wire mesh strainers can best be cleaned with an air hose, blowing from inside out. They can slso be washed in a solvent which is compatible with the reservoir fluid. Kerosene may be used for strainers operatin in petroleum base hydraulic oil. Do not use gasoline or other explosive or flammable solvents. The strainer should be cleaned even though it may not appear to be dirty. Some clogging materials cannot be seen except by close inspection. If there are holes in the mesh or if there is mechanical damage, the strainer should be replaced. When reinstalling the strainer, inspect all joints for possible air leaks, particularly at union joints (points B, E, G, H, J, and K). There must be no air leaks in the suction line. Check the reservoir oil level to be sure it covers the top of the strainer by at least 3" at minimum oil level, with all cylinders extended. If it does not cover to this depth there is danger of a vortex forming which may allow air to enter the system when the pump is running.

**STEP 2 - Pump and Relief Valve ...** If cleaning the pump suction strainer does not correct the trouble, isoloate the pump and relief valve from the rest of the circuit by disconnecting at point E so that only the pump, relief valve, and pressure gauge remain in the pump circuit. Cap or plug both ends of the plumbing which was disconnected. The pump is now deadheaded into the relief valve. Start the pump and watch for pressure build-up on the gauge while tightening the adjustment on the relief valve. If full pressure can be developed, obviously the pump and relief valve are operating correctly, and the trouble is to be found further down the line. If full pressure cannot be developed in this test, continue with step 3.

**STEP 3 - Pump or Relief Valve ...** If high pressure cannot be obtained in STEP 2 by running the pump against the relief valve, further testing must be conducted to see whether the fault lies in the pump or in the relief valve. Proceed as follows: If possible, disconnect the reservoir return line from the relief valve at point H. Attach a short length of hose to the relief valve outlet. Hold the open end of this hose over the reservoir filler opening so the rate of oil flow can be observed. Start the pump and run the relief valve adjustment up and down while observing the flow through the hose. If the pump is bad, there will probably be a full stream of oil when the relief adjustment is backed off, but this flow will diminish or stop as the adjustment is increased. If a flowmeter is available, the flow can be measured and compared with the pump catalog rating. If a flowmeter is not available, the rate of flow on small pumps can be measured by discharging the hose into a bucket while timing with a watch. For example if a volume of 10 gallons is collected in 15 seconds, the pumping rate is 40 GPM, etc. If the gauge pressure does not rise above a low value, say 100 PSI, and if the volume of flow does not substantially decrease as teh relief valve adjustment is tightened, the relief valve is probably at fault and should be cleaned or replaced as instructed in STEP 5. If the oil substantially decreases as the relief valve adjustment is tightened, and if only a low or moderate pressure can be developed, this indicates trouble in the pump. Proceed to STEP 4.

**STEP 4 - Pump ...** If a full stream of oil is not obtained in STEP 3, or if the stream diminishes as the relief valve adjustment is tightened, the pump is probably at fault. Assuming that the suctino strainer has already been cleaned and the inlet plumbing has been examined for air leaks, as in STEP 1, the oil is slipping across the pumping elements inside the pump. This can mean a worn-out pump, or too high an oil temperature. High slippage in the pump will cause the pump to run considerably hotter than the oil reservoir temperature. In normal operation, with a good pump, the pump case will probably run about 20F above the reservoir temperature. If greater than this, excess slippage, caused by wear, may be the cause. check also for slipping belts, sheared shaft pin or key, broken shaft, broken coupling, or loosened set screw.

**STEP 5 - Relief Valve ...** If the test in STEP 3 has indicated the trouble to be in the relief valve, point D, the quickest remedy is to replace the valve with one known to be good. The faulty valve may later be disassembled for inspection and cleaning. Pilot-operated relief valves have small orifices which may be blocked with accumulations of dirt. Blow out all passages with an air hose and run a small wire through orifices. Check also for free movement of the spool. In a relief valve with pipe thread connections in the body, the spool may bind if pipe fittings are over-tightened. If possible, test the spool for bind before unscrewing threaded connections from the body, or screw in fittings tightly during inspection of the valve.

**STEP 6 - Cylinder ...** If the pump will deliver full pressure when operating across the relief valve in STEP 2, both pump and relief valve can be considered good, and the trouble is further downstream. The cylinder should be tested first for worn-out or defective packings by the method described in our guide "Cylinder and Valve Testing". Other Components ... Check other components such as bypass flow controls, hydraulic motors, etc. Solenoid 4-way valves of the pilot-operated type with tandem or open center spools may not have sufficient pilot pressure to shift the spool.