Hydraulic Rescue Hoist Ground Support Equipment

ZGS-10000-5

Operation and Maintenance Manual

United States Patent # 7,429,031 B1

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Before operation of the Ground Support Equipment, thoroughly review the entire manual in order to prevent damage to the wire rope, hoist, helicopter or operator.

1.0) Introduction

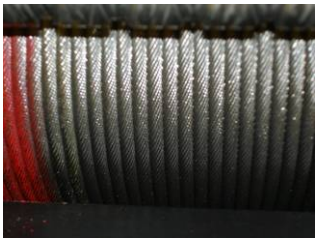
The purpose of this manual is to describe the operation and maintenance of the Zephyr International LLC Rescue Hoist Ground Support Equipment (RHGSE). Cautions are noted in Red where required.

2.0) Purpose of the Equipment

The equipment is designed to properly inspect and maintain any helicopter rescue hoist and the wire rope on the ground.

The equipment is:

- Man portable to and from the helicopter in order to perform pre and post flight checks of the wire rope and rescue hoist system.
- Allows one person to perform all inspections and maintenance operations in a minimum amount of time
- Maintains positive manual tension on the wire rope as it extends and applies a heavy load over the length as it retracts, while protecting the wire rope in a rotating tub during hoist maintenance.
- Accommodates any rescue hook and bumper configuration.
- Clean and dries the wire rope during post flight inspections after salt water use
- Lubricates the wire rope if required by the manufacturer
- Specifically designed to season and tension the wire rope without having to fly the helicopter after a complete cable inspection



Maintains clean & tight wire rope storage on the rescue hoist drum

3.0) System Description:
The Rescue Hoist Ground Support equipment consists of several subsystems that provide a complete system solution to rescue hoist wire rope maintenance. The subsystems include the following:

Mobile Frame
The mobile frame is easily transportable. It can be moved easily by one person to position under the rescue hoist next to the aircraft. It has a tow handle that can be used to tow it to the aircraft and it can be lifted via a fork lift. Do not exceed 5 mph / 8 kph when towing the RHGSE.
When not in use the tow handle should be stored in the upright position to eliminate the possibility of tripping over it.

Batteries and Charger
There are two 12 volt batteries included to provide power for the system. Each battery is a sealed Absorbed Glass Mat lead acid battery. *Absorbed Glass Mat (AGM)* batteries are the latest step in the evolution of lead-acid batteries. Instead of using a gel, an AGM uses a fiberglass like separator to hold the electrolyte in place. The physical bond between the separator fibers, the lead plates, and the container make AGMs spill-proof and the most vibration and impact resistant lead-acid batteries available today. The batteries are air transportable and sealed to eliminate leakage. Two of the batteries are used in series to provide 24 VDC to the hydraulic drive motor / pump assembly. One of the two batteries provides power for the system readouts and MagSens Assembly.
The onboard battery charger is a totally sealed computer regulated unit that monitors and charges each battery separately. The charger maintains the batteries in top condition by regulating the charging current. Powered with three-step automatic circuitry and on-board computer control, the TPRO320 shares a total of 20-amps. This unit is fully encapsulated, making it extremely vibration resistant and completely waterproof. It is designed to be connected indefinitely keeping batteries topped off and ready to go for short-term or long-term storage. The unit also features reverse polarity protection, ignition protection, and dual-color LED mode indicator lights. The system is protected by fuses in the event of a short circuit.

Back Up DC Power Adapter
The system includes a receptacle that can be used to provide 28 volts power to the take up for continuous operation or as a backup to the batteries if they are not recharged. There is a battery switch on the frame. Position 1 is for operation with the batteries, Position 2 is for operation with the backup supply. The displays use 12 volt from the inboard battery therefore, the batteries should be kept charged at all times even if the backup system is being used. Do not leave the battery switch in the Both position.

Hydrostatic Hydraulic Drive
The hydrostatic hydraulic drive consists of a 24 volt drive motor coupled to a hydraulic pump. The system uses Mil-H-5606 hydraulic fluid or other fluids such as Mil-H-83282 or general purpose AW hydraulic fluid specified by the customer.
The type of fluid is marked on the hydraulic tank and mixing of different type fluids could lead to leakage or failure of the hydraulic components.

The maximum pressure in the circuit is limited by a pressure relief valve. The system includes a hydraulic manifold that encloses the pressure relief valve and three other hydraulic valves. The manifold is coupled to a hydraulic motor which in turn drives the capstans. When the hydraulic fluid returns to the tanks it passes through a filter. The filter includes an indicator to warn when the filter needs to be replaced. When the system is used to reel off the wire rope from the rescue hoist, the hydraulic motor pulls the wire rope off the hoist as if the hoist was lowering a load. When the system is

used to reel the wire rope onto the rescue hoist, the hydraulic system creates a load on the wire rope. The load in each direction is easily adjustable.
Never actuate the rocker switch in the extend direction unless the rescue hoist wire rope has been attached to the capstans and all prerequisites for running in the extend direction have been completed. The rotating drum will spin very fast if this occurs and anything placed on the spooler will be ejected from the rotatub.

Capstans and pressure roller arms
The load is transmitted to the wire rope using two capstan drive rollers. Each roller is precisely sized to accommodate the wire rope and feed the wire rope into the rotating tub. The capstans are made from a material that maintains high friction between the wire rope and the rollers, even if the wire rope is lubricated. The capstans are covered by a hinged transparent guard. The transparent guard does not include a shut off switch. This is due to the fact that failure of such a switch or the failure to close the guard would give rise to an additional risk to the operator and the aircraft while retracting, causing the RHGSE to start to lift off the ground and imposing a high load on the rescue hoist wire rope. The capstan cover should be closed at all times while operating the RHGSE. The wire rope is held tight against the capstans by two pressure roller arms at the entry and exit tangent points where the wire rope contacts the capstans. Use care when removing the hitch pins to not impact the upper tensioner's base with your knuckles.

Lubridryer Assembly
The wire rope is cleaned, dried and can be lubricated using the Lubridryer. The Lubridryer includes replaceable pads that clean the wire and also can be used to provide lubrication to the wire rope. If the rotating tub has been filled with fresh water to wash saline residue off the cable, compressed air from the on-board air compressor is fed to the Lubridryer to dry the wire rope as it is reeled back on the rescue hoist. The Lubridryer is equipped with an oil shut off to stop the flow of oil when not in use.

MagSens ™ System
The wire rope structural integrity is measured using the MagSens head. The system requires a customer supplied lap top computer to interface with the system electronics via a USB cable to measure and record permanent records of the wire rope structural integrity. The laptop can be provided by Zephyr as an option at the time of purchase. The MagSens ™ head contains strong magnets; do not place it near computers or credit cards. People using a pacemaker should not handle the MagSens head.

- The MagSens™ rescue hoist wire rope inspection system detects indications of internal and external anomalies, that when correlated with the results of a visual inspection and upon consideration of the wire ropes history, allow the rescue hoist maintainer to determine if the wire rope should remain in service until the next inspection.

- The MagSens ™ system allows fast and efficient isolation of internal and external defects. This reduces the time and manpower required to perform rescue hoist maintenance.

- The MagSens ™ system provides objective documentation of the condition of the wire rope and the date and time the test was performed.

- The MagSens ™ system provides a method to move off of the zero defects policy in use today and scientifically track the deterioration of the wire rope until replacement is required.

Wire rope load indicator and length indicator.
The load applied to the wire rope is indicated via a digital indicator that utilizes the signal from a load cell. The length of cable in the rotating drum is indicated via a digital readout that utilizes the output signal of a magnetic encoder. The cable length indicator counts up to indicate the length of cable unreeled from the rescue hoist and down as the cable length exits the rotating drum. The readouts are for reference only.
If the battery charger is left unplugged or the system is used continuously for more then two hours the battery may dip below 8 volts, if this happens the displays will start blinking then go out completely.

If the readouts fail due to low voltage or a blown fuse the operator must use caution and visually watch the wire rope as it approaches the starting position.

Rotatub and Spooler
The wire rope is collected in a rotating tub and spooler system. The incremental length of the wire rope as it reels off and on the capstans is fixed, while the incremental length of the wire rope as it lays up in the rotatub and spooler is variable. Therefore the rotatub position is compensated during reeling in to accommodate the accumulated error in length. The rotatub can be filled with fresh water to rinse saline residuals off the wire rope. A plug is provided to drain the water. The rotatub is not enclosed and adjustment can be performed with the drum stopped. The rotatub and rescue hoist should be observed alternately when the RHGSE is in use.

Controls
The hydraulic drive system is controlled via a three position rocker switch located next to the Lubridryer. The indicators and MagSens ^{TM} system is powered via a toggle switch (Power) on the face of the control section next to the hydraulic tanks. The compressor is controlled via a toggle switch on the face of the control section. The MagSens ^{TM} system is adjusted via a potentiometer on the face of the control section.

All of the electronic components are protected by fuses. When activating the rocker switch insure the capstan covers are closed and no risk of entanglement exists for any persons in the vicinity of the RHGSE**.**

Hook Attachment Point

An eye bolt and nylon tether is included to allow applying a load to the rescue hook and the end of the cable. By lifting the front wheels of the RHGSE off the ground a 600 lbs. load is applied to the hook and cable.

4.0) Setting up the RHGSE

The equipment is shipped in a sturdy wooden box specifically designed to transport and store the RHGSE

Remove the screws from the crate where they are marked “remove”.

Remove the front panel and turn it upside down to use as a ramp to roll the GSE out of the crate.

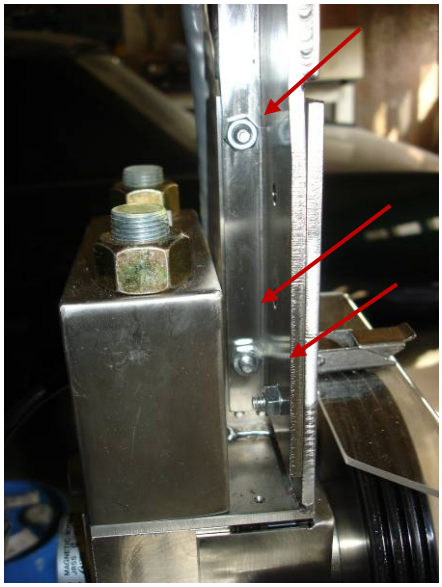
Remove the restraint piece at the base of the RHGSE

Roll the RHGSE out of the crate and down the ramp created by the front panel.

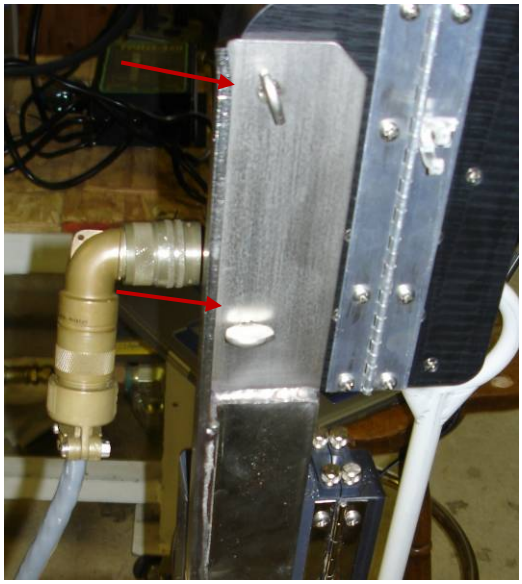
If hydraulic oil has been shipped with the unit, remove the panel and the wood restraint piece and remove the hydraulic oil from the crate.

The MagSens ™ head, Lubridryer, upright extension attaching cables and spare Lubridryer pads are inside the rotatub under the spooler. Remove them and place them to the side. Roll the GSE out of the crate and down the ramp carefully to insure the transparent capstan cover does not contact the crate or anything else.

Attach the upright extension to the upright bracket with the (3) Screws and locknuts provided.



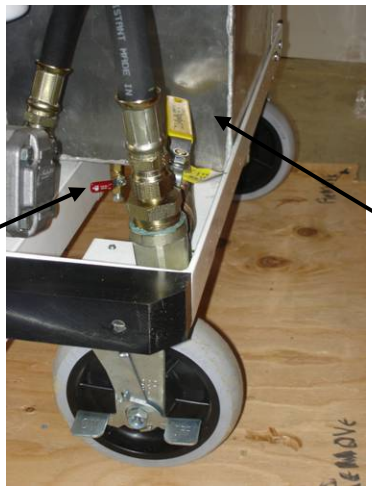
Attach the Lubridryer with (2) screws as shown, then attach the MagSens head with the (2) thumbscrews then attach the connector with the red dot at the MagSens head..



Fill the RHGSE with hydraulic oil supplied or use the specified oil. The unit has been tested with hydraulic oil specifically for the customers operation. Mixing of oil types is not recommended. Fill the tank with a minimum of 10 gallons of hydraulic oil. The hydraulic oil tank maximum capacity is 12 gallons.

Verify the drain valve is shut and the exit valve is open.

Drain Valve Shut
(Red handle)

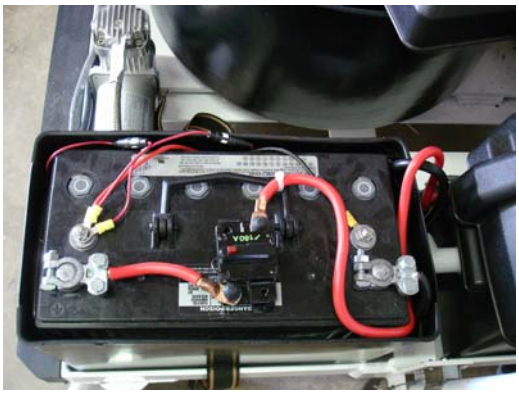


Exit valve open
(Yellow handle)

Open the outboard battery box and attach the three positive terminals to the threaded post, and the main positive terminal to the main post. Check to verify all the battery connections are tight.

Open the control section cover and attach the positive terminal to the battery.
Check the power to the indicator and control box.

Power switch



Plug the battery charger in and verify all three battery bank charging lights illuminate. It is critical the batteries be charged and maintained in the charged state as soon as possible upon uncrating the equipment.

Refer to Appendix A for the installation of the National Instruments Software. The National Instruments Software is included in the system.

Installation of the MagSens™ Software

A diskette is included with the MagSens TM system. You will need to copy the MagSens TM executable file and all the initialization files onto the lap top. First create a new folder in the C drive\ Program File and label it MagSens, then copy the entire disc to that folder. Then create another new folder in the C drive and label it MagSens Data.

5.0) Theory of Operation

The wire rope is reeled off of the helicopter hoist and is wrapped three times around the capstans and the rescue hook is positioned in a rotating tub. A spooler holds the rescue hook and establishes the starting position of the wire rope to achieve an even storage of the wire rope in the rotating tub. The wire rope is held firmly in the special grooving of the capstans by two tension roller assemblies. The tension roller assemblies are held open by hitch pins when installing and removing the wire rope from the capstans. The RHGSE is operated by using the rocker switch to select retract or extend. When the helicopter hoist is reeling out, the hydraulic pump and motor will provide a steady load and will rotate the rotatub at the speed allowed by the rescue hoist. When reeling in; the wire rope pulls against the capstans to develop torque on the hydraulic motor and develop a heavy load in the wire rope depending on the setting of the reel in load valve. A set of pads installed in the Lubridryer clean the cable, and can provide lubrication via an oil reservoir if required. When the wire rope is to be cleaned using fresh water, the tub is filled with water, and compressed air is fed to an orifice located below the Lubridryer to dry the cable as it is retracted. After the cleaning is finished the tub is easily drained via a removable plug.

If a wire rope inspection is required then a magnetic sensing system (MagSens^{TM}) inducts magnetic flux into the paramagnetic stainless steel to measure and record any defects in the wire rope. The records are then stored on a lap top computer.
The RHGSE weighs approximately 700 lbs dry and is easily transportable.

Each time the MagSens^{TM} program is used to check a cable the following general procedure is used.

1) Perform a pre-check procedure to verify the MagSens system is operating.
2) With an empty head adjust the LMA voltage level to -3.5 volts , then obtain an empty head reading
3) Then insert the rescue hoist wire rope into the head and obtain a full head reading
4) Then run the test
5) Close the test and save the data
6) Then open the test and review the results
7) Open the test information window and verify the window width for the full length of cable inspected
8) Set the window width to the full length of cable inspected
9) Set the scale to a standard value such as three volts

Inspect the data for any repeating indications

MagSens ™ Theory of Operation

Back Ground: Magnetic Flux Leakage inspection has been used for over 50 years for the purpose of wire rope inspection in deep mines and in the offshore oil industry. The MagSens™ system has been adapted from this technology for the purpose of augmenting visual inspection and providing an increased level of safety and cost effectiveness for rescue hoist maintainers. Magnetic flux leakage inspection is particularly effective when combined with visual examinations and a thorough understanding of the rescue hoist wire rope deterioration modes.

Operating Principle

The MagSens™ uses Magnetic Flux Leakage to locate defects in the rescue hoist wire rope. The device uses strong permanent magnets to create a magnetic flux circuit and Hall Effects sensors mounted to magnetic flux concentrators detect variations in the magnetic flux circuit that result from local faults (LF) or loss of magnetic area (LMA). The variations or anomalies show up as signals that are recorded and displayed on a laptop computer.
The MagSens™ signal characteristics are indicative of rescue hoist wire rope defect characteristics. However the indications or the spike size and shape may be similar for different types of defects. Using the MagSens ™ system along with a visual examination and knowledge of the history of the wire rope provides the users the ability to determine when the wire rope should be replaced.

Basic Concepts

Magnetic Flux-term used to describe the total amount of magnetic field in a given region. The term *flux* was chosen because the power of a magnet flows out of the magnet at one pole and returns to the other pole in a circulating pattern. These patterns are called lines of induction. The lines of induction originate on the north pole of the magnet and end on the south pole; their direction at any point is the direction of the magnetic field, and their density (the number of lines passing through a unit area) gives the strength of the field. Near the poles where the lines converge, the field and the force it produces are large; away from the poles where the lines diverge, the field and force are progressively weaker.

Flux Leakage- A distortion of the magnetic flux that has been introduced into a wire by a permanent magnet. Flux leakage is used to detect wire defects since flux leakage is caused by changes in the thickness of the wires (LMA) and by pits and holes or tears (LF) in the surface of the individual wires. Flux leakage distorts the magnetic-flux lines and induces a signal into the Hall Effects sensors.

Hall Effects Sensors are devices that generate a voltage based upon the strength of the magnetic field that they are placed in. Analog Hall effect sensors provide an analog signal that is proportional to the magnetic field that they are placed in. The variation the in the flux leakage is detected by Hall Effects sensors and the signal is amplified and conditioned for use in the MagSens circuitry and stored and displayed on a lap top computer.

LMA Loss of Metallic Cross Sectional Area indicates loss of cross sectional area due to external of internal corrosion, external wear due to abrasion, nicking, high pressures or poor lubrication.

LF Local Fault indicates a wide variety of external and internal discontinuities such a broken wires, corrosion pitting, internal strand nicking and abrasion, and welds of individual wires.

Paramagnetic Behavior of Cold Worked 302/304 Stainless Steel

302/304 stainless steel is non-magnetic when annealed, however the act of cold working gives it great strength and imparts magnetic properties in the hardened condition. In a rescue hoist wire rope cold work is imparted to the wires as they are drawn through dies to form the individual wires. The wires are pulled through many dies in order to reduce the wire size from about ¼ inch to .015 inches, and they are also preformed imparting additional cold work. This means that the individual wires are magnetic. This is also the basic reason the MagSensTM can detect many different types of defects in individual wires. Individual wire softening due to any cause can be detected.

Limitations- A magnetic flux leakage indication is a function of the size and type of defect in the wires of the wire rope, and the flux leakage is proportional to the size of the surface breaking defects or softening in individual wires. Surface breaking conditions on individual wires produce large variations in the magnetic flux leakage while defects such as cracks produce small variations in the magnetic flux leakage. Internal crushing and abrasion can produce heat and thus softening and indications that appear as large or larger then the more expected defects such as broken wires. Broken wires that are not separated produce almost no variation in the magnetic flux leakage until they are physically separated.

Stress is known to impact flux leakage by separating the surface defects. The MagSens^{TM} when used in conjunction with the Zephyr Ground Support Equipment measures magnetic flux leakage with the wire rope under stress and allows the easy isolation of the defect for a subsequent visual inspection.

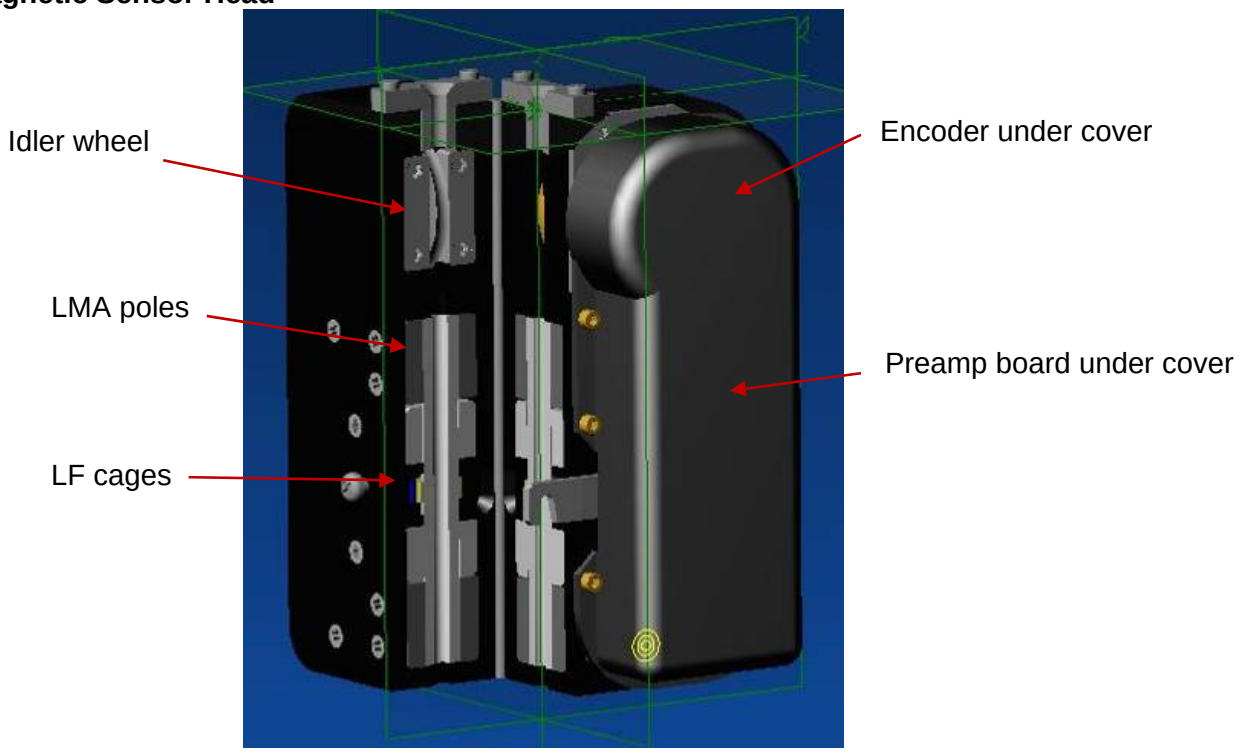
Therefore it is recommended when using the MagSens system the extending load should be set at 100 lbs and the retracting load should set at 300 lbs.

Since the Rescue Hoist Manufactures have adopted a zero defect policy based on the low safety factors the system has been designed to, the Local Fault indications are the first warning to be used to determine if a wire rope is ready for replacement. This creates the possibility for premature wire rope replacement if a welded wire is present in a wire rope and no other factors are considered.

Welded Wires – According to one wire rope manufacturer it is possible that welded wires are in strands used to form individual wire rope assemblies. The weld is a soft section of the wire due to the high temperature annealing welding produces. Therefore it is possible to get a large spike from a weld on a new wire rope. If no visual defects are noted then the wire rope assembly can be used as is and the size of the weld indication monitored over the life of the wire rope assembly.

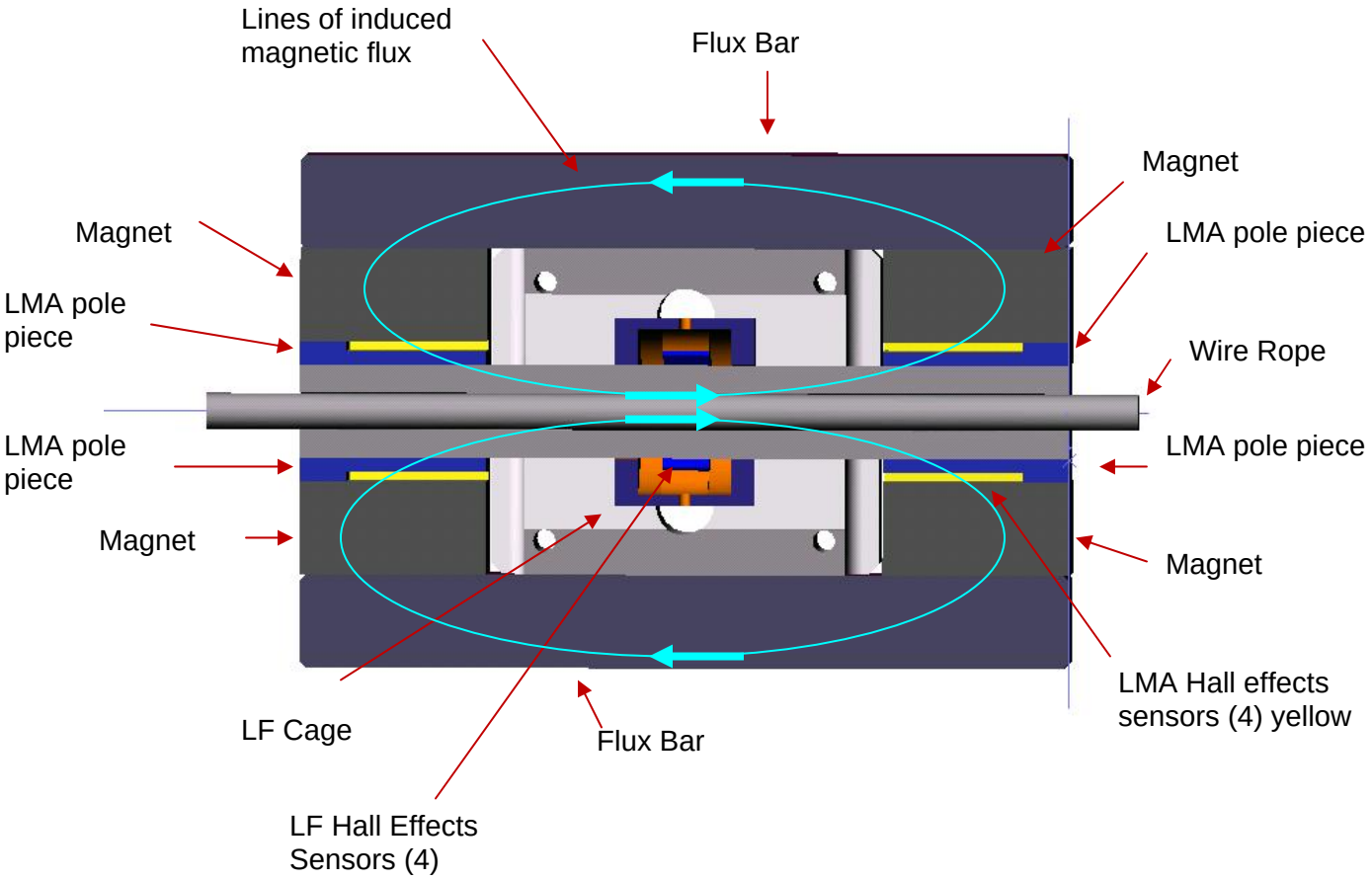
Comments on welded wire indications: Depending on the post treatment of the weld and the environmental conditions the wire rope is subjected to, the welded area may start to corrode as a result of carbide precipitation due to the heating process. Therefore the weld indication should be monitored closely over time to determine if it is increasing, and a visual inspection should be performed to identify any external signs of corrosion such as staining.

Magnetic Sensor Head



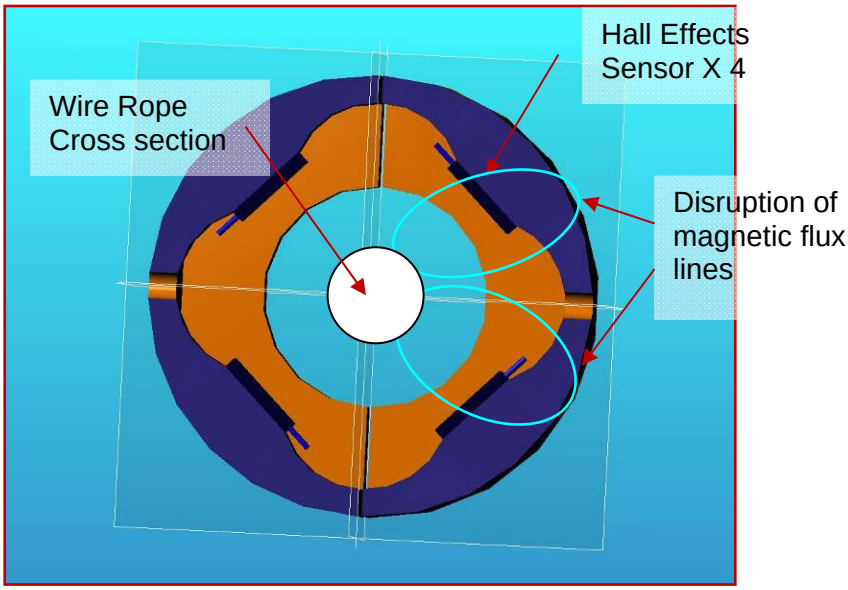
The Magnetic sensor head includes four powerful Neodymium magnets that are arranged in a magnetic circuit that is completed by two flux bars and four LMA pole pieces as shown below. The magnetic circuit is a magnetic flux path. If there is a disruption in the magnetic flux path the Local Fault cage concentrates the distortion such that the Hall Effects sensors can detect it. The Hall Effect sensors then emit a small voltage that is amplified in the preamp board and then conditioned by the signal conditioner board for use by the digital to analog converter in the DaqPad.

The cross section of the MagSens ™ head is shown below.



The main function of the MagSens ™ is the detection of local faults (LF).
The secondary function of the MagSens head is to detect changes to the cross sectional area of the cable, or the loss of metallic area (LMA).

The cross section of the LF Cage Assembly when closed is shown below



By using 4 Hall effects sensors arranged as shown the LF cage assembly is extremely sensitive to small discontinuities in the magnetic flux field in three planes.

As the local fault passes through the LF cage it sets up a north and a south poll disruption in the magnetic flux field. The Hall Effect sensor then emits a voltage variation that is proportional to the size of the defect.

However this effect is only qualitative in nature and not quantitative, i.e. we know something is there, but not exactly what it is. Therefore the system requires a visual inspection of the area in question and knowledge of the history of the wire ropes life.

The main point is the MagSens ^{TM} can detect flaws in a matter of minutes and then track them throughout the installed life of the wire rope.

6.0) Operation of the equipment

The operation of the RHGSE is simple, but proper rescue hoist maintenance requires strict attention to detail and situational awareness of the operation of the rescue hoist and the RHGSE at all times.

RHGSE operation requires:

- Attaching the wire rope to the system through the MagSens, Lubridryer around the capstans and into the Rotatub.
- Adjusting the spooler position and compensating for length error
- Operating the rescue hoist controls
- Activating the extend or retract mode rocker switch
- Activating the power switch
- Filling with water and then draining the rotating tub
- Replacing the lubricating and cleaning pads
- Activating the onboard air compressor
- Operating the MagSens ^{TM} System

Cautions:

Before operation of the Ground Support Equipment, thoroughly review the entire manual in order to prevent damage to the wire rope, hoist, helicopter or operator.

When not in use the tow handle should be stored in the upright position to eliminate the possibility of tripping over it.

The system is protected by fuses in the event of a short circuit.

The type of fluid is marked on the hydraulic tank and mixing of different type fluids could lead to leakage or failure of the hydraulic components.

Never actuate the rocker switch in the extend direction unless the rescue hoist wire rope has been attached to the capstans and all prerequisites for running in the down direction have been completed. The rotating drum will spin very fast if this occurs and anything placed on the spooler will be ejected from the rotatub.

If the motor fails to turn off while extending and the rocker switch is turned off (i.e. a stuck motor relay), the system will go into a retracting mode and the rotating drum will not turn in the extending direction. Remove the battery cover and disconnect the battery if this happens.

Use care when removing the lower tensioner pin to not hit the upper base with your knuckles.

The rotatub is not enclosed and adjustment can be performed with the drum stopped. The rotatub should be observed at all times when the RHGSE is in use.

All of the electronic components are protected by fuses. When activating the rocker switch insure the capstan covers are closed and no risk of entanglement exists for any persons in the vicinity of the RHGSE.

Never operate the RHGSE with loose clothing, jewelry, ties, long hair or anything that may become entangled with a wire rope.

Never actuate the rocker switch when the transparent capstan cover is open. The transparent guard does not include a shut off switch. This is due to the fact that failure of such a switch or the failure to close the guard would give rise to an additional risk to the operator and the aircraft while retracting with the pendant, causing the RHGSE to start to lift off the ground and imposing a high load on the rescue hoist wire rope.

Never actuate the rocker switch to the extend position with a slack wire rope.

Always observe the wire rope at all times and be prepared to stop at any time.

Always pay attention to the wire rope for indications it is approaching the full out position. In the event the full out limit switch of the rescue hoist does not stop the hoist, stop the hoist by removing the down command from the pendant.

Failure of the rescue hoist full out limit switches could cause the wire rope to come off of the rescue hoist drum. Be prepared to stop the system if that happens.

It is essential that the rocker switch be set to the correct position when reeling in, in order to prevent damage to the wire rope, or the operator. Do not actuate the rescue hoist pendant in the up direction without actuating the rocker switch to the retract direction. Running the hoist up when the rocker switch is switched to the extend direction will lift the RHGSE off the ground as a dead load and could cause damage to the wire rope, aircraft or operator.

When using the fresh water rinse the maximum retracting load should be reduced to 100 lbs.

Do not allow excessive water to enter the air cleaner at the inlet to the air compressor.

If the readouts fail due to low voltage or a blown fuse the operator must use caution and visually watch the wire rope as it approaches the starting position.

The MagSens ^{TM} head contains strong magnets; do not place it near computers or credit cards.

Failure to properly ground the helicopter may result in erroneous data or static electrical discharge.

Failure to turn the Lap Top on first then the power switch second may cause the MagSens ^{TM} system to malfunction.

Do not let the MagSens ^{TM} head spring open i.e. control it as it opens

When tightening the wire rope to remove the slack do not jerk the cable with the hoist control.

Do not activate the rocker switch to the extend position if there is any slack in the wire rope. Remove any slack with the rescue hoist first, then activate the extend switch to the extend position.

Failure to stop the hoist at or near the starting point (zero indicated cable length) will cause damage to the RHGSE and possible damage to the hoist wire rope. An alarm will sound if you run the hoist beyond the starting position indicating you should stop immediately.

Always disconnect the fitting from the main positive battery terminal before repairs of or servicing any of the moving components of the RHGSE.

The MagSens ™ can not inspect the entire length of the wire rope without disassembling the hook and bumper assembly. Therefore a careful visual inspection of the wire rope in the area of the hook attachment is required.

The MagSens ™ output can be affected by the movement of a metallic object in close proximity to the MagSens ™ head.

6.1) Installing the wire rope in the MagSens and Lubridryer

With approximately 16-25 feet (painted length) of wire rope paid out of the helicopter hoist, open the MagSens Head and the Lubridryer by flipping the latch up and opening the covers. Be careful when opening the MagSens Head to not let the cover pop open due to the force of the magnets. Position the wire rope in the MagSens and Lubridryer and close the covers and latches.

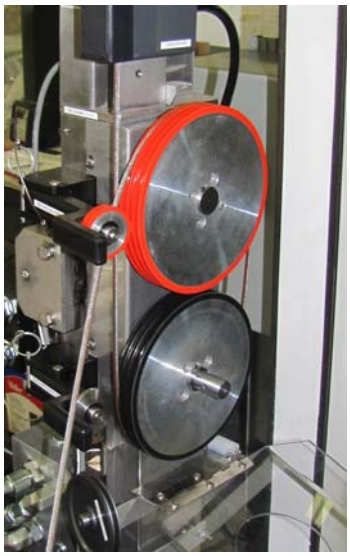
Step 1

Step 2

Step 3

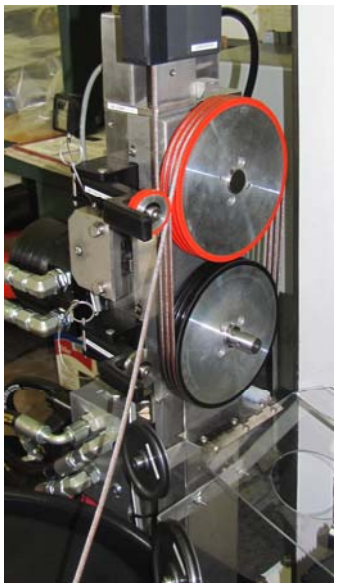
6.2) Wrapping wire rope around capstans

Wrap the wire rope around the capstans three times starting with the lower capstan innermost groove as shown:



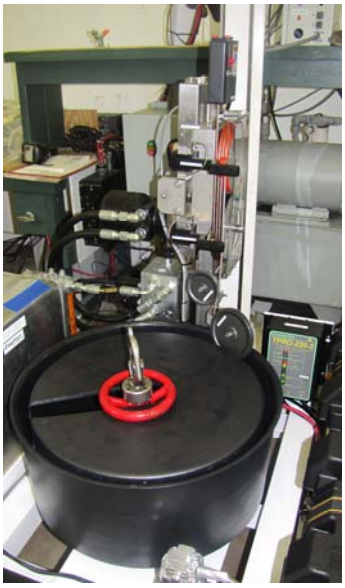
Step 4

Step 5



Step 6

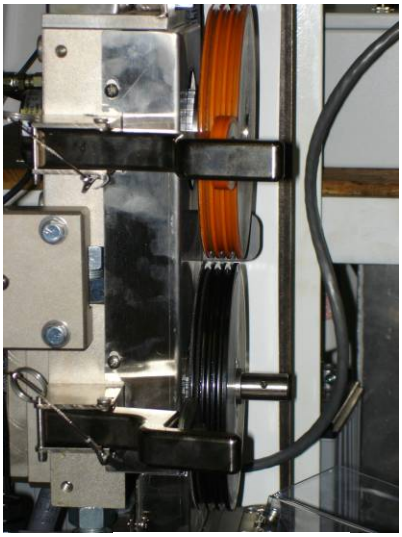
Step 7



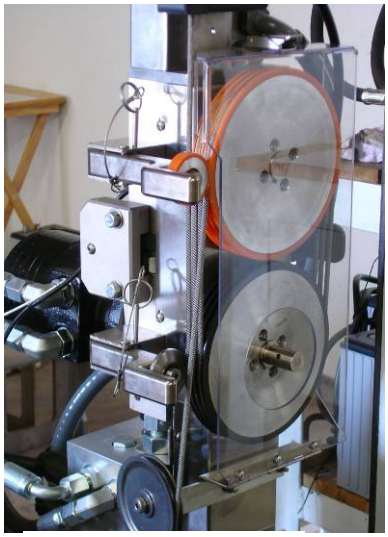
Step 8

6.3) Applying the pressure rollers

Remove the pins to apply the pressure rollers to the wire rope after it is wrapped on the capstans. Use care when removing the lower tensioner pin to not hit the upper base with your knuckles.



Open Position



Operating Position

Insert the pins into the pin storage hole in the pressure roller arm base. Give a strong tug on the wire rope to insure it is imbedded in the grooves of the capstans.
Never actuate the rocker switch when the transparent capstan cover is open**.**

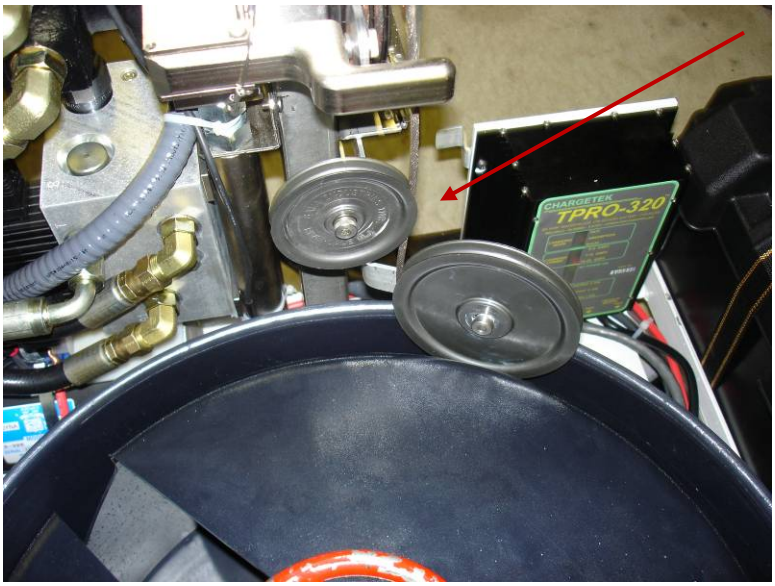
Close the transparent cover.

6.4) Setting the rotatub and spooler orientation

It is important to set the spooler orientation correctly in order to wrap the entire length of cable in the rotating tub.

The rotatub and spooler can be adjusted as required to correct the relative position of the wire rope wrapped in the rotatub versus the capstans. This provides the ability to adjust the relative wrapping of the rotatub to the capstans if required for any reason at any time.

If not enough wire rope is paid out from the rescue hoist to place the wire rope in the spooler correctly once the wire rope is wrapped on the capstans and the tensioners are applied, activate the rocker switch to extend and run the hoist in the down direction for a couple of feet and adjust the spooler as required.



Note the wire rope position. Lift and rotate the spooler to place the wire rope in the cable guide rollers and loosely wrapped into the spooler slot, while rotating the rotatub clockwise

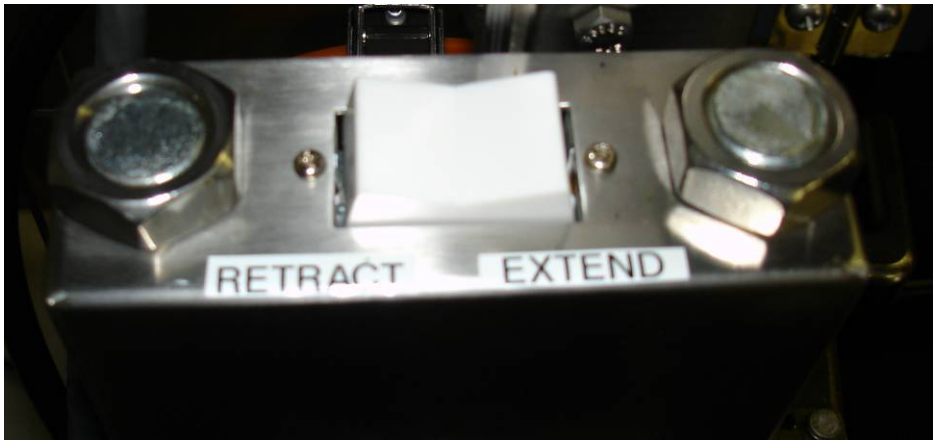
Setting the initial position of the rotatub to the wire rope in the spooler is accomplished by rotating the rotatub manually in a clock wise direction. Once the cable is completely reeled out, one can adjust the position of the drum by rotating the drum in the counter clockwise position as required to keep the cable properly positioned in the cable guide and not too tight on the spooler.

The spooler may be a tight fit in the rotatub. Once the spooler is in the starting position push it down to firmly seat it in the rotatub. Check to insure the wire rope is loosely sitting in the bottom of the grooved cutout in the spooler

6.5) Applying a reel out load to the wire rope

To run the hoist down, the wire rope must be properly wrapped around the capstans and the rotatub and spooler set in the proper relative position, the slack removed from the wire rope and the capstan transparent cover closed.
Never actuate the rocker switch to the extend position with a slack wire rope.

The hydraulic system will start and the load indicator will show the load being applied to the wire rope. Note: The load in the extend direction is set at approximately 100 lbs at the factory. The load that is indicated is for reference only and is within 10% of the actual load in the cable.



6.6) Running rescue hoist in the down direction (Extending)

Turn on the power switch, and then activate the rocker switch in the extend direction. Actuate the rescue hoist pendant to start the hoist running in the down direction. Start slowly and observe the wire rope to insure it is completely seated in the capstan grooves. Run the hoist in the down direction at a speed that allows you to observe the hoist operation. Extend the wire rope completely; always paying careful attention to the helicopter hoist and to the condition of the wire rope. If the wire rope snags in the Lubridryer pads for any reason such as a kink or a broken wire or broken strand; the wire rope will loosen between the top of the Lubridryer. In this event, the wire rope needs to be replaced; run the wire rope out into the drum and follow the manufacturer's instructions for replacing the hoist wire rope. Absent any deficiencies noted during inspection, run the hoist in the down direction until the helicopter hoist is stopped by the rescue hoist full out limit switches.

Always observe the cable as it wraps on the spooler, if the extending load is adjusted too high then excessive slipping may occur. If this happens, either reduce the load or reach down and cause the Rotatub to slip thus allowing the cable to fall to the bottom of the spooler.

Do not adjust the extending load to above 250 lbs, use 100 lbs as the nominal load while extending.

Failure of the rescue hoist full out limit switches could cause the wire rope to come off of the rescue hoist drum. Be prepared to stop the system if that happens.

6.7) Running the rescue hoist in the up direction (Retracting)

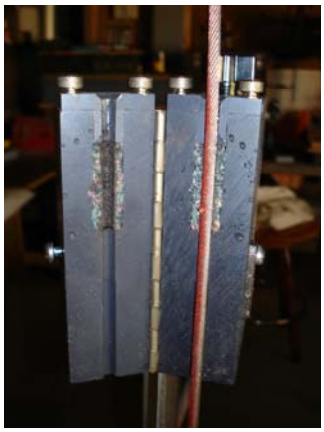
Do not actuate the rescue hoist pendant in the up direction without actuating the rocker switch to the retract direction. Running the hoist up when the rocker switch is switched to the extend direction will lift the RHGSE off the ground as a dead load and could cause damage to the wire rope, aircraft or operator.

Actuate the rocker switch to the retract direction. With the hoist control pendant run the helicopter hoist in the up direction. The wheel brakes on the RHGSE should be unlocked to allow the equipment to center itself under the hoist. Observe the wrapping of the wire rope on the rescue hoist drum. Approximately 20 feet before the wire rope is completely retracted onto the hoist drum, slow down and observe the rotatub. Stop the hoist operation when the spooler is in approximately the same position as starting and there are no more wraps in the rotatub and the counter reading approaches zero. The load can be adjusted to any value between 5 to 600 lbs.

Note: The indicated load in the retract direction is accurate within +/- 5%.

6.8) Replacement of the Lubridryer pads

The Lubridryer pads are replaced by removing the four thumbscrews, removing the bushings and removing the old Lubridryer pads and then installing new pads.

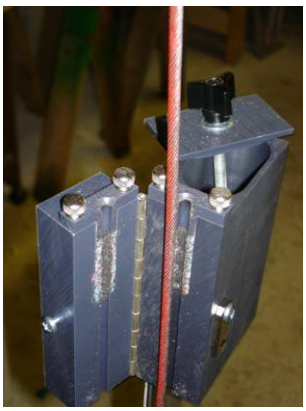


Used pads

One set of screws, bushing and pad

New pads installed

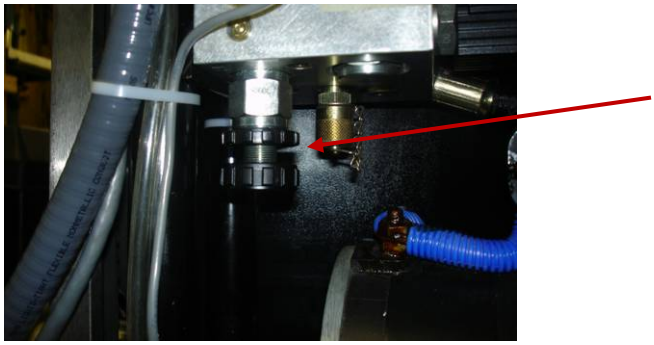
6.9) Using oil lubrication



The Lubridryer includes a reservoir that can be filled with oil. Use oil only as per the hoist manufacturer's recommendations. The reservoir is also used to store spare Lubridryer pads.
When oil is added to the reservoir it seeps through a small hole to lubricate the rear pad. The front pad should be soaked in oil before installing it. Therefore always keep a spare set of pads in the reservoir of oil to use as the next set. Wipe excess oil off of the frame and use a clean cloth to keep the oil off of the capstans when the RHGSE is not in use. Close the red tee handle to prevent oil flow when not in use.

6.10) Adjusting the retracting load

The reel in load is adjusted by turning the adjustment knob on the lower pressure relief valve. To increase the load, turn the knob clockwise when looking up at the knob or counterclockwise from a standing position.

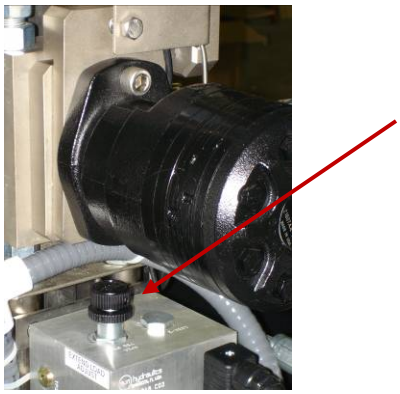


Never try to adjust the retracting load while retracting the wire rope at a very slow speed. This will lead to cogging of the hydraulic motor and an inaccurate adjustment. Obtain a moderate steady speed then make the adjustment while maintaining that speed.

Normally a load of 200 lbs is sufficient to insure a tight set of wraps on the hoist drum. The only time a load as high as 600 lbs is required is when conditioning a cable after is has been installed.

6.11) Adjusting the extending load

The extending load is adjusted by turning the knob on the upper pressure relief valve. To increase the load, turn the knob clockwise.



Extending load adjustment knob

Note: The maximum load in the down direction is approximately 250 lbs, However to prevent excessive slippage it is recommended to limit the load in the down direction to 100 lbs unless required to troubleshoot the hoist

Always observe the cable as it wraps on the spooler, if the extending load is adjusted too high then excessive slipping may occur. If this happens, either reduce the load or reach down and cause the Rotatub to slip thus allowing the cable to fall to the bottom of the spooler.

6.12) Using fresh water wash

When using the fresh water rinse the maximum retracting load should be reduced to 100 lbs.

In order to flush away saline residuals after salt water exposure, fill the rotating tub ¾ of the way with fresh water and extend the wire rope all the way down. Using a hose rinse off the helicopter hoist and the wire rope between the helicopter hoist and the rotatub. Turn on the air compressor switch and carefully observe the wire rope at all times on the capstans. Retract the entire wire rope out of the rotatub, and remove the plug at the bottom.

Drain plug

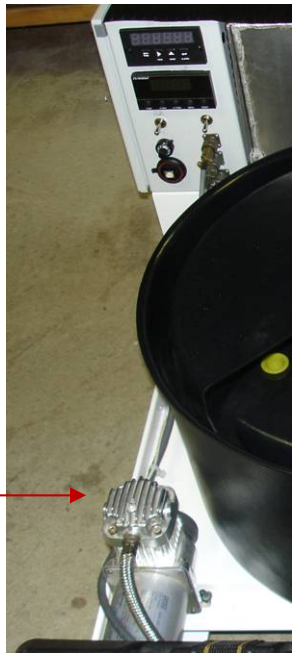
When using the GSE to rinse saline residuals off the cable it is recommended to run the cable out into the Rotatub full of water then change the Lubridryer pads. Then run the cable back onto the hoist using compressed air to dry the cable. After the cycle is complete the Lubridryer pads full of saline residuals should be removed and discarded.

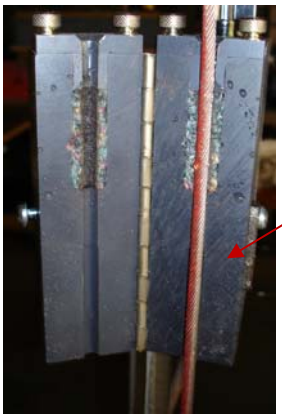
6.13) Using the Dryer

After extending the wire rope into the rotatub and after it has been filled with water, actuate the rocker switch in the retract direction and run the rescue hoist in the up direction. Compressed air will force the majority of the water off the cable prior to leaving the Lubridryer.

Compressor switch

Compressor



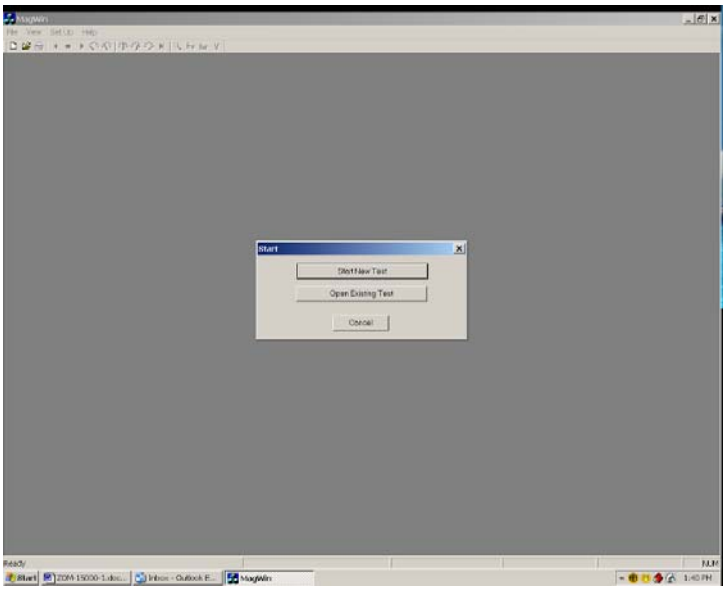


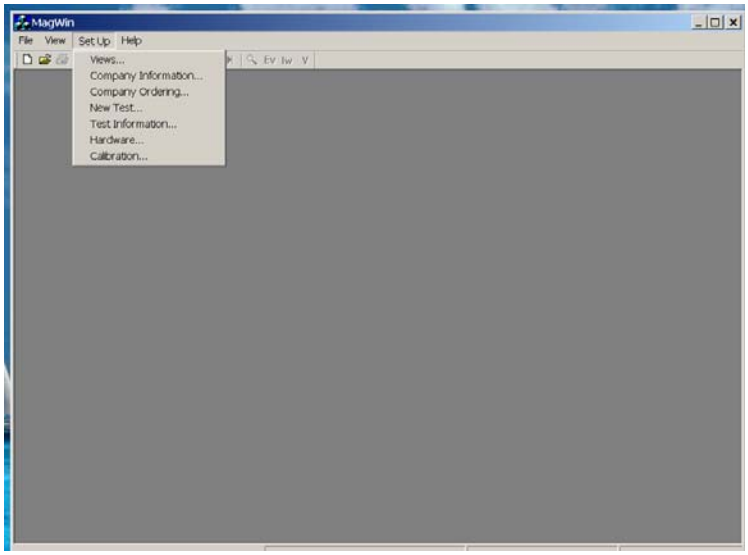
Air exit point

Do not allow excessive water to enter the air cleaner at the inlet to the air compressor.

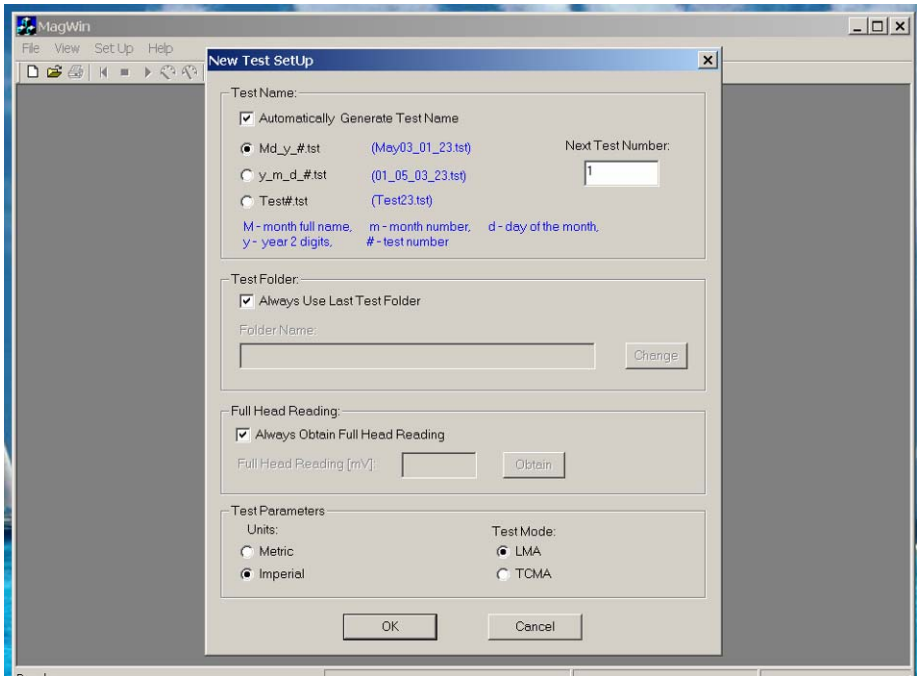
6.14) MagSens ™ Operating Procedure

MagSens ™ Software Description
When you first start the MagSensTM program you will see the startup screen. From this point you can start a new test, review existing test data or setup a new test numbering sequence. To start a new test or view existing test data, you will click on the appropriate box. To setup a new test numbering sequence click on cancel, then move the cursor over the Set Up Menu box. When the Set Up dialogue box opens you will see many options. Because the MagSens has been adapted to the rescue hoist inspection task there are many setup options that you will not need and others that should not be changed.



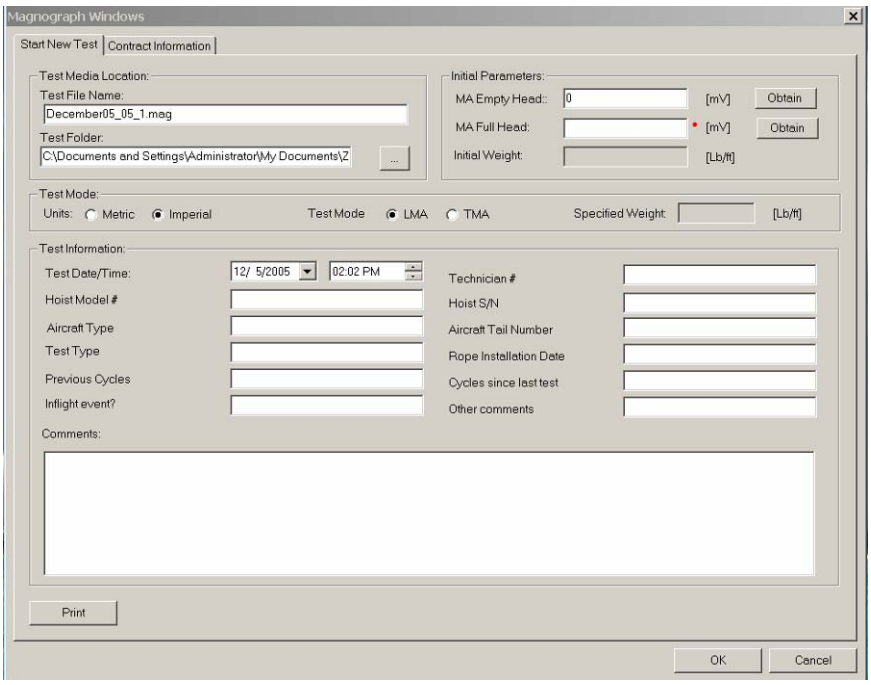


The only setup information that should be changed from time to time is the New Test box.

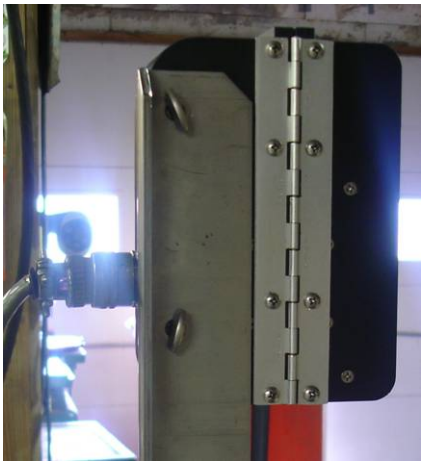


You have the options of selecting the way the data files are named and what the next test number is. Once the next test number is selected the program will automatically increment the test data file name by one for each test performed. You also can select Metric or Imperial units. If you want to send the data to a different folder, you can uncheck the “Always Use Last Test Folder” and then specify where the next data file should be stored.

When you start a new test the Start New Test Data Entry Screen appears.



In this screen you should enter data relevant to the test you are about to perform. The hoist type and s/n, and the aircraft tail number and date provide a way to track each wire rope individually in the event multiple aircraft and multiple hoists are monitored with the MagSens TM system.



If the MagSens Head is not already attached to the upright bracket attach it with two 5/16 thumbscrews.

Caution- The MagSens head contains strong permanent magnets. Do not place it near the laptop computer or near credit cards as the strong magnetic field will erase any data on these devises. People with pacemakers should not handle the MagSens head.

Attach the MagSens Head cable with the red dot at the MagSens Head.

Place the lap top computer (optional equipment or customer supplied) on the RHGSE as shown. Attach the USB cable to the laptop.

To insure the best data capture the Lap top battery charger and the onboard battery charger should be disconnected with the respective batteries fully charged.

Failure to properly ground the helicopter may result in erroneous data or static electrical discharge.

Install wire rope as per section 6.1 through 6.4

Position the RHGSE so that with the wire rope installed it does not create a large fleet angle with the hoist. Tighten the wire rope carefully between the hoist and the RHGSE.

Then pay out enough cable to allow opening the head and removing the cable.
Open MagSens TM Head while holding the cover so that it does not spring open.

Do not let the MagSens TM head spring open i.e. control it as it opens

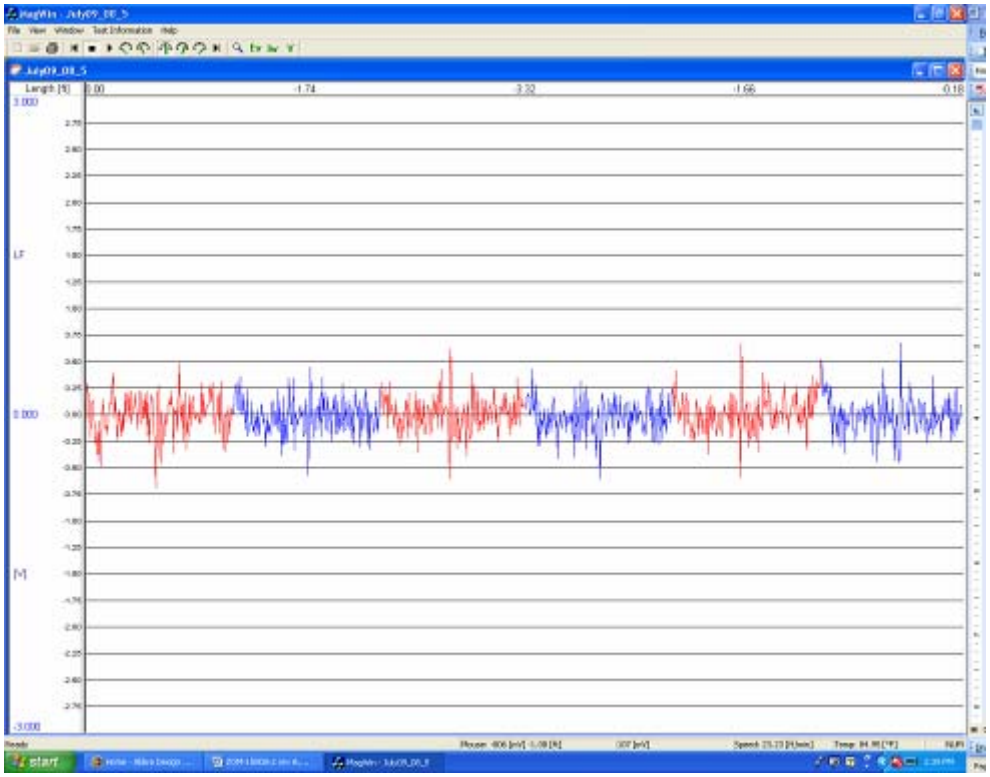
The following general procedure is used to check the cable.
1) Perform a pre-check procedure to verify the MagSens system is operating.
2) With an empty head adjust the LMA voltage level to -3.5 volts , then obtain an empty head
3) Then insert the rescue hoist wire rope into the head and obtain a full head reading
4) Then run the test

Turn on the laptop first then turn on the control section power switch. You should hear the ding-dong of the USB interface. Allow the system to warm up for 5 minutes.

Failure to turn the Lap Top on first then the power switch second may cause the MagSens ™ system to malfunction.

Pre-check Procedure:

1) Start the Lap top and let it boot up
2) Turn on the control section and let it warm up at least 5 minutes to stabilize the LMA signal
3) Start the MagSens program and start a new test
4) With no rescue hoist cable in the head obtain an empty head reading while adjusting the potentiometer to -3.5 Volts
5) Place a 4 feet long section of wire rope that has one broken wire and a gap of .08 to .1 inch into the MagSens head.
6) Obtain a full head reading
7) Click on OK and start pulling the test piece through the head
8) Pull it through completely and then reverse the direction and pull it through the opposite direction
9) Reverse direction multiple times
10) Verify the system is operating by observing the indication caused by the broken wire gap. The indication should look similar to the trace shown below, with the average value being approximately +/-.25 volts and a peak occurring at the point where the defect is located. See the notes below.
11) Close the test
12) Then start a new test and check the rescue cable.



Notes:
1) The average value of the signal is about +/-.25 Volts and the peak due to the broken wire is approximately .5 to .7volts depending on direction of travel.
2) The actual size and shape of the peak may vary each time the direction is reversed.

Head Adjustment Knob

Rescue Hoist Cable Inspection Procedure

Failure to properly ground the helicopter may result in erroneous data or static electrical discharge.
Do not install a separate ground to the GSE or MagSens, the ground is through the rescue hoist cable.

Turn on the laptop first and let it boot up, then turn on the control section power switch. You should hear the ding-dong of the USB interface. Allow the system to warm up for 5 minutes.

Failure to turn the Lap Top on first then the Indicator switch second may cause the MagSens ™ system to malfunction.

Install the rescue hoist wire rope around the capstans and insert the cable into the GSE as per the procedures.

Then pay out a little slack so that the Magsens head can be closed without the rescue hoist wire rope in it to obtain an empty head reading. Adjust the potentiometer on the control section panel to obtain an empty head reading of -3.5 volts. .

Open the head and insert the rescue hoist wire rope. Open the head carefully and do not let it spring open.

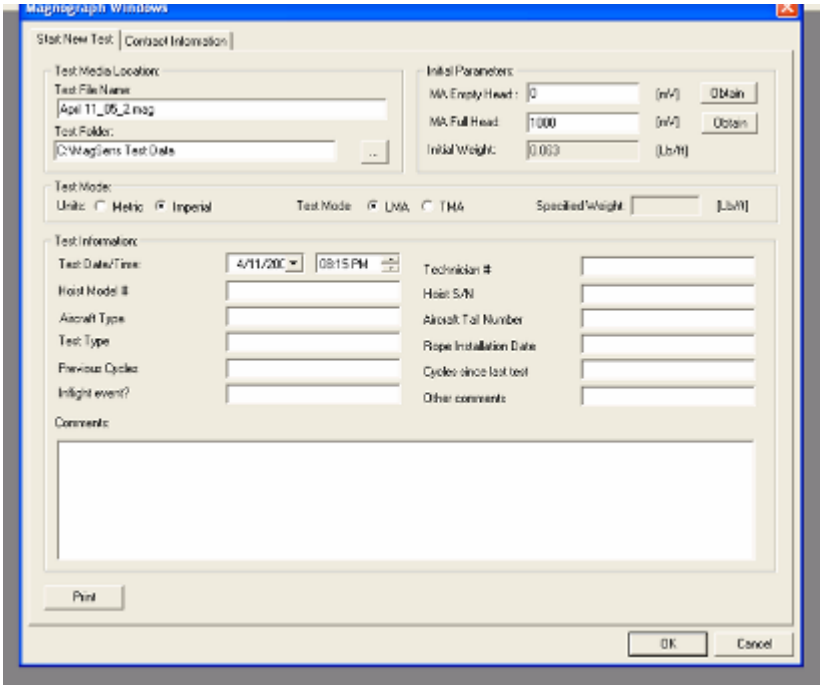
Tighten the rescue hoist wire rope with the hoist on the aircraft very slowly and carefully. When tightening the wire rope to remove the slack do not jerk the cable with the hoist control.

Position the RHGSE so that with the rescue hoist wire rope installed it does not create a large fleet angle with the hoist. Tighten the wire rope carefully between the hoist and the RHGSE.

Then obtain the full head reading. Do not readjust the potentiometer during this step.

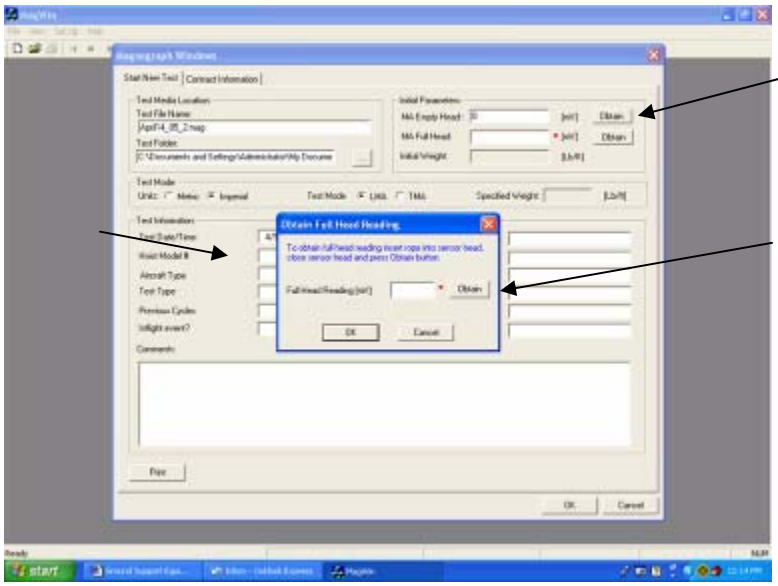
Starting a New Test

Open the MagSens program and Click on Start a new test.
The Data Entry Screen will appear.



With an empty head click on obtain and when the empty head obtain box opens click on obtain . In a few second a reading should appear in the box. Adjust the potentiometer on the control box and click on obtain again until a reading of approximately -3.5 volts is obtained, then click on OK to store the empty head reading.

Head Adjustment Knob

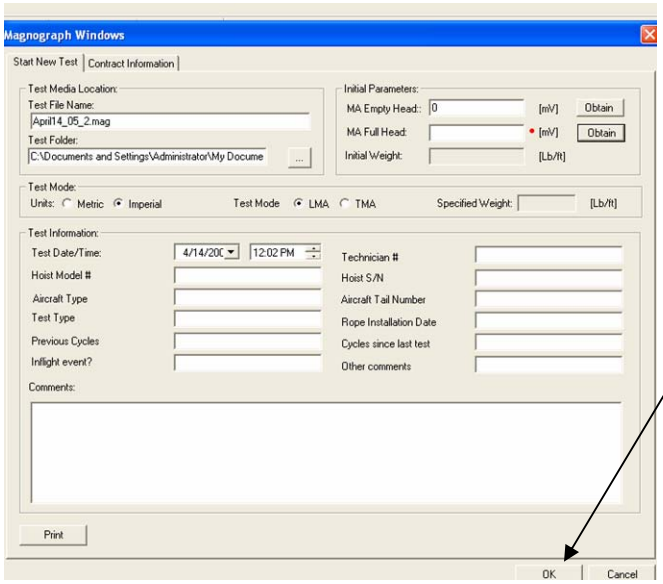


Open the head and insert the rescue hoist wire rope. Open the head carefully and do not let it spring open.

Tighten the rescue hoist wire rope with the hoist on the aircraft very slowly and carefully. When tightening the rescue hoist wire rope to remove the slack do not jerk the cable with the hoist control.

Obtain full head reading;
Click on Obtain Reading button. The Obtain Reading Dialog Box will open and then click on Obtain Reading.

Click on OK to save the full head reading.
Enter all other relevant test record information, or the information can be added later if desired.



Click on OK to start test

Activate rocker switch to the extend position and unreel the wire rope off of the rescue hoist.

Do not activate the rocker switch to the extend position if there is any slack in the wire rope. Remove any slack with the rescue hoist first, then activate the extend switch to the extend position.

Using the hoist pendant control run the hoist in the down direction at a steady speed while observing the rescue hoist and cable until the full out switch stops the hoist.
As the hoist pays out the wire rope the trace should begin moving across the screen. Extend the wire rope at a steady speed that allows visual inspection of the cable as it extends. If obvious defects such as kinks or broken strands are observed. Terminate the test and replace the wire rope.

Activate the rocker switch to the off position

Activate the rocker switch to the retract position, and using the hoist pendant control run the hoist in the up direction at a steady speed until the cable length indicator reads zero feet. As the hoist reels the
cable up the trace should start again in Red (or any other color chosen). Any defects noted in the extend trace should appear in the reverse mode during the retracting trace.

Failure to stop the hoist at or near the starting point (zero indicated cable length) will cause damage to the GSE and possible damage to the hoist wire rope. An alarm will sound if you run the hoist beyond the starting position indicating you should stop immediately.

If anomalies are observed verify the defect by running the cable back to the indicated location and verify the defect either visually or by feel. If no visible defect is noted then measure the diameter of the cable carefully in the area indicated. If no defects are found then make a note on the test data comments field for future inspection reference. i.e a possible internal wire has broken or is close to breaking and may show up on future inspections.

If defects are verified, remove and replace the wire rope as per manufacturer's instructions.

6.15) Removing the wire rope from the RHGSE and check the remaining length of cable.

To check the remainder of the wire rope, leave the test open and remove the wire rope from the capstans, do not open the MagSens ^{TM} head yet.

Removal of the wire rope is the reverse of the installation procedure.
Open the transparent cover.

Caution: Do not actuate the rocker switch with the transparent cover open.

Remove the hitch pins from their storage hole and rotate the pressure roller assemblies away from the capstans and reinstall the hitch pins to hold the pressure wheel off the wire rope. Unwrap the wire rope from the capstans and carefully remove the twist by lifting the hook out of the spooler slot and placing it hook facing down into the slot.

Lay the wire rope out neatly away from the helicopter to avoid touching anything as it is retracted.

Carefully retract the remaining wire rope onto the helicopter hoist being careful not to catch the wire rope on the RHGSE or anything else. As the rope runs through the MagSens ™ Head it will be checked for internal anomalies.
Stop when the hook is within two feet of the head.

Pull the remaining cable through the MagSens ™ head by hand.

Remove the wire rope from the MagSens ™ Head.

Carefully inspect the wire rope termination at the area not inspected by the MagSens ™.

Store the hook fully as per the manufacturers' instructions.

6.16 Closing the MagSens Inspection Software

Close the file by clicking on the Close Button under the File Dialog Box. Close the MagSens Software then turn off the power switch on the control section box.

Caution: Do not turn off the power switch on the control section with the MagSens Software still running. Doing so will cause a fatal error and the Laptop will require rebooting.

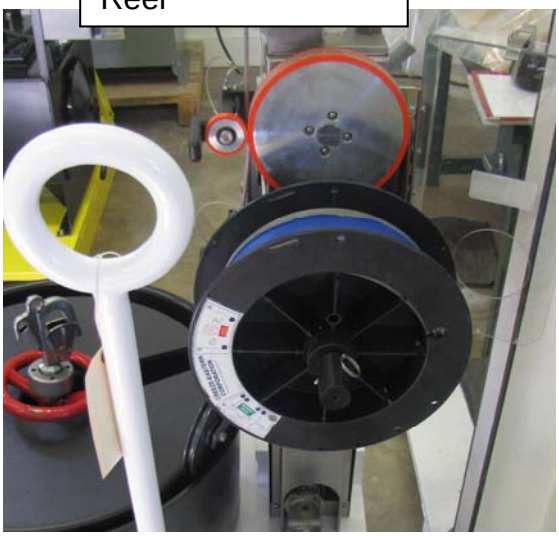
6.17 Hook Attachment Check

A nylon strap and eyebolt is available to attach the rescue hook to in order to perform the hook load test.
When the front wheels of the RHGSE come off the ground there will be a 600 lbs. load on the hook and cable end.

6.18) Installing a new wire rope with the cable reel extension

The RHGSE has the ability to attach the wire rope shipping reel in order to facilitate installation of a new wire rope.
Attach the ZGS-10454-1 Cable Reel Extension with its pin as shown.
Slide the shipping reel on the extension and attach the wire rope following the OEMs instructions. The adapter can be used with both major OEM's cable shipping reels.

Goodrich Cable Reel



Breeze Cable Reel

Once the wire rope is completely on the rescue hoist, remove the cable reel and cable reel extension and run the wire rope on and off the hoist onto the RHGSE three or four times while increasing the load incrementally on each cycle in order to condition the wire rope.

Conditioning a new Wire Rope

RH cable conditioning is the process of acclimating the newly installed cable to the smaller diameter of the rescue hoist drum.

It is only required for new cables and is not effective at salvaging cables that do not meet the Mil-Spec and have loose outer strands. The loose strands may disappear temporarily but will soon return as soon as the cable is extended with no load on it.

Cable conditioning should be done with a low load and at slow speed, while gradually increasing the load up to the rated load.

Always extend with a low load of approximately 100 lbs. and at a max speed of 100 feet per minute in either direction

Perform 3 cycles

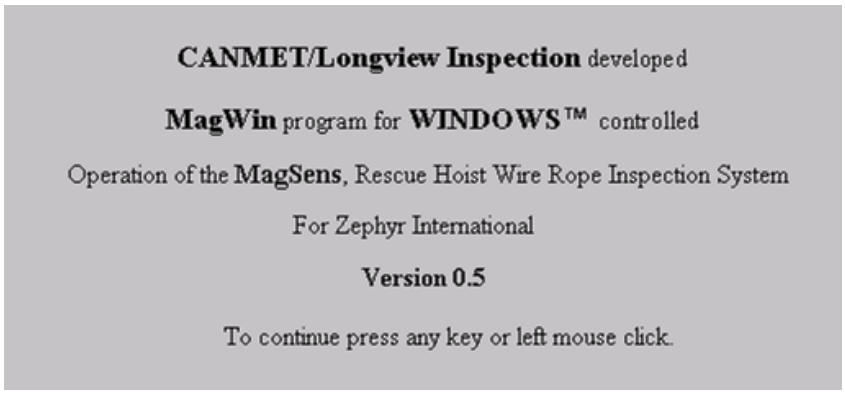
Extend at 100 lbs. then retract the cable at 100 lbs., then 200 lbs., then 300 lbs.

Then during the next flight extend the cable to full extension and retract under approximately 200 lbs. load. This procedure is considered the best practice.

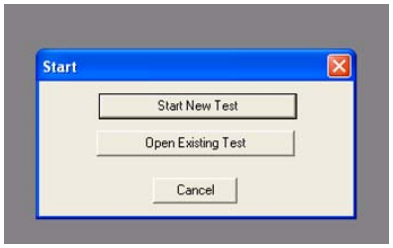
7.0) Analyzing the MagSens Results

Use the following screen guide to see the options available to view the MagSens data.

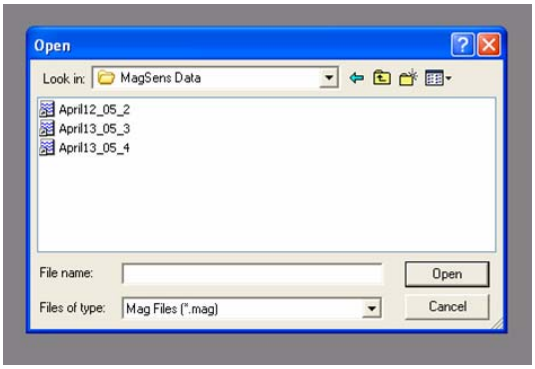
Opening Screen



Start Screen

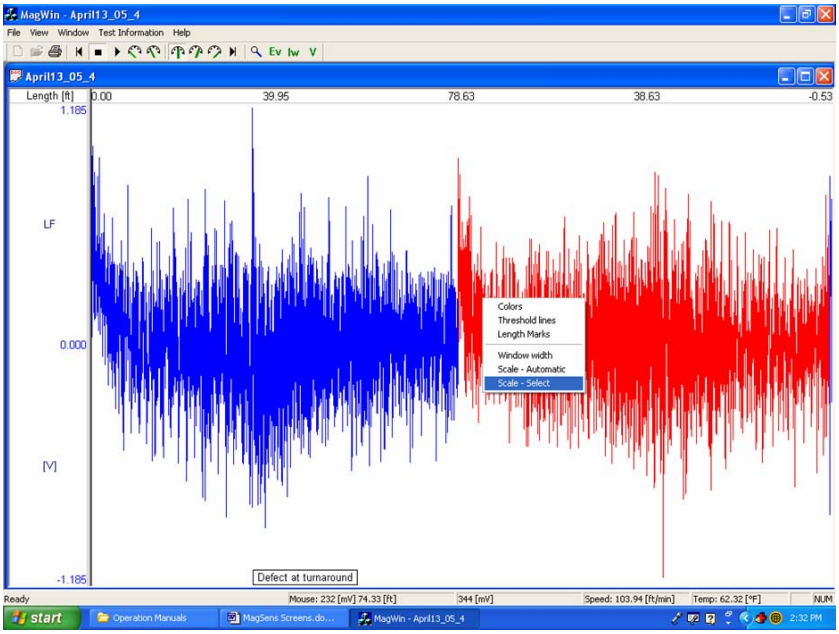


Open existing test screen

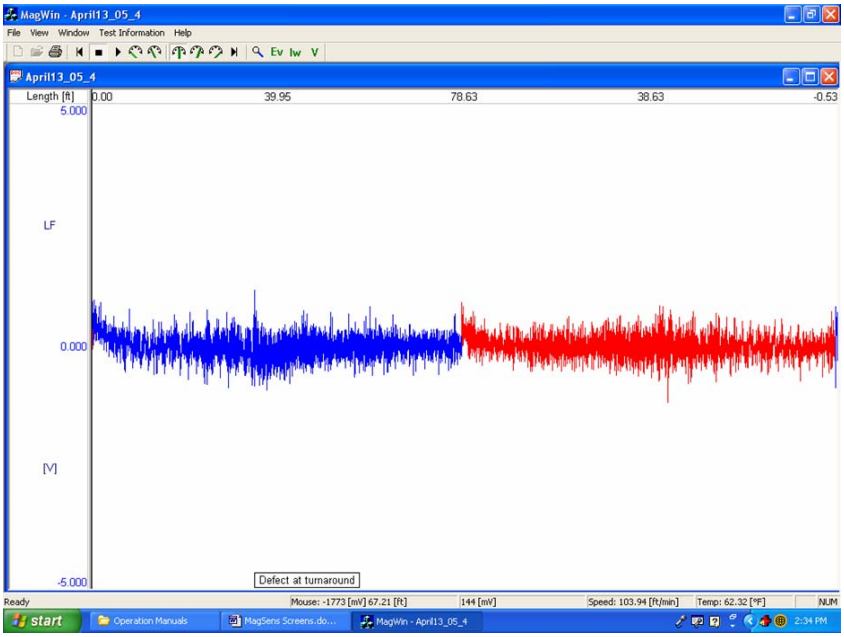


Select a test data file to be viewed.

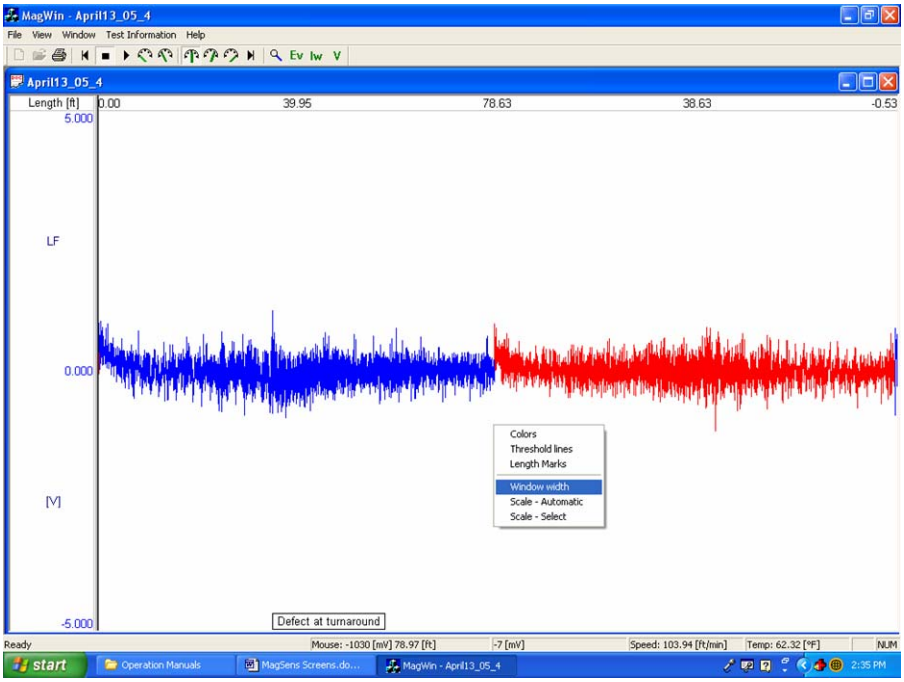
Adjust the scale



Set scale to 5 volts as an example

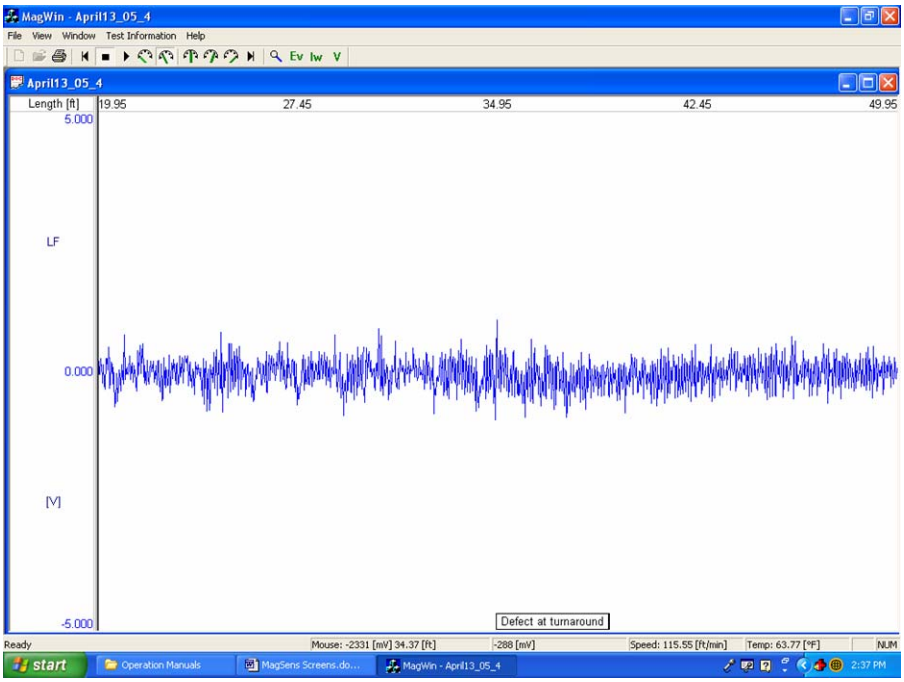


Adjust the window width

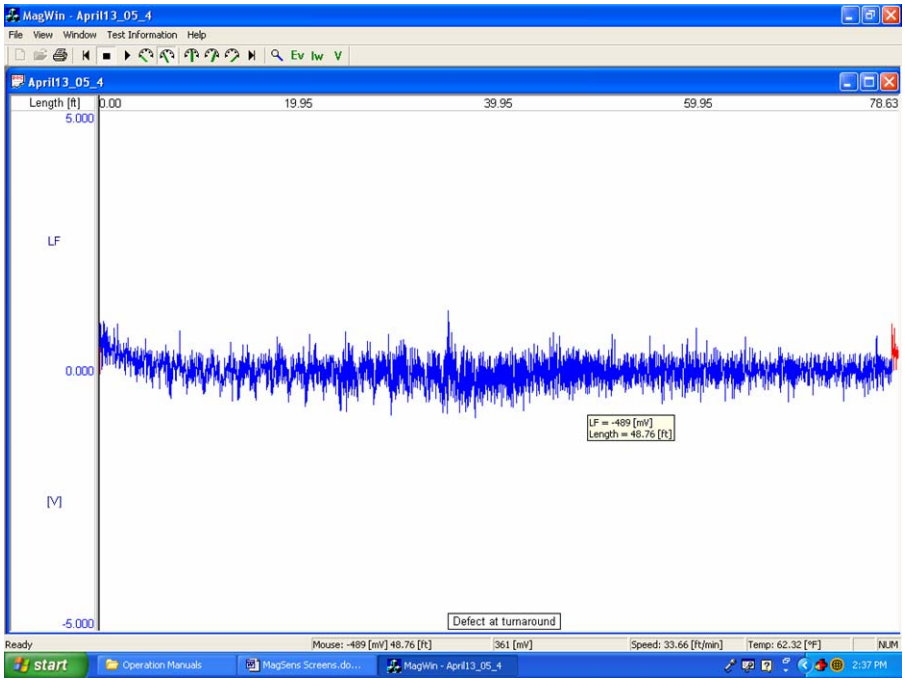


Try different values to get used to the system.

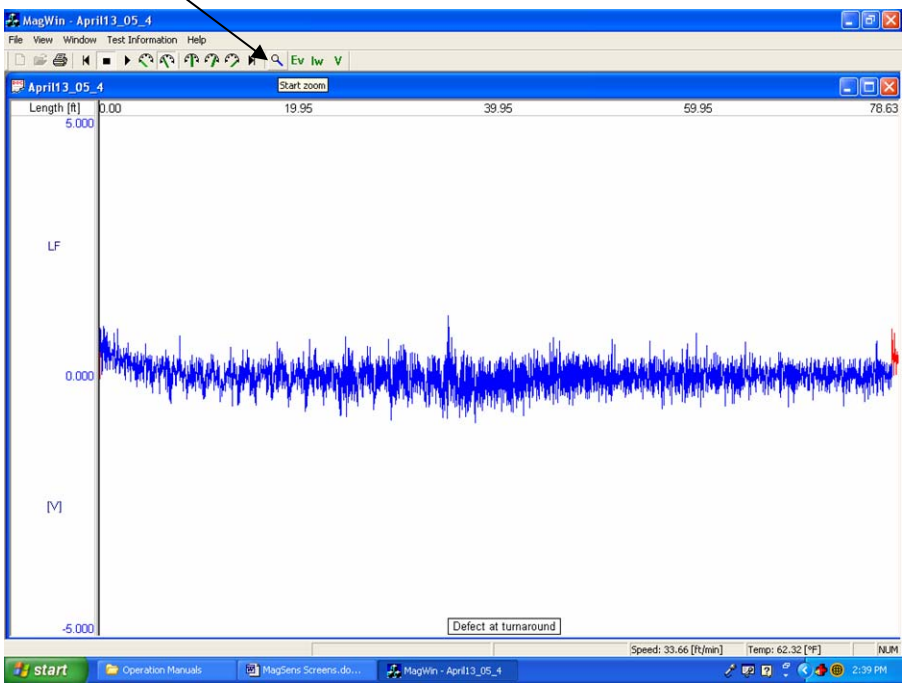
Set 30 feet



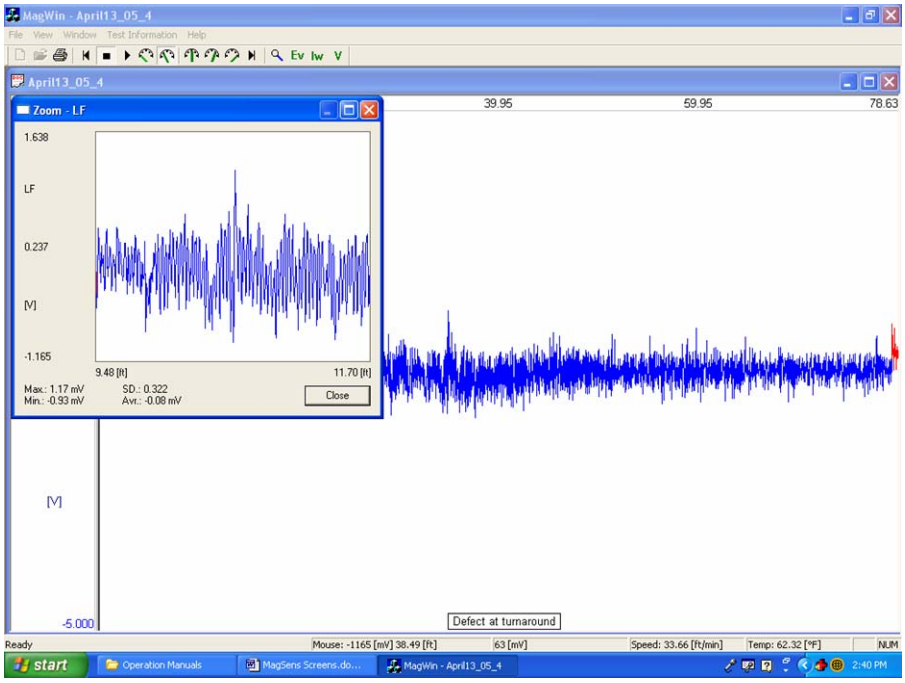
Set 80 feet



Use the zoom command

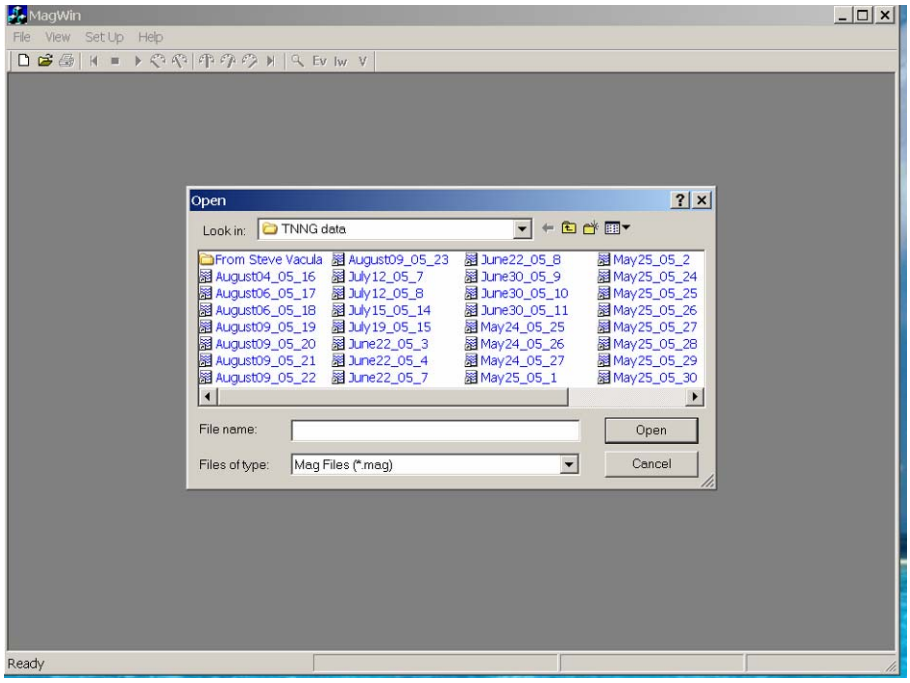


Zoom the defect

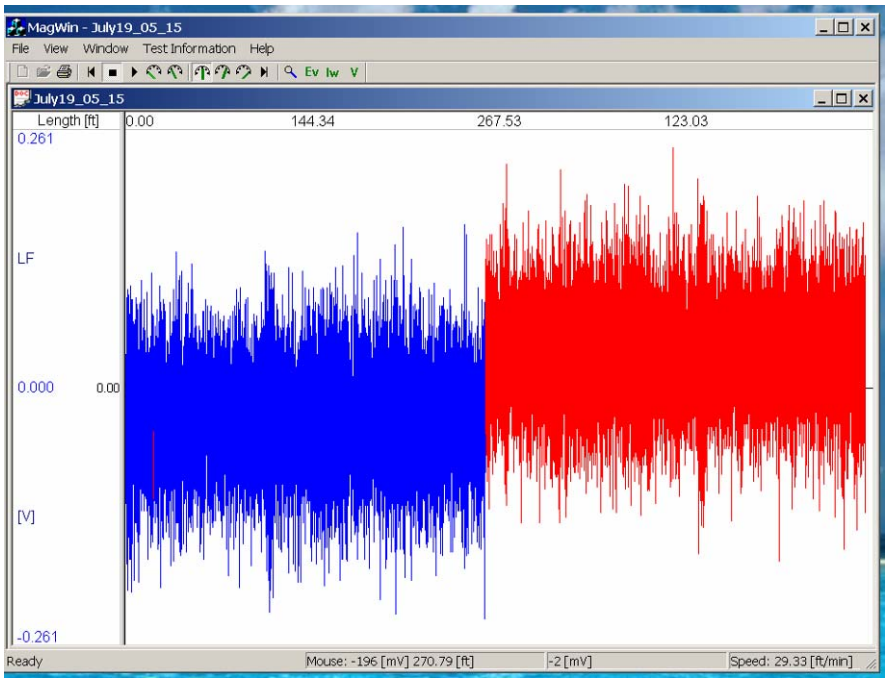


To analyze the date perform the following steps

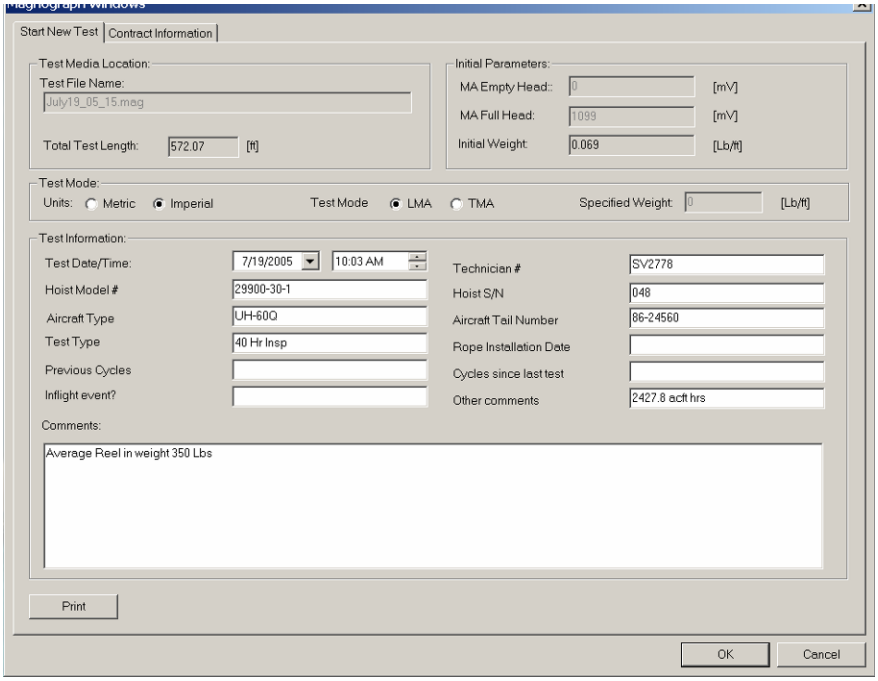
Select the test data to be viewed.



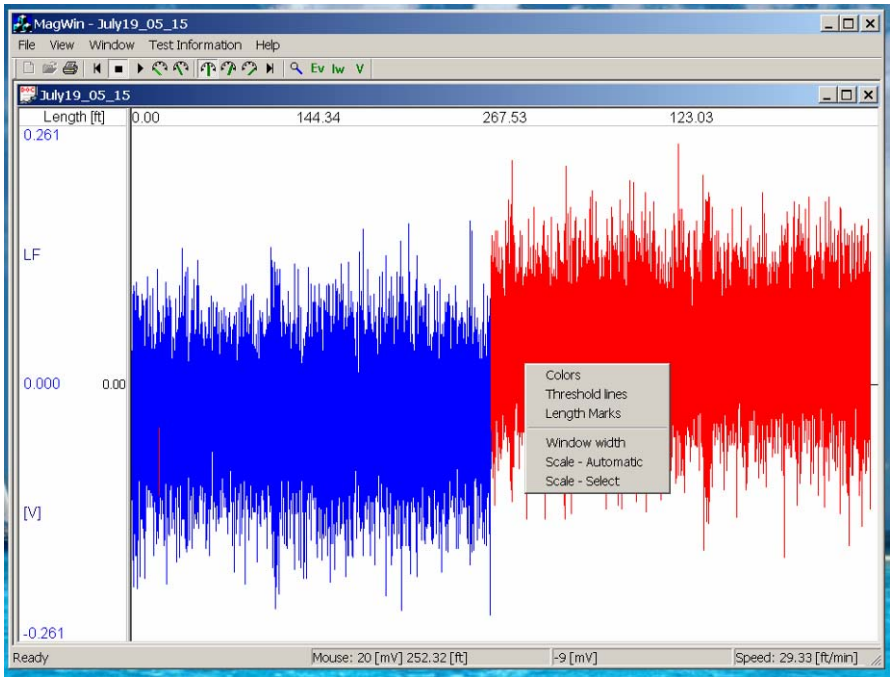
The test record will open and the entire test will be shown. The system selects a scale based on the maximum voltage it recorded. You must now set the window width (length of the test) and the scale that you want to view the data at.



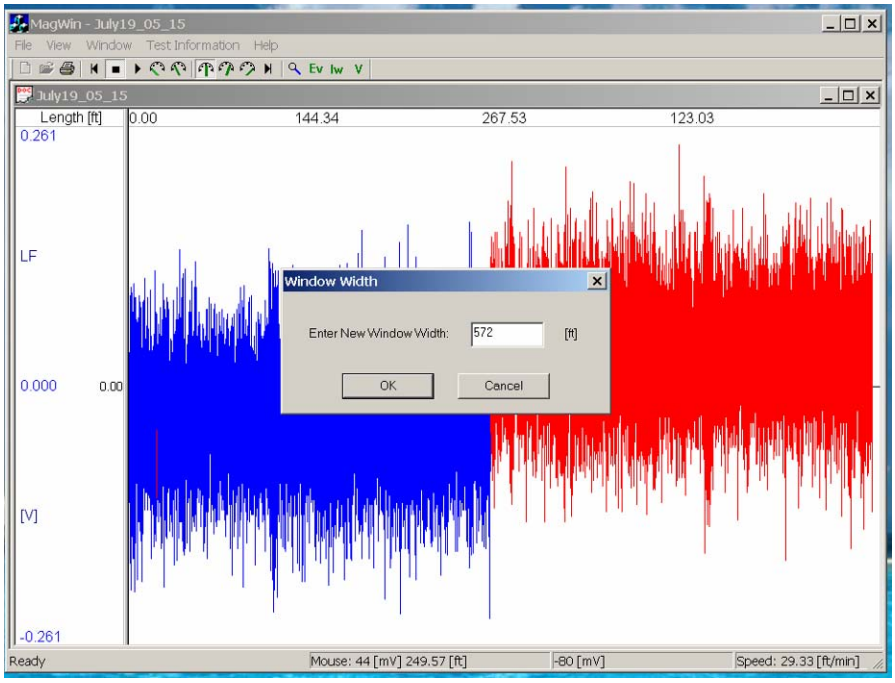
Next click on Test Information the following screen appears.



Here the total test length was 572 feet, click on OK, then right click on the image.

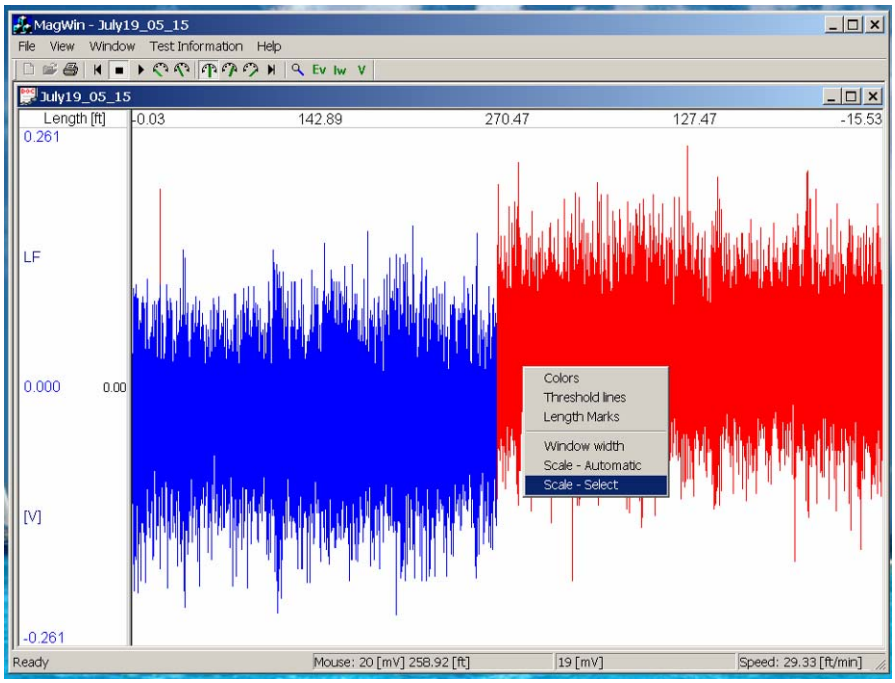


Select Window Width and enter the length of the test you wish to view, in the case 572 feet.

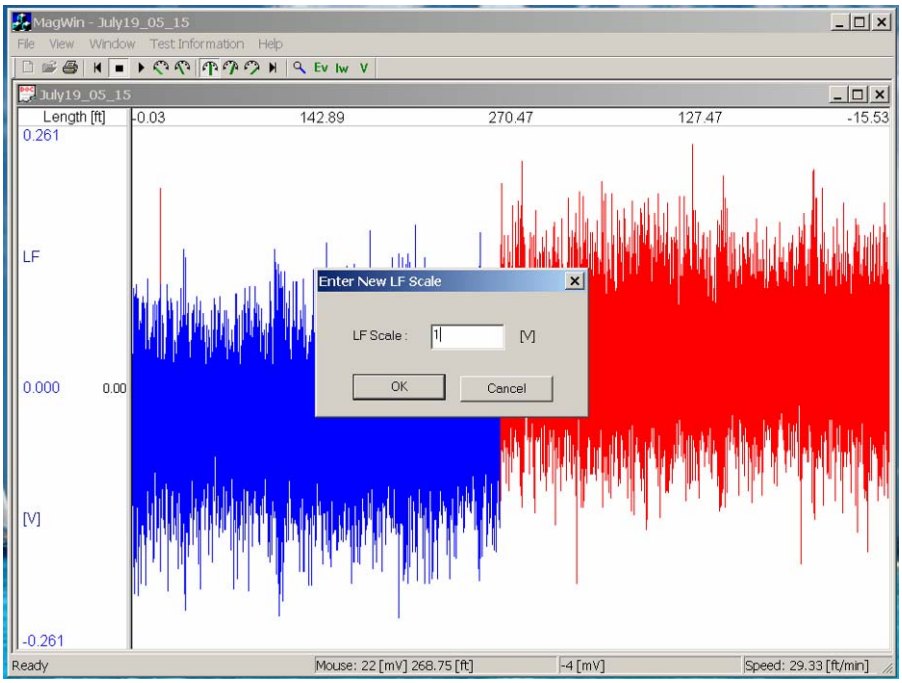


Then click on OK

Next select Scale Select

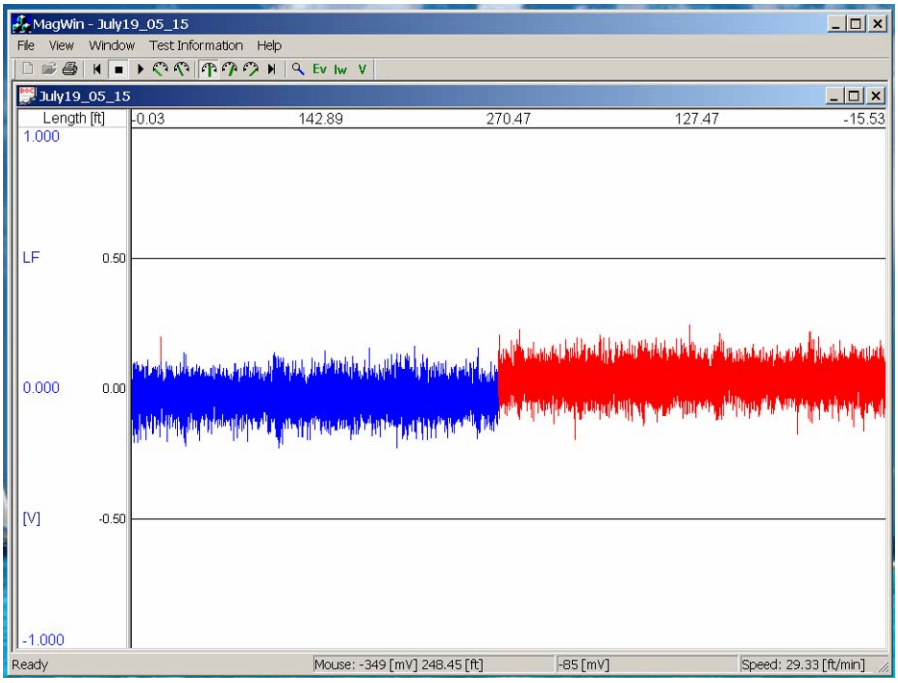


Enter the scale you would like to use, in the case 1 [V].

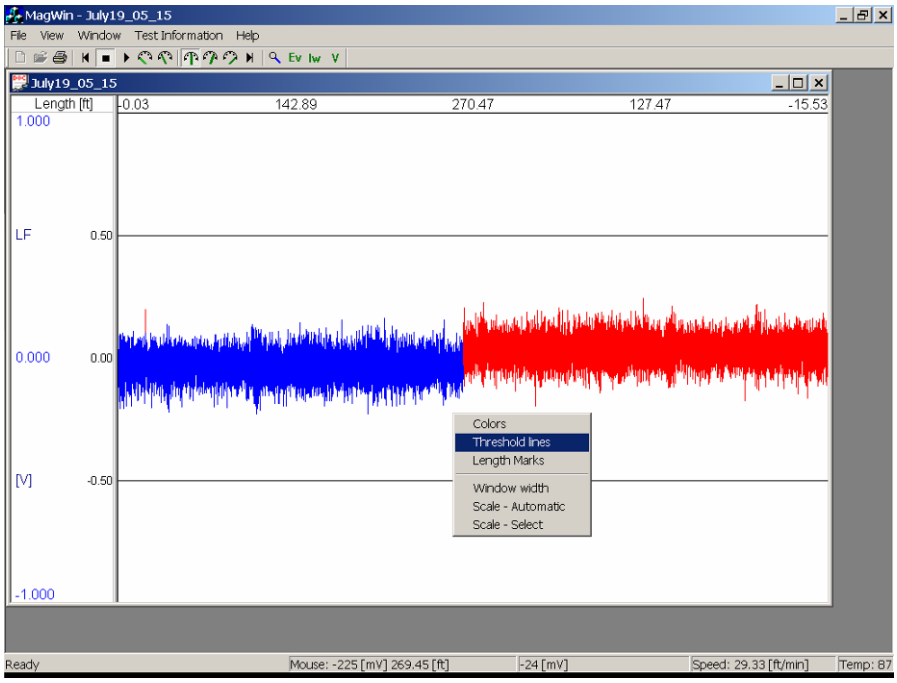


Click on OK

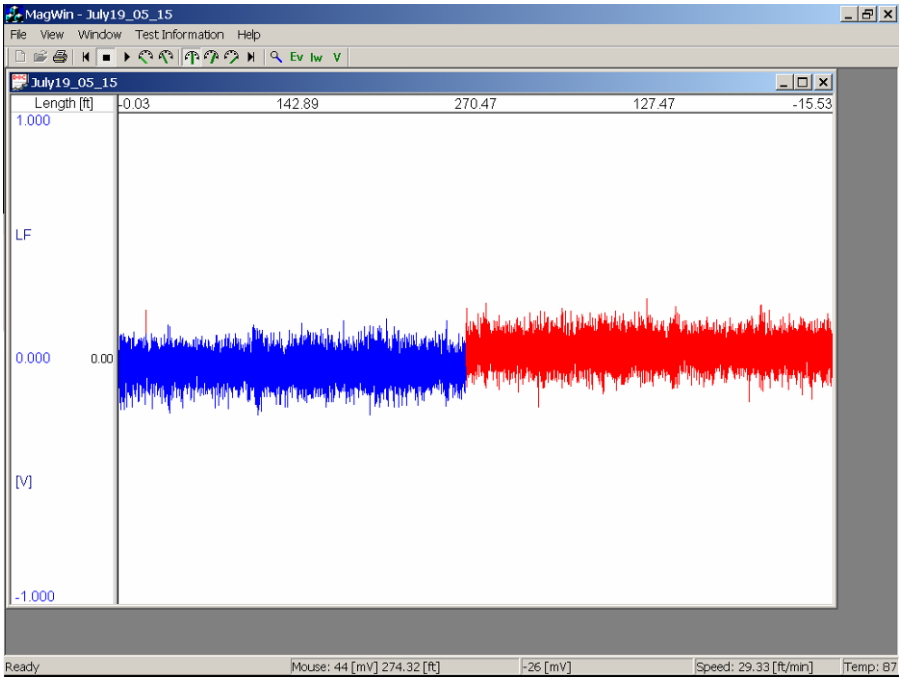
The following screen appears.



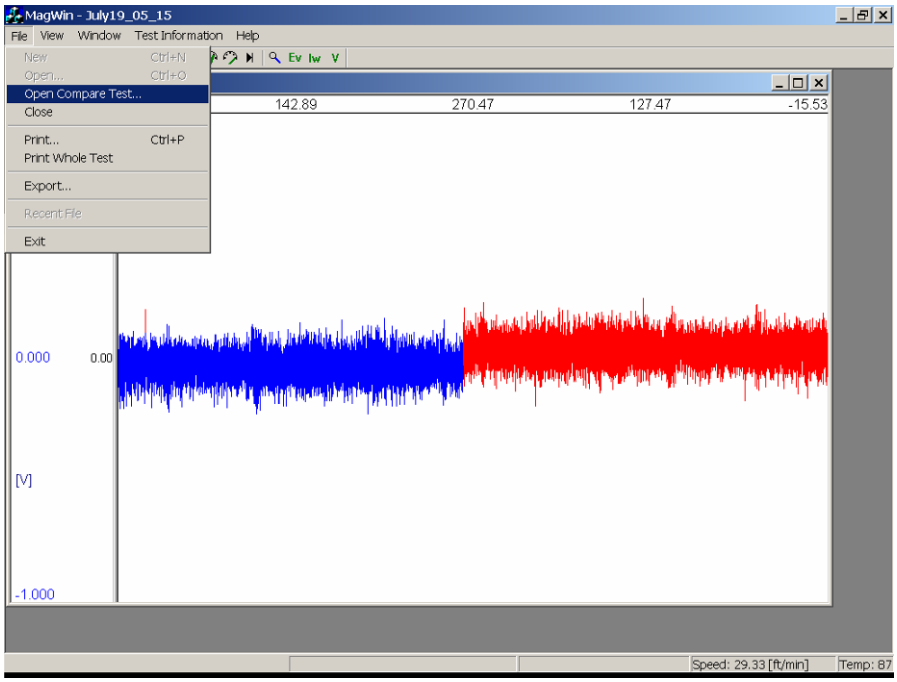
Now set the threshold lines to one volt (1000 mV)



This is the preferred setting for the threshold lines although they may be set to any value allowable by the selection box.

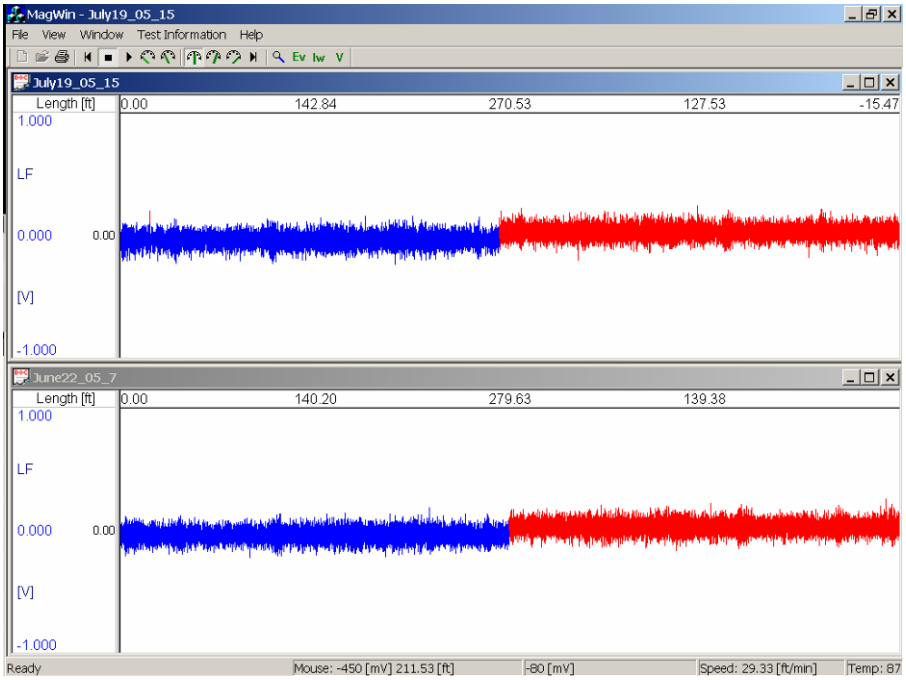


Now compare this test to a previous test. Click on the File icon and select Open Compare test

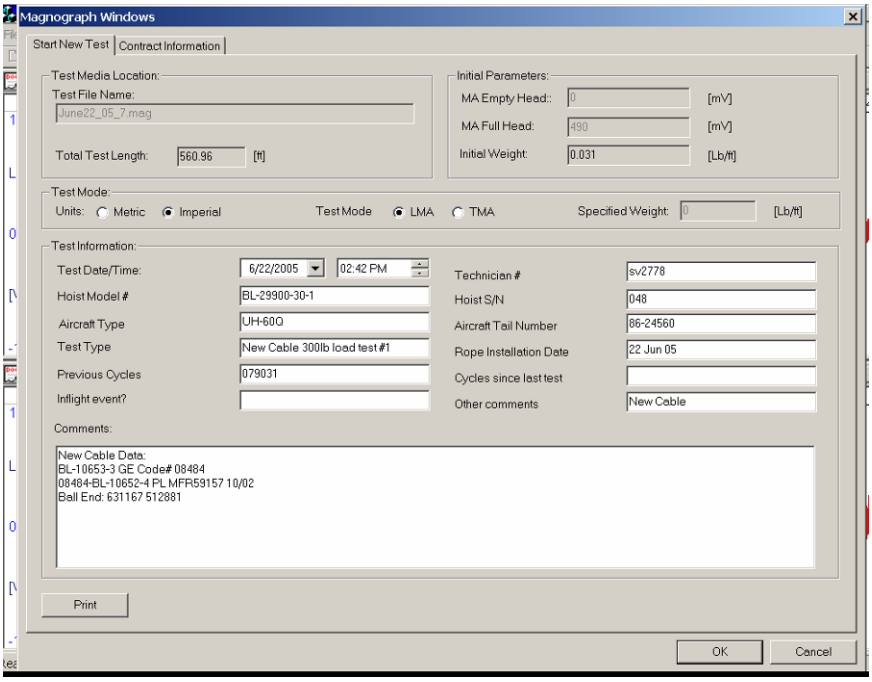


Select the appropriate prior test and the following screen appears, click on the prior test and select test information, then set the window width accordingly, then set the scale to match the test to be compared.

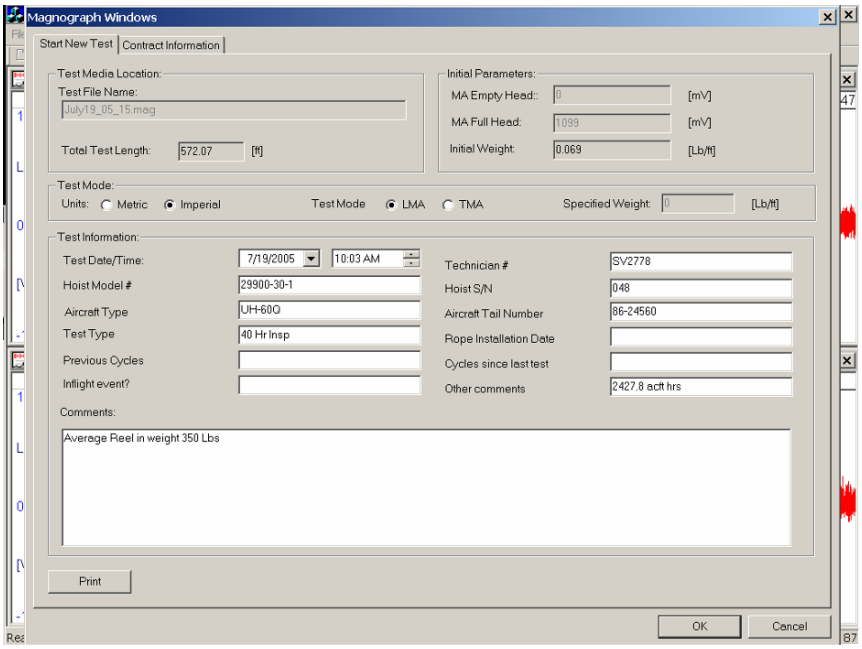
The screen now shows the two tests.



Here you can see the similar patterns and no serious degradation or new spikes in the data. Click on the first test and click on test information.



Click on the second test and click on test information.



Here you can see how the data that is entered gives a historical record of the life of the wire rope and allows accurate tracking of the wire rope over its installed life.

7.1) Notes and Limitations of the MagSens ™ Inspection System

The MagSens ™ output must be interpreted by a trained person.

The MagSens ™ can not inspect the entire length of the wire rope without disassembling the hook and bumper assembly. Therefore a careful visual inspection of the wire rope in the area of the hook attachment is required.

The MagSens ™ output can be affected by the movement of a metallic object in close proximity to the MagSens ™ head.

7.2) Interpretation Guidelines

The MagSens™ display output along with the physical condition of the wire rope in the area of interest and a detailed knowledge of the wire rope history is required to make an accept or reject decision.
The indications on the MagSens readout by themselves do not give the rescue hoist maintainer enough information to reject the wire rope outright unless visual and tactile correlation exists. After an anomaly has been isolated, a thorough visual and tactile inspection should be performed in the area of interest. The MagSens™ provides the capability to measure the exact location of the defect by running the wire rope in and out to determine if the defect has a repeatable signal; then the location can be isolated. Factors that need to be considered are the length of time the wire rope has been in service, prior data records that may or may not exist, and the report of the crew who flew the last mission.

Scenario 1) No prior data record exists, no recorded history of the length of time the rope has been in service, no indications or reports from the prior flight.

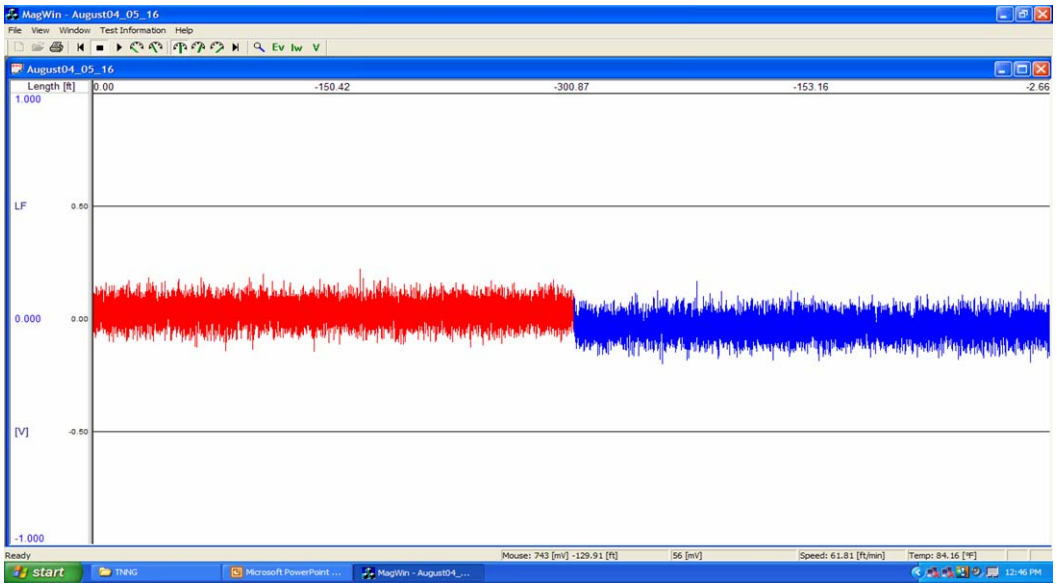
This is the most common scenario because the MagSens™ is a new tool that is now available to the rescue hoist maintainer. Consider the cases of a rope that shows no indications and a rope that shows indications. In the first case of no indications, it is an easy call, the test data record becomes the baseline for comparison to future tests.
In the second case, if there is no measurable variation of the outside diameter of the wire rope and no tactile indications of any kind. Then the defect should be identified as an unknown internal indication. Upon future inspections the size of the indication should be compared to the past data. If no increase in size is noted. The wire rope can remain in service until such time that the defect either increases beyond the allowable threshold value (TBD) or additional defects start to appear. Increased frequency of inspections should be used to determine if the defect is stable or changing.
In the event that there is a measurable variation in diameter or if external damage is detected then the wire rope must be replaced immediately.

Scenario 2) Prior data exists

In the case where prior data has established a baseline and the original baseline indicates no defects, and a present measurement now indicates a new anomaly has developed, then the indication should be isolated and the location marked using the MagSens. If no external visual variation in outer diameter is measurable or detectable, then the flight crew from the previous mission should be questioned as to the possibility of an in-flight event. This will allow the maintainer to determine the possibility of internal damage as a result of a dynamic event. If no in-flight event has been noted then the location of the indication should be compared to possible correlation with the turnaround points on the rescue hoist drum to determine if possible internal crushing has started as a result of misalignment of the rescue hoist levelwind mechanism. If no correlations can be drawn then the location and size of the indication shall be noted and compared to future inspections and the frequency of future inspections should be increased. Upon future inspections the size of the indication should be compared to the past data. If no increase in size is noted. The wire rope can remain in service until such time that the defect either increases beyond the allowable threshold value (TBD) or additional defects start to appear. In the event that there is a measurable variation in diameter or if external damage is detected then the wire rope must be replaced.

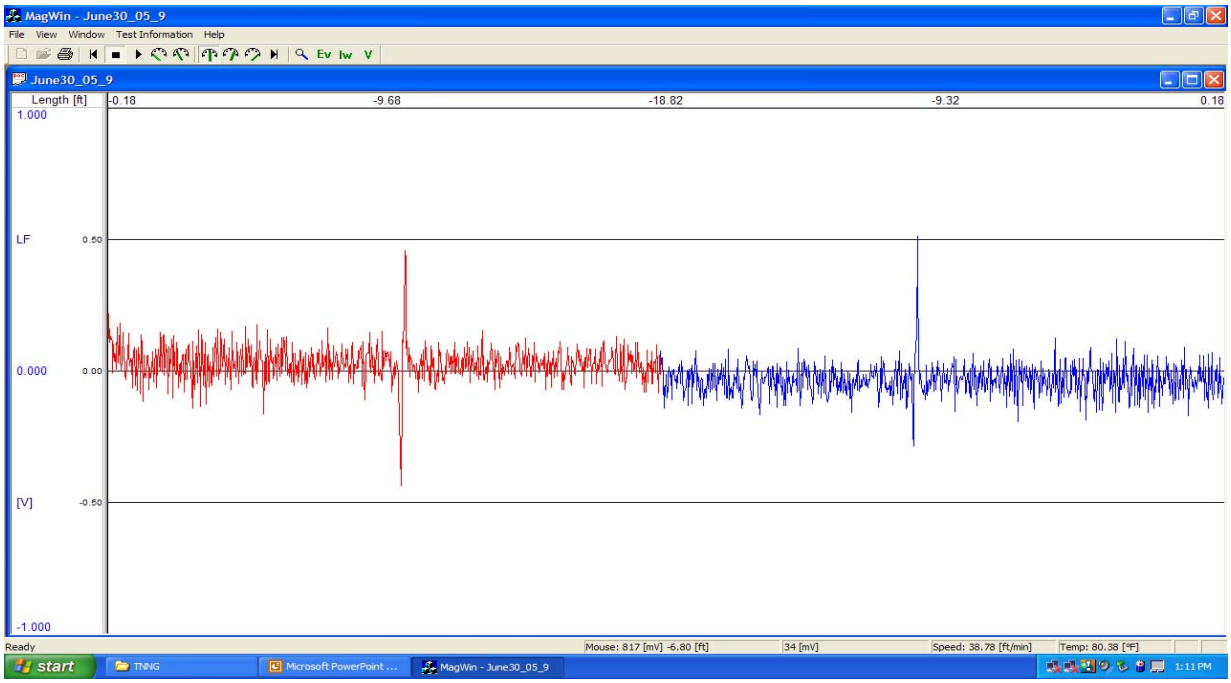
7.3) Representative Wave Forms

New Wire Rope baseline

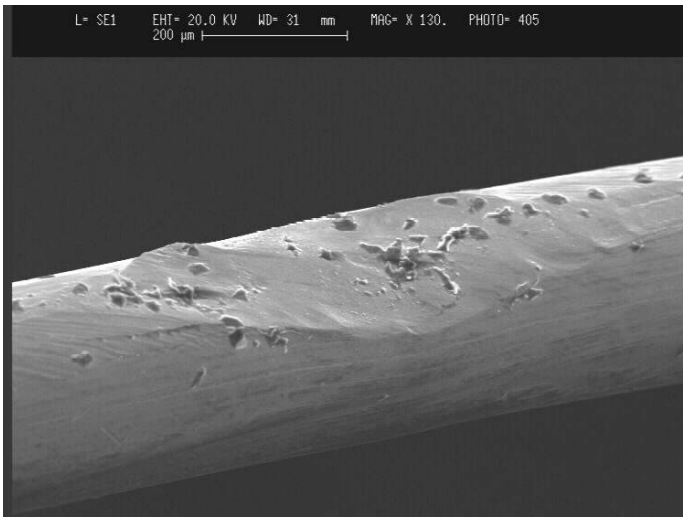


Establishing a baseline When a new wire rope is installed and after it has been conditioned to remove constructional stretch it should then be checked using the MagSens™ to establish a baseline for comparison to future inspections.

Single Internal Defect

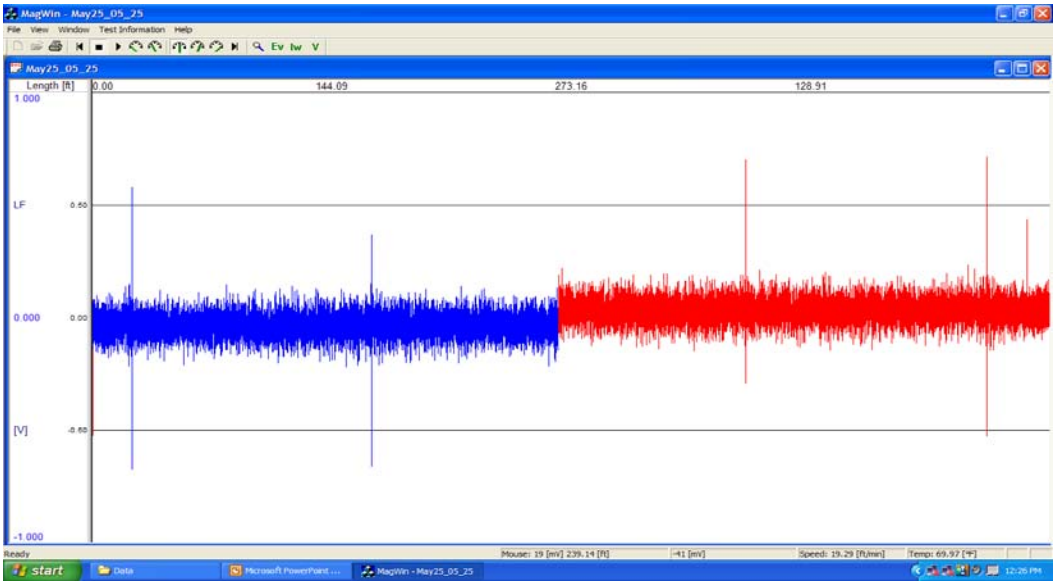


In this case the internal defect was determined to be due to peening of the internal strand wires against the external strand wires. This is a common yet undetectable flaw that occurs on 19 x 7 rotation resistant rope that is being wrapped on multilayer drums at high speed. This peening is a plastic wear produced by localized impact or very high bearing pressure. This can occur by the slap of the rope at the crossover points as the rope slips from layer to layer. Plastic wear can cause a fin on the edge of a worn wire that provides ready site for the initiation of fatigue cracks. A SEM photograph of the indicated defect is shown below.

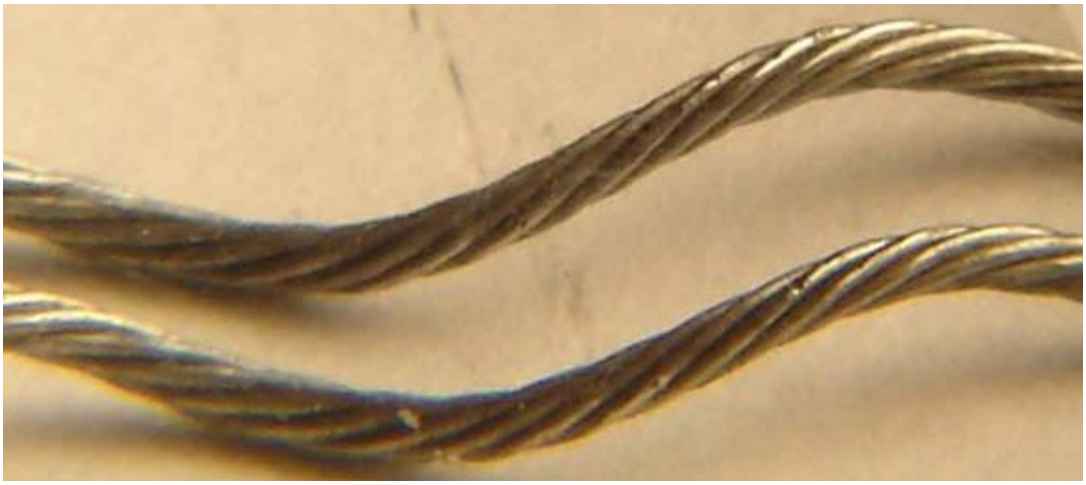


Multiple Internal Defects

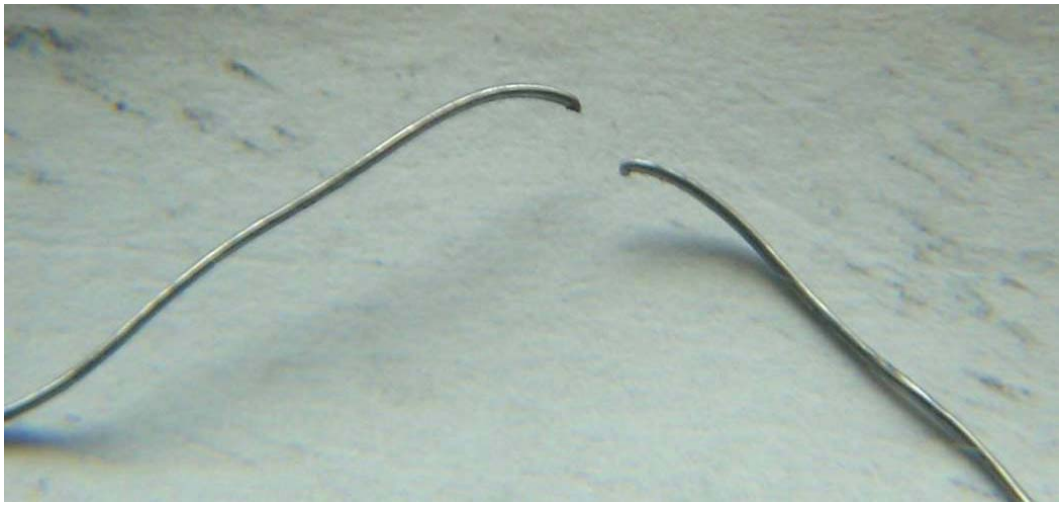
The following example shows two indications. Note that the indications repeat in each direction. The first indication is larger then the single indication above by approximately 30 %.



When this wire rope was disassembled the first indication was discovered to be multiple cases of severe internal peening between the internal and external strands.

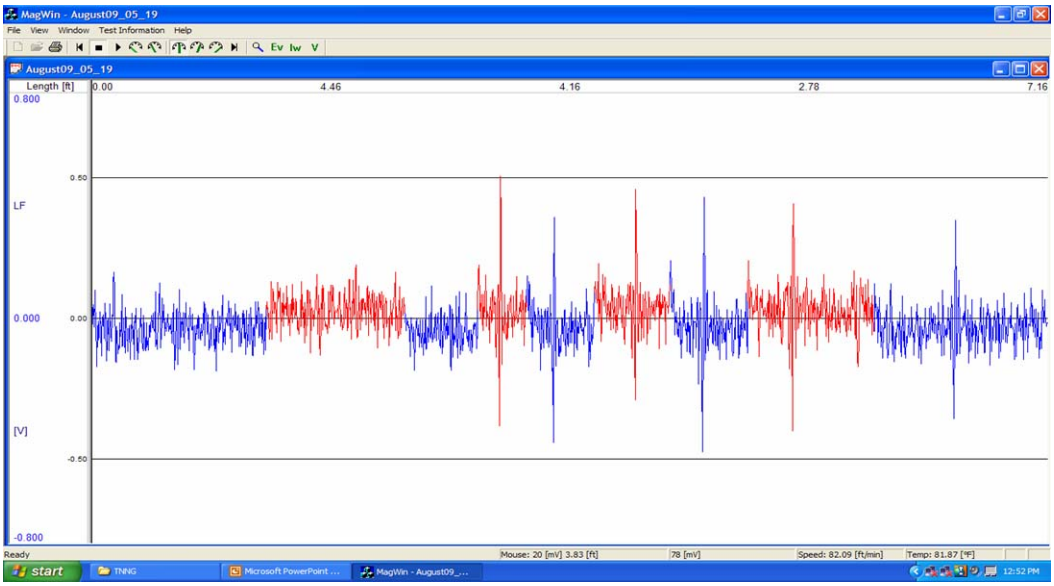


The first defect was located at approximately 38 feet from the ball end. When one of the internal strands was disassembled the external wire broke at one of the pits created by the peening..



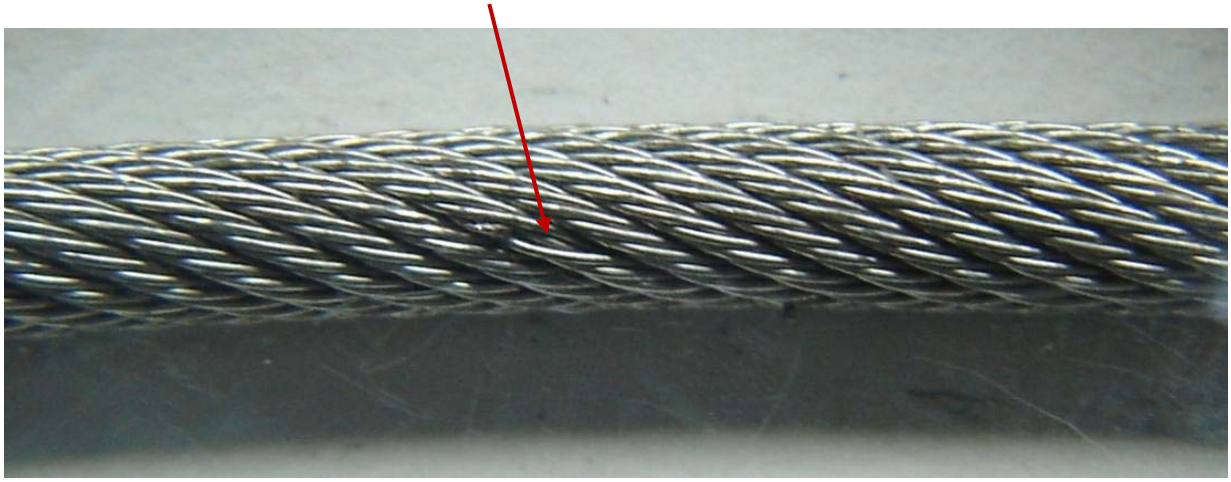
The second defect at 183 feet was only discovered after disassembling 18 of the 19 strands. It was a center wire of an external strand that broke upon disassembly. The wire was ductile in the area of the break and still hard in the rest of the sample. This may mean that the wire was annealed somehow, possibly this was a weld.

Single Broken Wire

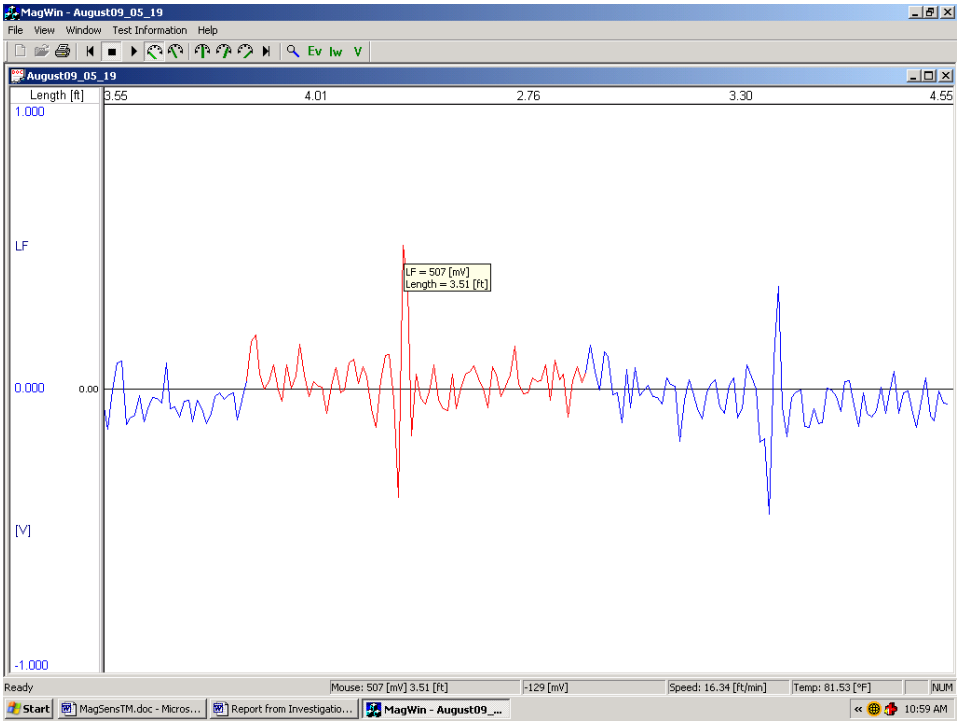


As stated above a single broken wire may not allow very much flux leakage until it pulls apart. The flux leakage increases as the ends separate. The trace above shows this concept very clearly. In the first three passes through the MagSens ^{TM} there is no indication but on the fourth pass the wire separated and the indication was quite evident. Note that the signal strength is approximately 500 mV or about the same size as the internal peening noted above.

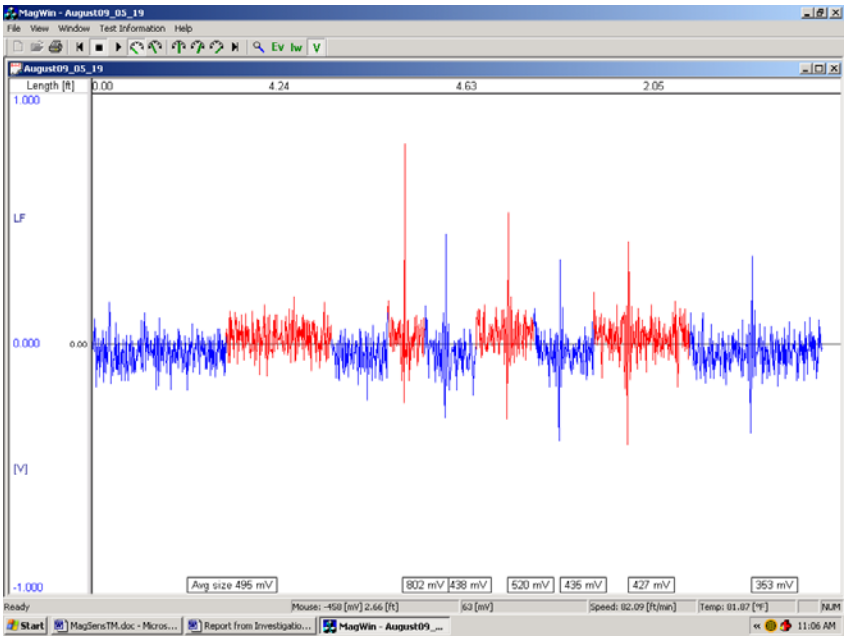
The single broken wire is shown below



Signal Strength may vary for the same defect. MFL inspection techniques provide a qualitative indication but not a quantitative indication. i.e. the techniques shows that an anomaly is present but it can not tell with certainty what type of anomaly it is.

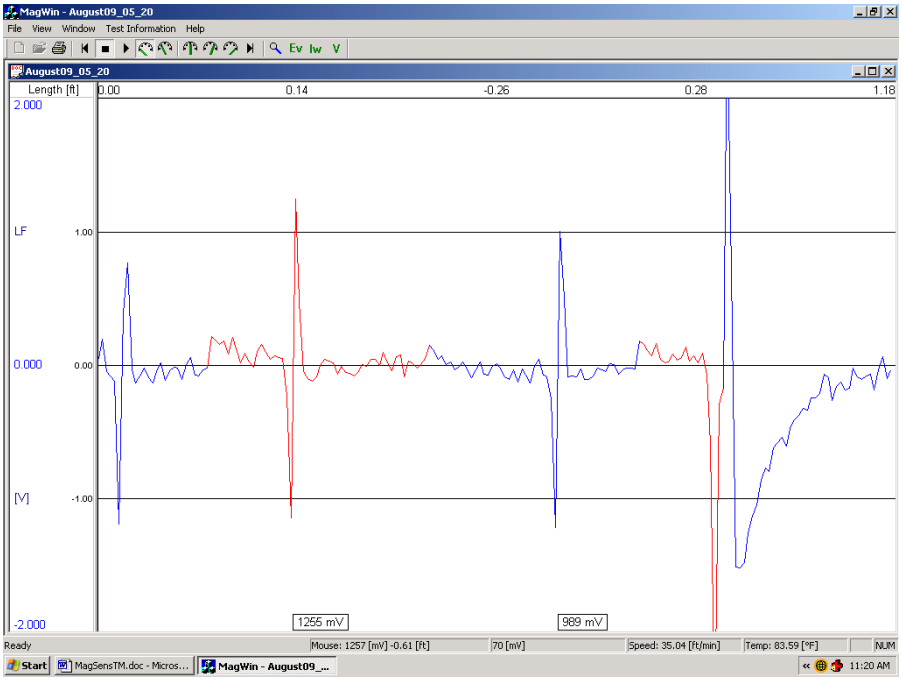


This picture shows that the size of the indication varies during each pass through the MagSens™ head.



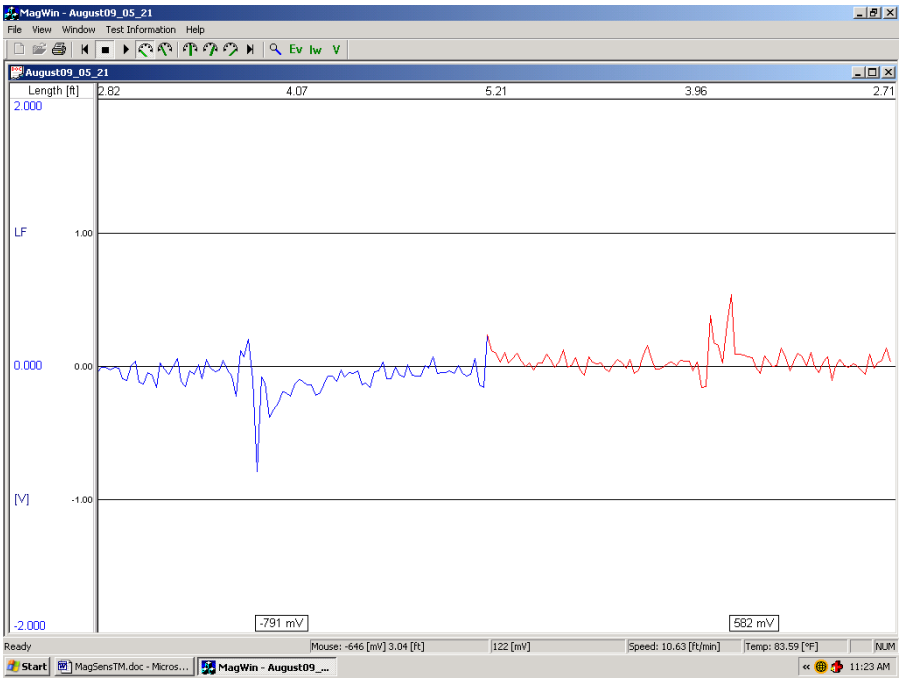
External Cut Strand

An external strand produces a very strong signal



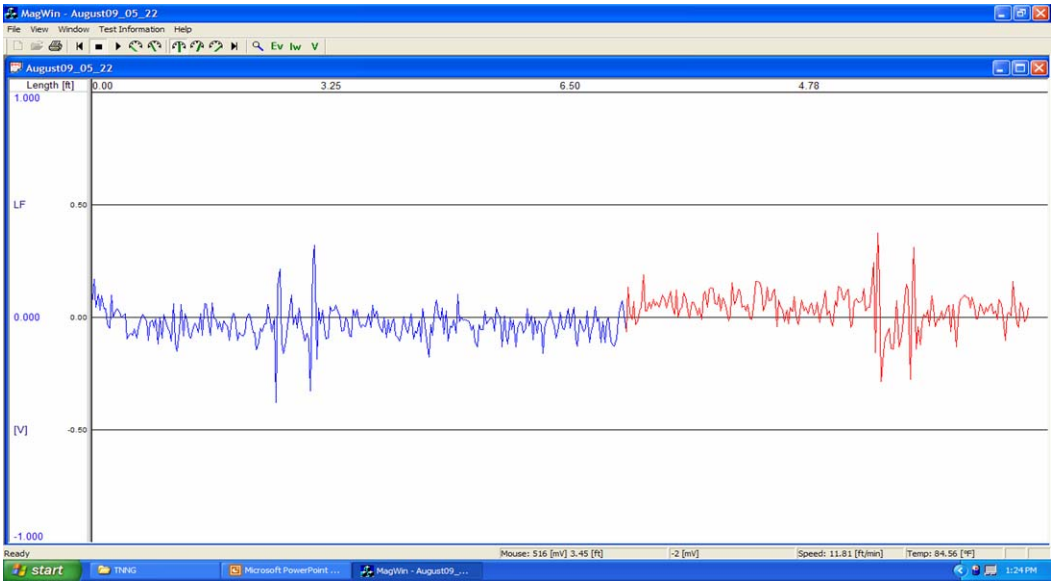
Internal Cut Strand

An internal cut strand does not produce such a strong signal due to the fact that the wire ends are in close proximity to each other,



Multiple internal nicked wires

This example shows the indication from two wires in the central strand that had been cut but not all the way through. When the sample was disassembled and the individual wires were flexed two wires broke apart.

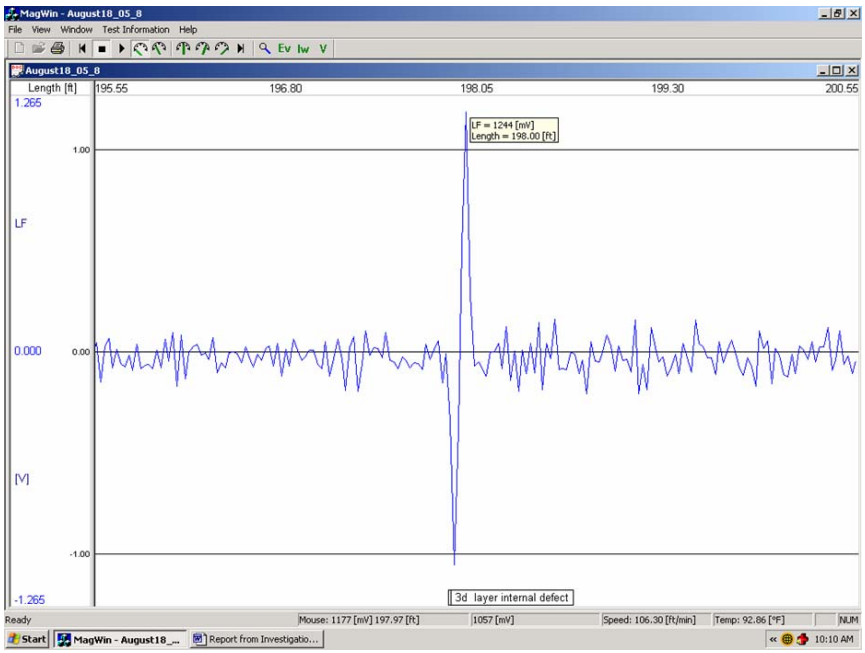


Central Strand with two nicked wires

Welds in individual wires

It is possible to receive a new wire rope with indications. The indication may be a welded wire. Per the specification individual wire welds are permissible as long as they are no closer then 20 feet apart in any individual strand.

This trace show a weld in the center wire of the center strand. The signal strength is 1244 mV.



302/304 Austenitic wire when welded and a post weld anneal is not applied may develop internal corrosion in the area of the weld. Therefore it is important to monitor the welded area carefully upon future inspections.

Surface corrosion as a result of carbide precipitation in the area of a welded wire

Chlorides are a big problem for 300 series stainless steel. Outside of water; chloride is the most common chemical found in nature and the most common water treatment is the addition of chlorine.

Carbide precipitation causes the stainless steel to loose its corrosion resisting properties in the areas affected. Best seen at areas of welding, rusty discoloration indicates that the alloy was robbed of its Chromium.

Conclusion:

When inspecting the wire rope with the MagSens ^{TM} it is possible to determine the type of indication by referring to the MagSens data base of indications. In general broken wires are the smallest indications and welds are usually much larger yet on the same order of magnitude as broken strands. When welds are discovered in a new wire rope, they should be monitored for growth over time.

8.0) Maintenance of the RHGSE

8.1) Storage of the RHGSE

After using the RHSGE it should be stored indoors in a dry location. Use compressed air to blow off any water remaining on the RHGSE or towel dry. The battery charger should be plugged in at all time when in storage.

8.2) General Preventive maintenance

- Keep the RHGSE MagSens Head relatively dry.
- Rinse off the RHGSE after a wire rope cleaning.
- Do not impact the Rotatub, especially in cold operating conditions.
- Do not leave water in the tub in conditions likely to freeze.
- Clean any excess oil from exposed portions of the upright assembly as required.
- Wash the RHGSE capstans with water when required to clean and then set out to dry or blow off excess water with compressed air.
- Keep all loose components in their respective storage locations.
    - Tub plug in the rotatub
    - Tension release hitch pin in the pressure roller base storage holes
    - Spare Lubridryer pads in the Lubridryer reservoir

8.3) Periodic Maintenance

Table of Periodic Maintenance Tasks

Task	Paragraph	Period
Charging the batteries	7.3.a	Daily
Replacing the batteries	7.3.b	On condition
Adjust the adjustable platen	7.3.e	On Condition
Change the hydraulic fluid filter	7.3.c	On condition
Lubricate the wheels and Swivels	7.3.d	Yearly
Lubricate the adjustable platen	7.3.e	On Condition
Check the capstans	7.3 e.1	Ob condition
Clean the Lubridryer	7.3.f	As required
Replace the Lubridryer pads	7.3.g	As required/ at salt water rinse
Replace the MagSens or Lubridryer bushings	7.3.h	As required
Capstan drive chain oiling	7.3.i	Monthly
Inspect the belts and chain for tension	7.3.j,k,l,m	Yearly

Always disconnect the fused positive battery terminal before making repairs or servicing any of the moving components of the RHGSE.

A) **Charging the batteries**

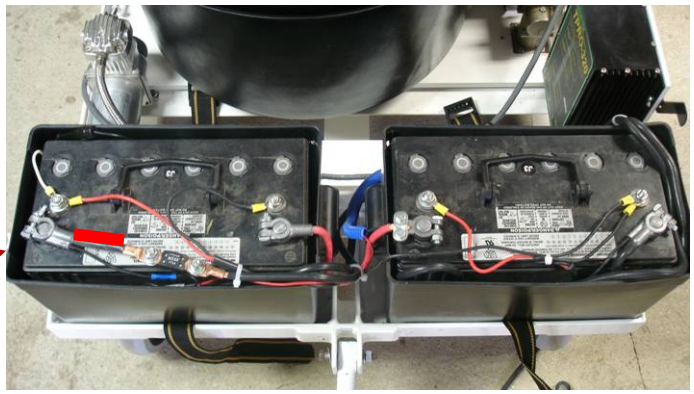
Whenever the RHGSE is not in use the battery charger should be plugged in. When the battery charger is not being used store the electrical cord as shown.

Battery charger cord storage

B) Replacing the batteries

The two main batteries weigh 79 lbs each. Loosen the battery cover straps and remove the tops of the battery boxes. Disconnect all terminals and replace the batteries. Note the polarity markers on the wires for proper connection of the new batteries. Dispose of the old batteries properly.

+ terminal



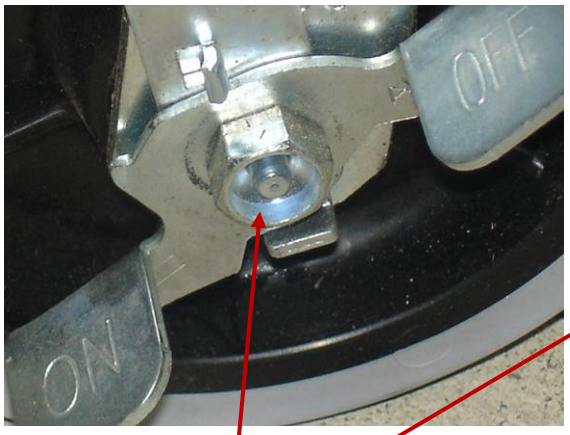
C) Maintaining the hydraulic system

The hydraulic system should be maintained leak free. If leakage develops tighten the appropriate fitting. The hydraulic filter includes a pop up indicator and a spin on cartridge. The filter cartridge should be replaced on condition when the indicator indicates a blocked filter. The hydraulic oil should be sampled every year depending on the environmental conditions. The hydraulic oil should be filtered and recycled as required by the sampling results.

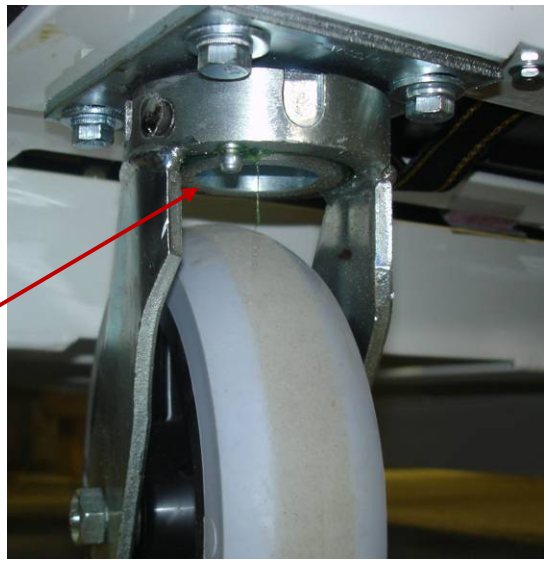
Spin on filter element

D) Lubricating the wheels and swivels

The wheels and swivels should be lubricated on a yearly basis with a good quality general purpose grease.

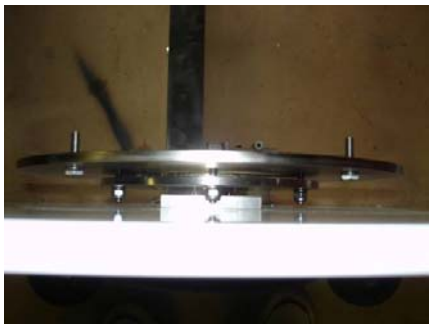


Grease fittings

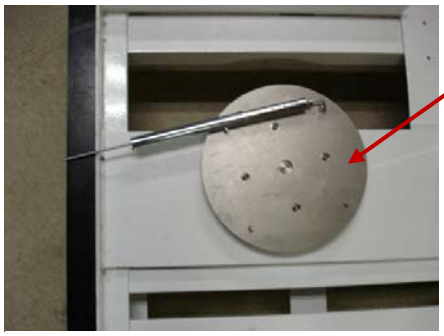


E) Checking and lubricating the adjustable platen

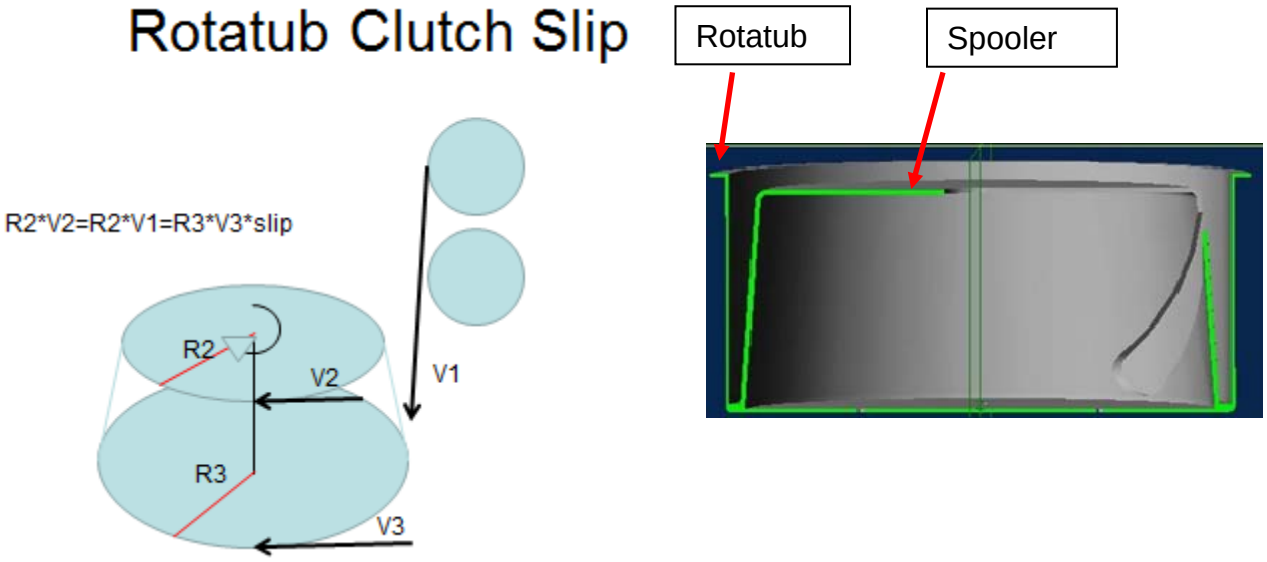
With the cable attached to the capstans (to prevent rotation) rotate the Rotatub fully counter clockwise while looking down upon it. It should rotate with moderate to light force (1-2 lbs.) at the outer diameter of the Rotatub. To adjust the rotation force, remove the tub by removing the (4) lock nuts and washers in the tub, and adjust the four adjustment screws until 5-6 lbs. force is required to slip the adjustable platen while measuring the force with a spring scale as shown below. To re-lubricate the platen use MIL-G-81322 Grease on the upper and lower surfaces of the bronze disc.



View of adjustable platen



Views of adjustable platen with tub removed and slip value being measured



The above pictures shows that as the cable is wrapping at the bottom of the spooler it is going at maximum speed which is the same speed as it is coming off the capstans. As the cable starts to climb up on the spooler it starts to slow down due to the reduced diameter. But the Rotatub must actually go faster in order to collect the cable and not allow it to back up in the Rotatub. Therefore the clutch is slipping the most when the cable is at the bottom of the spooler. If the clutch does not slip properly the cable is forced up the spooler and there is less room on the spooler to collect all the cable. Never continue operating with the cable wrapping tightly on the upper edge of the Spooler, as the cable can come out of the Rotatub and twist and kink.

Effect of overall cable diameter

When a cable is new its diameter is at its maximum and is approximately .194 inches**.** As it is accumulates time in service it wears and stretches and its diameter becomes smaller over time. As the diameter is reduced the slippage on the capstans increases. As the slippage increases the tension in the cable as it wraps on the Spooler increases. When this happens the cable may start to ride to the top of the spooler. If this is noted during extending, the operator can slow down the Rotatub with a hand or foot contact to allow the cable to fall to the bottom of the Rotatub in order to complete the evolution. Afterwards the Rotatub clutch should be adjusted as per paragraph 7.15 above.

Effect of cable manufacturing process

When a cable is manufactured it is critical that the producer properly setup and engineer the manufacturing process. During the manufacturing process the producer must strive to properly balance the inner and the outer strands to create a spin resistant cable that will wrap on a modern rescue hoist drum. In order to do this the wires and the strands are preformed so that they do not abrade on each other under load and they do not tend to unwrap under load. If the preforming and balancing is incorrect the cable will loosen up prematurely. If it is required to keep the cable installed then hoisting in a hover with a heavy load will tighten the cable back up temporarily but the area where the looseness began will soon reappear. If a cable that is bordering on being loose is used with a RHGSE with a Rotatub clutch that is set too high, the result can be the loosening of the cable between the top of the RHGSE and the rescue hoist.

Effect of cable lubrication

When a cable is new the internal spaces between the wires are full of the lubricant used to produce them. One rescue hoist manufacturer removes the external lubrication and the other does not. Therefore it is the operator' responsibility to determine if adding additional lubricant is required. If additional external lubricant is applied then the coefficient of friction is reduced and slippage on the capstans increases.

Effect of worn capstans

The capstans will wear as a result of slipping and heavy loading. The first groove on the lower capstan will wear out first because it has the heaviest load applied to it. The lower capstan is of a harder material than the upper capstan. When the wear of the capstans becomes significant the cable will slip excessively on the capstans. The results may be seen as the cable starting to ride to the top of the spooler or twisting of the cable between the top of the RHGSE and the rescue hoist.

Zephyr International maintains excess inventory of spare capstans and has a trade in policy, whereby when a user advises they need a new set of capstans, for a fixed price a new set can be sent out immediately and the users then return the old pair to Zephyr for refurbishment.

In general, in order to reduce cable slippage, reduce the cable load and or the speed of operation.

E-1) Checking the Capstans

It is essential to replace the capstans when the pitch diameter of the first groove, of the lower roller becomes too small. To check the pitch diameter a 6-7 inch micrometer is required and a set of pins of the correct diameter is required.
There are several capstans available for the different size cables in use. It is important to use the correct style capstans for the type of cable being serviced. The following table lists the relevant dimensions for each capstan style

Cable Diameter	Lower Capstan Part number	Measurement Pin diameter	Minimum dimension over pin
3/16 inch	ZGS-10113-20-1	.185	6.745 in
4.5 mm	ZGS-12474-1	.175	6.725 in
5/32 inch	ZGS-10113-30	.156	6.715 in
3.5 mm	ZGS-10340-1	.132	6.695 in
1/8 inch	ZGS-10113-40	.120	6.685 in

Note: ZGS-12474-1 can be used for 3/16 and 4.5 mm cables.

A) Lubridryer cleaning

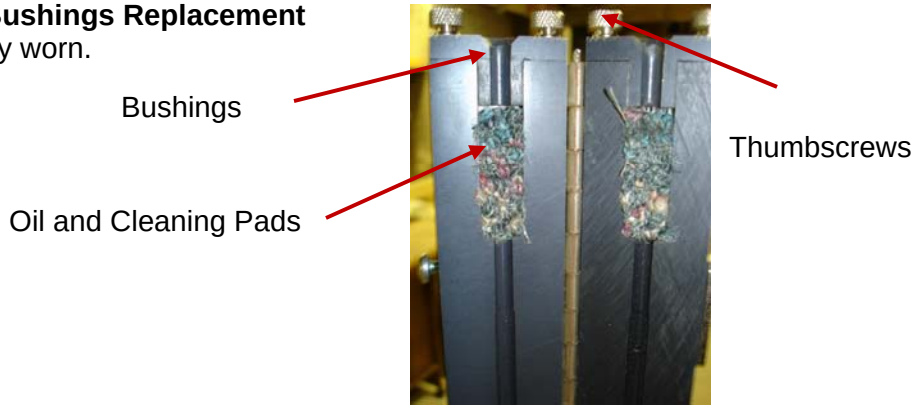
Occasionally clean the Lubridryer reservoir out because dirt and dust will accumulate over time

B) Oil and Cleaning pads replacement

Open the Lubridryer and unscrew the (4) thumbscrews. Remove the two Lubridryer bushings. Remove the used Lubridryer pads. Discard of the used pads properly. Insert new pads, install the bushings and thumbscrews.

H) MagSens and Lubridryer Bushings Replacement

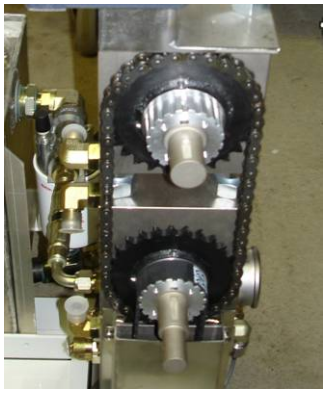
Replace the bushings when excessively worn.



I) Capstan drive chain oiling

Once a month drip a few drops of oil on the upper capstan chain through the small hole in the upright bracket base

J) Chain and belt adjustments



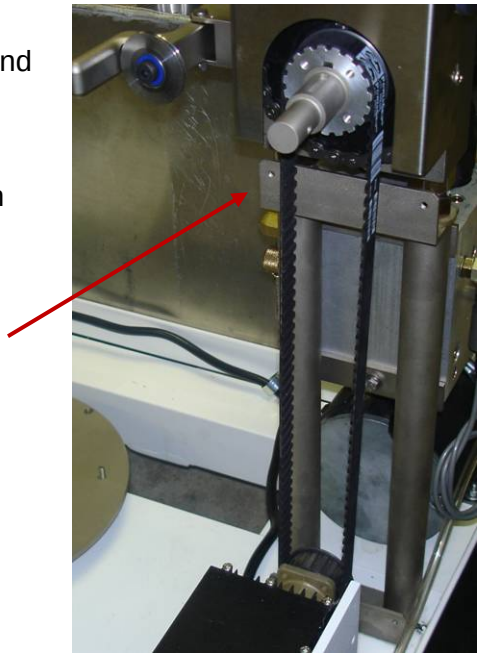
Before making any adjustments remove the covers.
The capstan shafts are coupled by a roller chain. The heads are adjustable on two threaded rods. To make any adjustments of the chain or vertical drive belt requires loosening and adjusting all of the nuts from the top of the upright assembly down. When making adjustments always loosen from the top down and then tighten from the bottom up while checking to insure belt or chain for proper tension and the upright components are square to each other and the base when completely tight. While the chain cover is off check the tightness of the setscrews in the chain sprockets and capstan drive pulleys

K) Capstan drive chain adjustment

The upper capstan chain should be adjusted depending on usage, and once a year it should be checked. Check for excessive chain looseness by removing the capstans, removing the upper capstan cover to expose the chain. Check the chain by pressing on the chain. The chain should be tight with a small deflection of 1/32 of an inch with moderate hand force.

L) Vertical drive belt adjustment

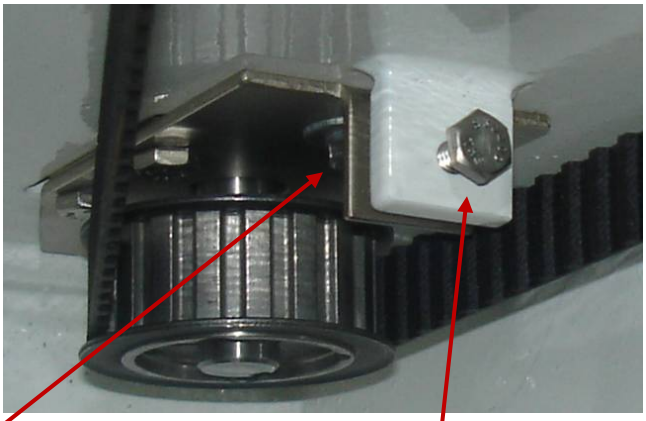
The vertical drive belt should be adjusted depending on usage, and once a year it should be checked.
Remove the vertical belt cover. Adjust the lower capstan head upwards to obtain approximately 1/8 inch deflection with a light hand force. Readjust the chain, and the replace the rocker switch support.



Vertical Drive Belt

M) Drum drive belt adjustment

The drum drive belt should be adjusted depending on usage, and once a year it should be checked. Loosen the (2) screws that hold the Anglegear assembly to the base. Turn the drum belt adjusting screw so as to tighten the drum drive belt such that a small deflection of approximately 1/16 an inch is obtained with moderate hand force. Tighten the two cap screws securely.



N) Calibrating the Load Indication System

The Ground Support System is not intended for precision load application but only as a tool to be used to apply approximate loading to insure the cable is tensioned and conditioned during ground maintenance. However in the event one desires to understand the accuracy of the load display then the following section applies. **The display of the load is accurate to within +/- 5% only in the retracting direction. Each machine is tested in the factory to insure it is within these limits.**

The displayed load in the extend direction is slightly higher then the actual load due to the slight inefficiency of the capstans and the fact that the motor must overhaul the load.

The load indication system consists of a load cell and a load display. The load cell reacts the torque of the hydraulic motor as it pulls or resists the pull of the wire rope.

Therefore the exact calibration curve for each machine is measured in the factory and a calibration curve calculated. The calibration curve is supplied with each machine.

Do not attempt to tighten or loosen the bolt that attaches the load cell to the reaction arm. Doing so will change the load cell display and render it inaccurate.

There are two methods to set the load cell display, one is with a fixed hoist test facility, and the other is to use the known weight of the GSE to set the display at the point where the GSE starts to lift off the ground

Method using the Fixed Hoist Test Facility

In order to calibrate the load display system the mobile GSE must be checked on a fixed hoist test facility. In the event the FHTF is available the following procedure applies.

Perform a load calibration run, Set up the Omega DP25BS as follows

1) Set Dip switches for a 0-100 MV input signal
   12345678
   XOCOOXXO
2) Set dip switches for a 10 V excitation voltage
   12345678
   COCOOCOO
3) Program the meter as follows
   a. Select input type **INPt**
      i. **100M**
   b. Select decimal point display
      i. FF.FF
   c. Scale with unknown loads as follows:
   d. Determine the load cell sensitivity from the load cell calibration sheet. Load Cell sensitivity is mV out = LSC=_____
      i. IN1=**0000**
      ii. IN2= LSCx5x100=_____
      iii. Rd1=**0000**
      iv. Rd2=**LSC**
   e. Select Reading Configuration to set the input resolution
      i. Set R.2=1 for a 20mV input signal
4) Set up the system and measure the actual loads indicated by the test frame and the output of the load cell in mV and record them on the test data sheet.
5) Plot the results and calculate the slope of the curve in lbs /mV and the y intercepts point.
6) Calculate the GSE max load **Y= M x LSC+B** to determine the mechanical correction factor
7) Change the decimal point display to **FFFF**
8) Reprogram the meter with the new Rd2=**Y=**_____
9) Make another run and measure the actual test frame indicated loads and the GSE indicated loads

   a. Plot the new loads and determine if the indicated loads are with 5% of each other at the high end of each range.
      i.e. extending maximum load range is 300 lbs
      i.e. retracting maximum load range is 600 lbs

10) Enter the results into the calibration test data record and include the data into the ATP record for the particular unit.

If no fixed hoist test facility is available, one can check the load readout by retracting at medium to fast speed. The GSE will start to lift off the ground at around 600 lbs.

Scaling with known loads Method

1) With the rocker switch set to the retract mode position, i.e. pump running but no movement
2)
3) 1. Press the **MENU** button until the meter shows RD.S.O.
4) 2. Press the **>TARE** button. The meter shows IN1 (Input 1).
5) IN1 (Input 1) is the unscaled display reading at minimum input.
6) 3. Press the **>TARE** button again. The meter shows last stored value for Input 1.
7) 4. Press the **>TARE** button once more. The meter shows the actual signal being
8) received.
9) 5. Press the **MENU** button to store this value as IN1 (Input 1). The meter shows
10) RD1 (Read 1). RD1 (Read 1) is the desired display reading at Input 1.
11) 6. Press the **>TARE** button. The meter shows the last stored value for Read 1.
12) 7. Press the **^NT/GRS** button to change the value of your digits to 0000
13) 8. Press the **>TARE** button to scroll horizontally to the next digit.
14) 9. Press the **MENU** button to store value as RD1. The meter shows IN 2(Input 2).
15)
16) 10. Start retracting the load with the hoist, and adjust the load on the GSE until the GSE just starts to lift off the ground. Try to keep the load as steady as possible. (This requires an assistant to run the hoist while the next steps are performed.
17)
18) 11. Press the **>TARE** button again. The meter shows the last stored value for Input 2.
19) 13. Press the **>TARE** button once more. The meter shows the actual signal being
20) received.
21) 14. Press the **MENU** button to store Input 2 value. The meter shows RD 2(Read 2).
22) RD2(Read 2) is the desired display reading at input 2.
23) 15. Press the **>TARE** button. The meter shows the last stored value for Read 2.
24) 16. Press the **^NT/GRS** button to change the value of your digits to 0600
25) 17. Press the **>TARE** button to scroll horizontally to the next digit until the meter reading matches the load cell meter reading of 600
26) 18. Press the **MENU** button to store value as RD 2(Read 2). The meter momentarily shows STRD, followed by RD.CF. Meter scaling is now complete.

O) Calibrating the MagSens™ system

The MagSens ™ system has been set up at the Zephyr International LLC factory. System calibration procedures are included here in the event the system requires adjustment. One of the only reasons one may need to perform a calibration is possibly due to changing a head and control system combination. In the event a head is replaced or repaired or swapped between systems the system may need to be recalibrated as follows:

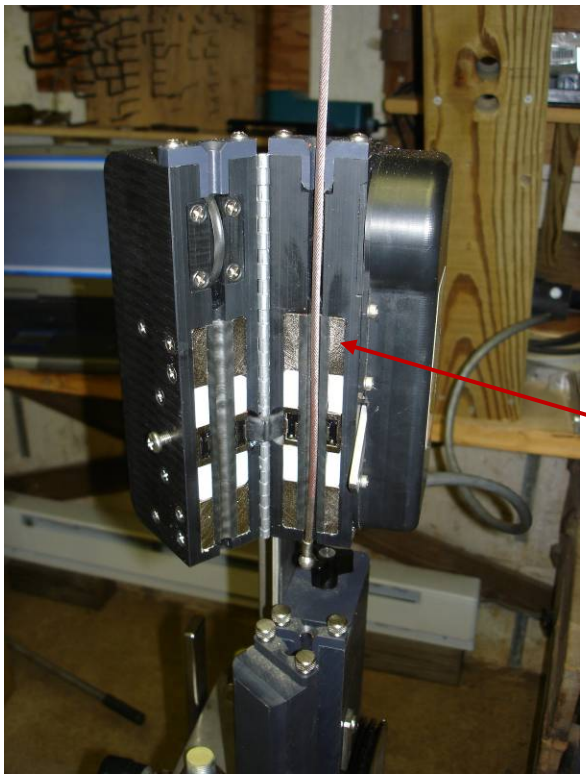
Attach the MagSens head and the cable to the control section.

1) Perform a Temperature Compensation adjustment
    a. Start the Measurement and automation software and switch to channel 4
    b. Attach a temperature probe so that it contacts the upper/inner LMA pole piece
    c. Let the system warm up for at least ten minutes
    d. Set the probe to read out in Centigrade
    e. Adjust R25 for an average reading on the test panel to match the temperature reading, but with the decimal point moved one place to the left. i.e 25 degrees C is 2.5 on channel 5.
    f. End procedure

2) Perform a full head calibration (refer to full head calibration picture below)
    a. Attach the head, control section and laptop, the control section and lap top should be on battery power only
    b. Boot up laptop and turn on the control section
    c. Let the system warm up approximately 5 minutes. This may require more time if the MagSens™ system is moved from a cool area to a hot area or visa versa. If this is the case let the system warm up for 10 minutes minimum.
    d. Using the Measurement and Automation program, open test panel, and verify you are looking at channel one
    e. The head should be empty and closed at this point
    f. Adjust the head adjustment knob for approximately Zero volts
    g. Place the test piece wire rope in the head and close it
    h. Open the control section cover and locate R17 and R6
    i. Adjust R17 for an average reading as close as possible to 1000mV. If the reading starts to increase and then decreases stop remove the test piece wire rope and begin the procedure from e) again.
        i. Turn the R17 adjustment screw ½ turn at a time until a reading of close to 1000 mV is attained.
        ii. Remove the test piece from the head, and close the head
        iii. Verify the voltage on channel zero is close to Zero volts.
        iv. Open the head and insert the test piece wire rope and close the head.
        v. Verify the voltage on channel zero is close to 1000 mV.
    j. Due to system drift the steps in i) need to be performed in less then two minutes. If the system is allowed too much time to drift then the signal will change and the procedure will need to be repeated stating from e.

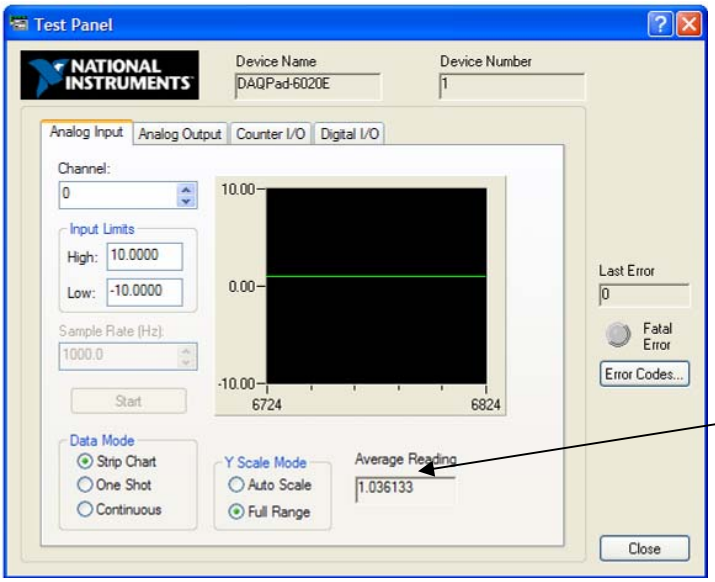
3) Perform a LF gain calibration (refer to LF gain adjustment picture below)
    a. This procedure should be performed immediately after the full head calibration test
    b. Open the MagSens program and start a new test
    c. Obtain an empty head reading of approximately -3.5 volts
    d. Install the test piece wire rope into the head.
    e. Obtain a full head reading and start the test

f. Pull the wire rope through the head and observe the signal strength
g. Adjust R6 to obtain an average signal of +/- .25 volts
h. Turning the R6 adjustment screw counter clock wise increases the gain and thus the LF signal, turning it clockwise decrease the gain and thus the LF signal.
i. Remove the cable and close cover
j. Reattach the battery chargers to the lap top and the control section



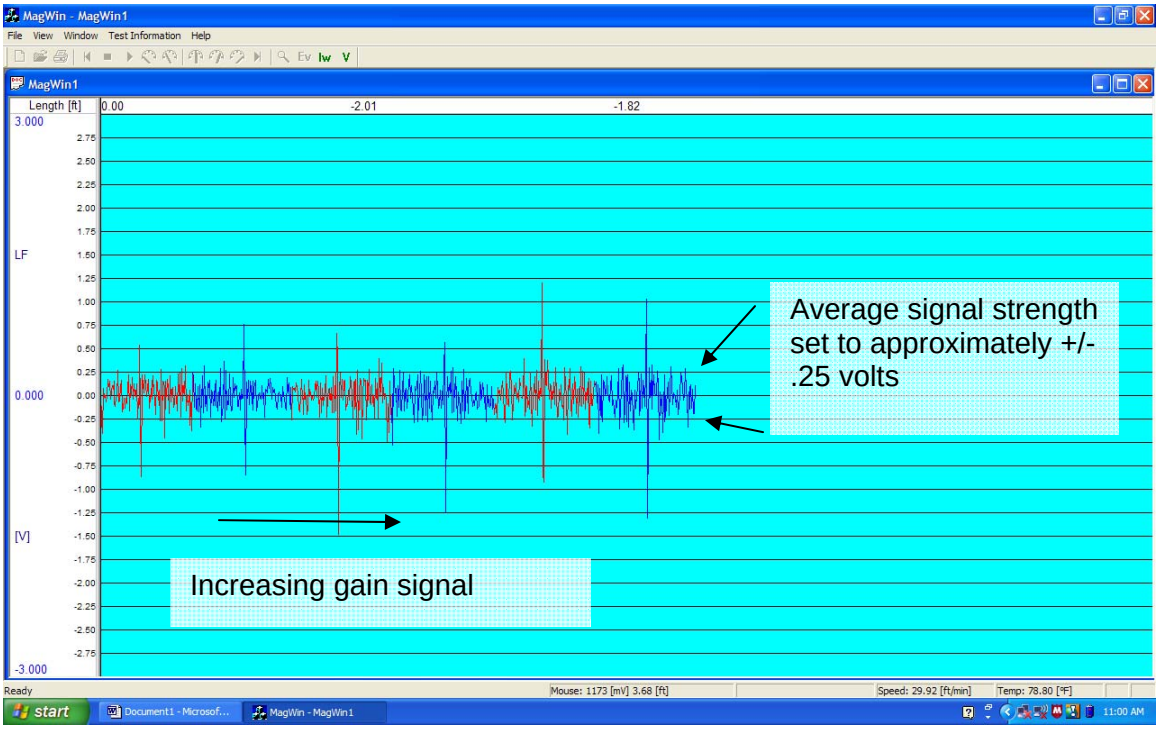
Upper inner LMA pole piece

Full head calibration



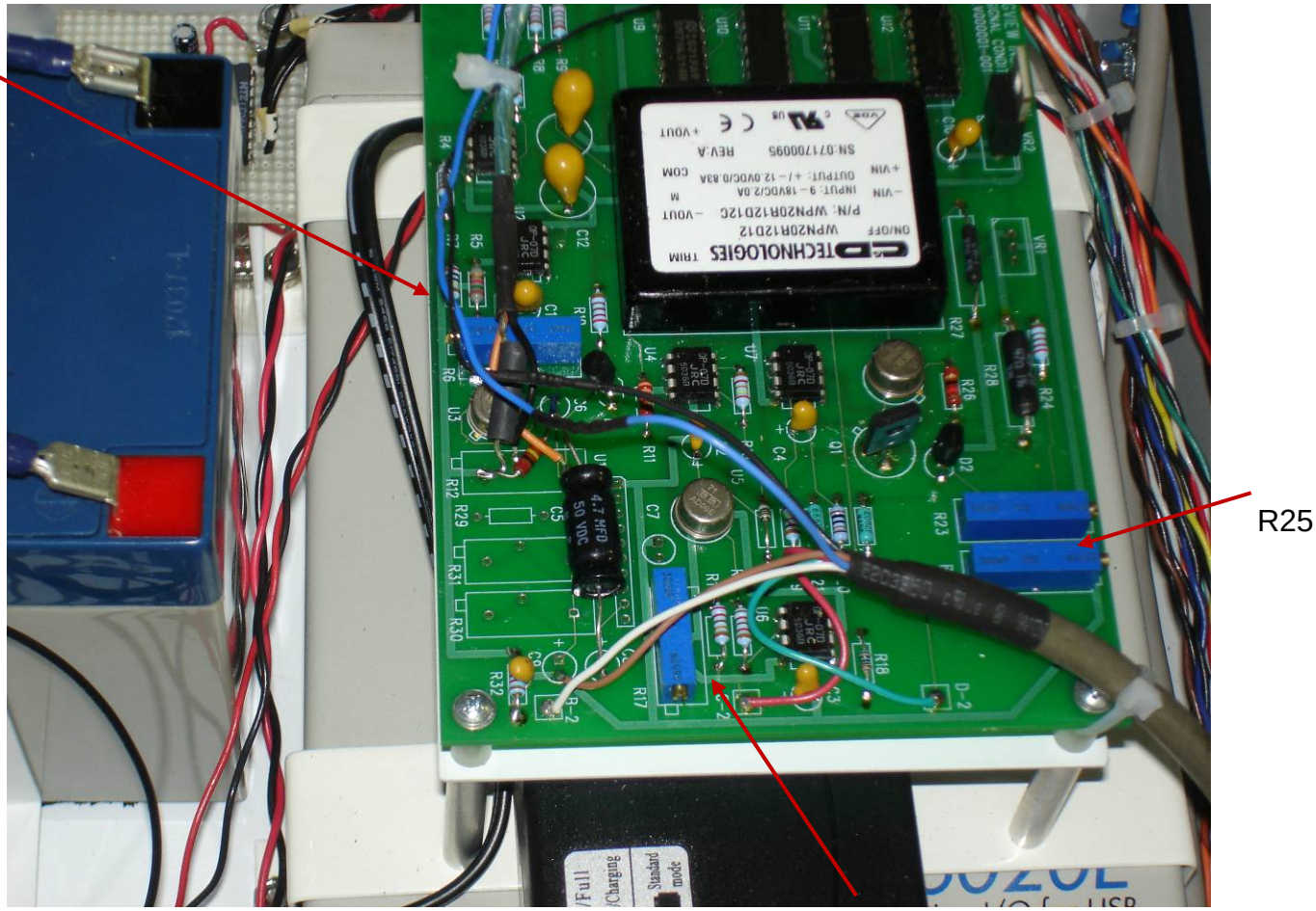
Adjust R17 immediately after closing head with cable in it

LF gain adjustment



Adjust R6 CCW to increase gain, CW to decrease gain

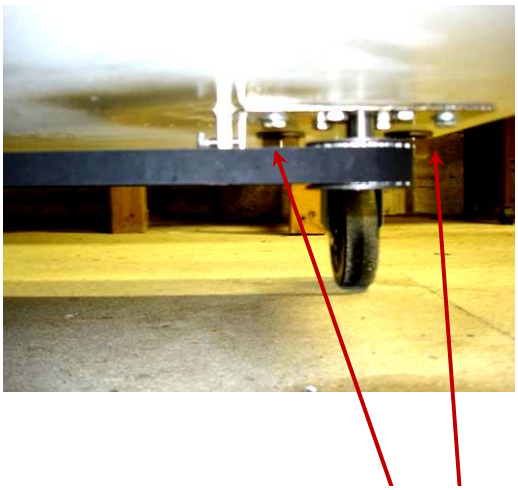
Adjustment Potentiometers Position



8.4) Standard Replacement Procedures

A) Drum drive belt replacement

Jack up the RHGSE on place on car jacks to allow access to the drum drive belt. Loosen the two screws that hold the Anglegear assembly to the base. Turn the drum belt adjusting screw so as to loosen up the drum drive belt to remove and replace it.



Loosen these screws to adjust or replace the drum drive belt

B) Vertical drive belt replacement

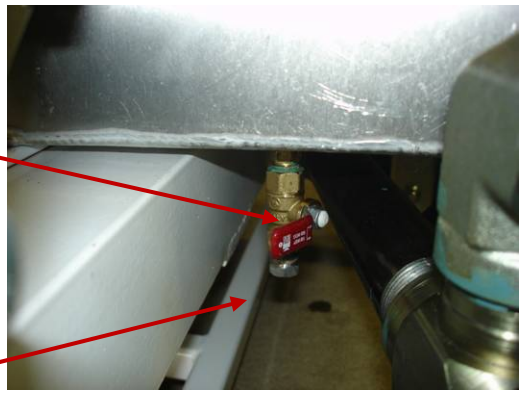
Lower the lower capstan head enough that the vertical drive belt can be removed and replaced.

E) Hydraulic Fluid Replacement

To drain the hydraulic fluid remove the drain plug located on the left bottom portion of the hydraulic tank**.** Open the drain valve and drain the fluid into an approved container. Use hydraulic pipe thread sealant when reattaching the plug, not Teflon tape. Close the drain valve
Replace the hydraulic fluid with new or recycled hydraulic oil of the same type that was removed.

Drain Valve- rotate handle down to open

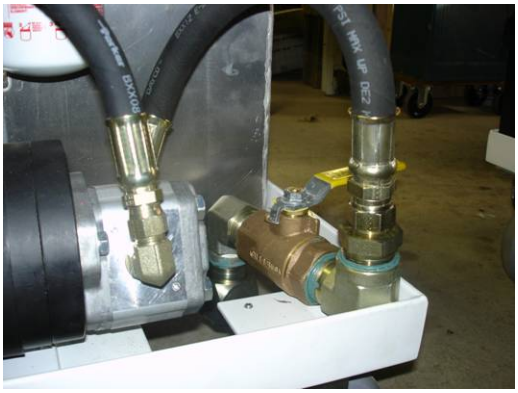
Drain Plug



F) Other Hydraulic System Maintenance

If any hydraulic system components require replacement, close the main inlet valve to prevent the hydraulic oil from draining down from the tank. It is critical that the valve be opened again before starting the motor and pump assembly.

Valve Open



Valve Closed

G) Capstan Replacement

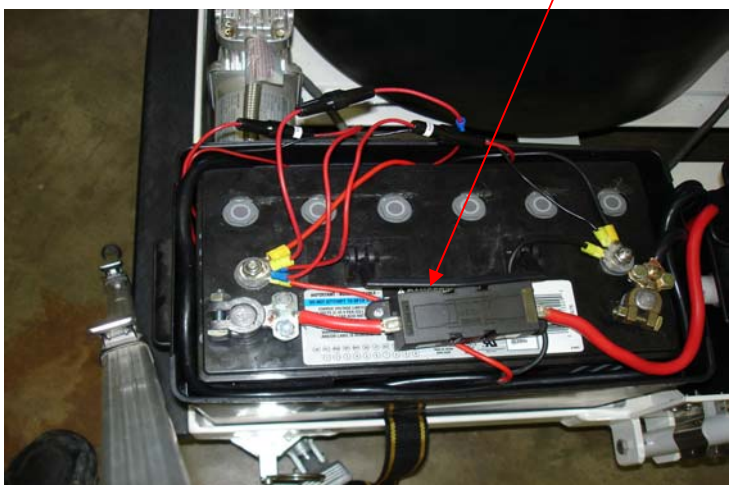
Check the capstans for wear, they can be easily replace when required. Also, if different size wire rope is to be serviced then the capstans will have to be changed to accommodate the different wire rope diameters.

Replacing Capstans					
	Open the cover and remove the (4) 10-32 x 1-1/2 screws from the upper capstan. Remove old capstan *(Note: that the upper capstan uses longer screws than the lower capstan.)*		Verify the .7 Key has remained in its location		Install new upper Capstan (Orange) and attach using the (4) 10-32 x 1-1/2 screws
	Remove (4) 10-32 x 1-1/4 screws from the Lower Capstan (Black) And remove old Capstan		Verify the .8 Key has remained in its location		Install new lower capstan (Black) and attach using the (4) 10-32 x 1-1/4 screws

H) Replacing the fuses.

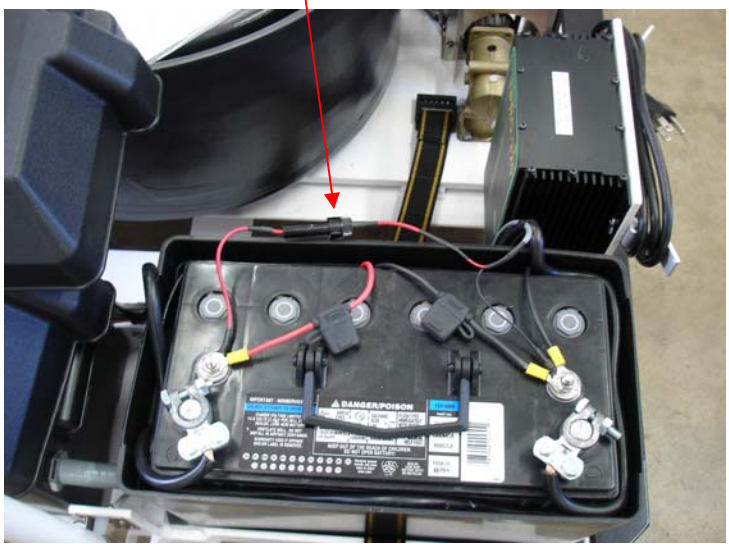
There are several fuses included in the system. The main fuse is under the outboard battery cover. The main fuse is rated fro 200 amps. If the battery wires connections become loose or if the extending load is adjusted above 150 lbs the main fuse may blow. It is there to protect the motor from excessive current. In the event the main fuse blows check all the battery wire connections to insure they are tight and check the extending load setting to insure it is less than 150 lbs. A spare main fuse is included in the spare parts package included in the system

Main Fuse Location

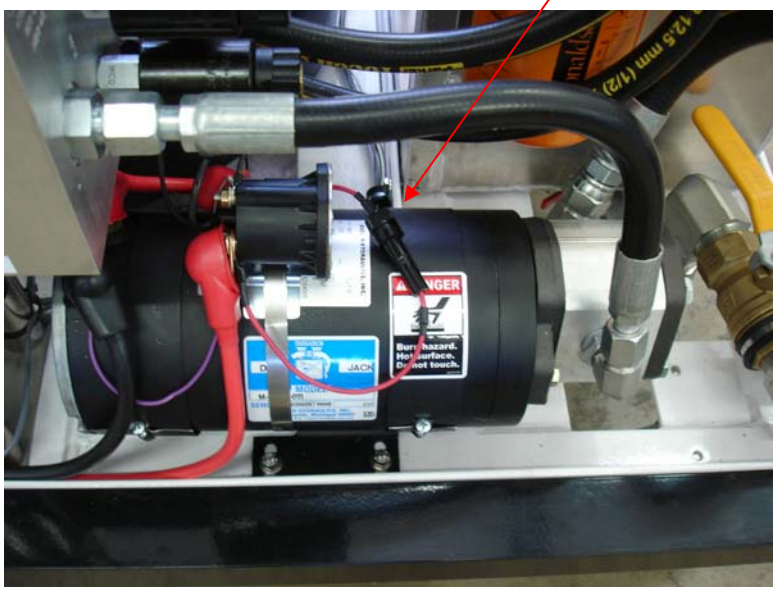


There are two control fuses rated for 5 amps each. One is located under the inboard battery cover and the other is attached to the motor/ pump positive terminal.

Control Section Fuse location

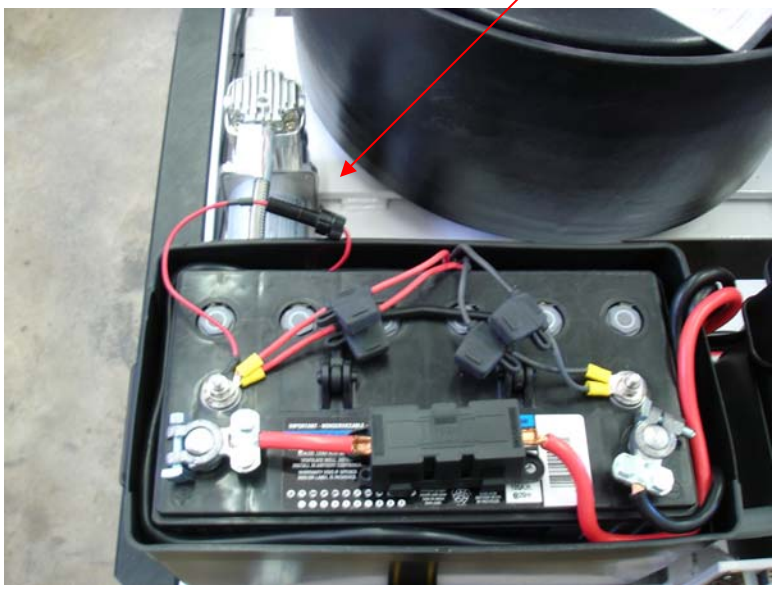


Motor starting and direction control circuit fuse location

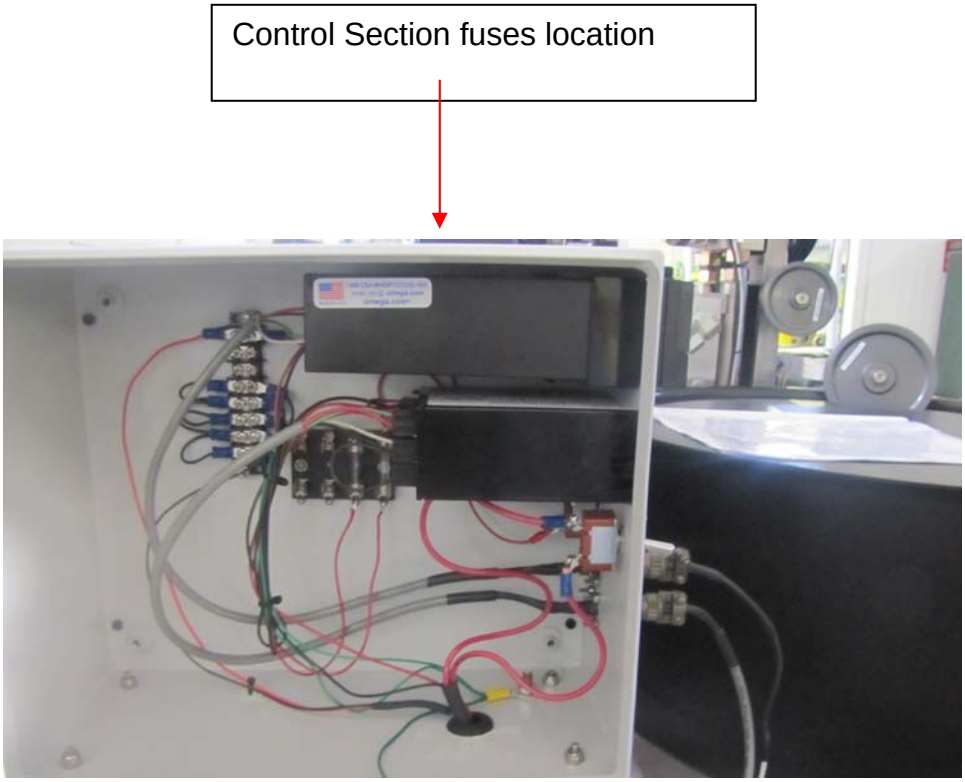


There is a 15 amp fuse that protects the air compressor.

Air compressor fuse location



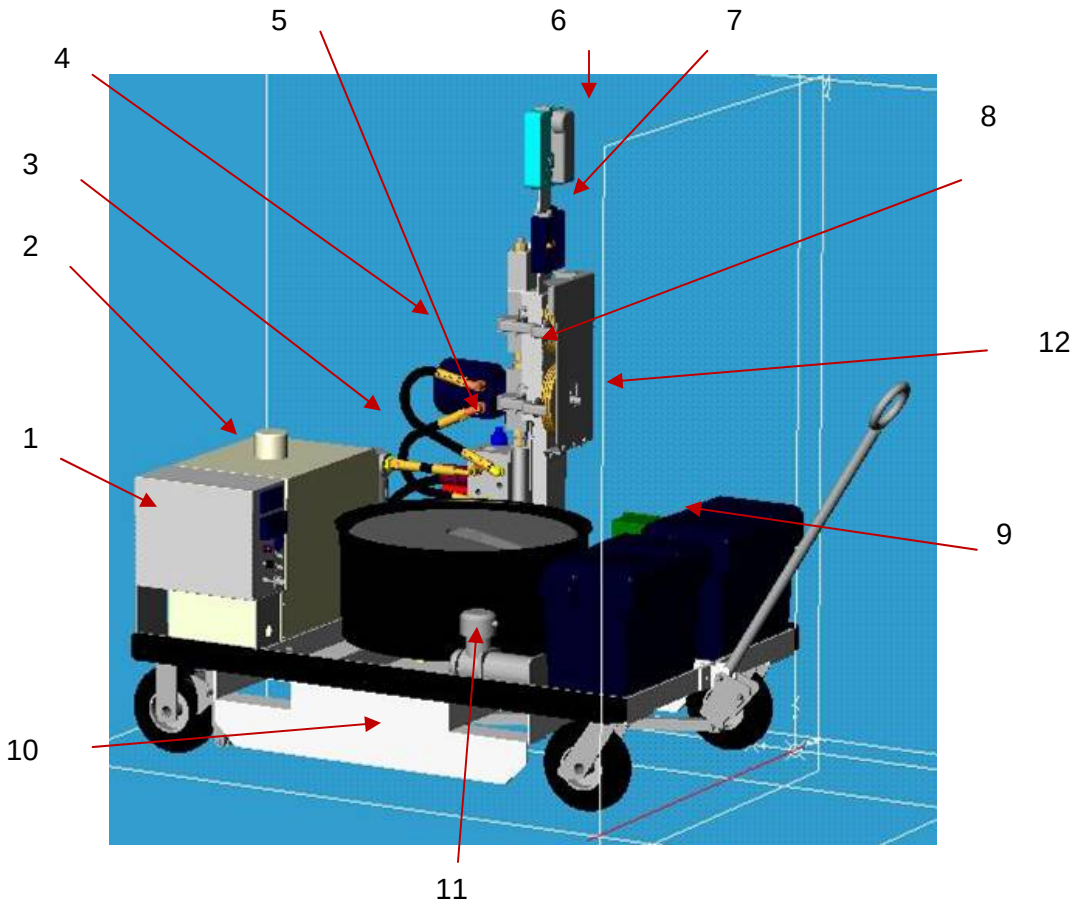
There are (2) one amp fuses inside the control section for each display



9.0) Standard Replacement Parts List

Parts List	
Part Name	**Part Number**
Batteries	
Battery (Main) MK8A31DT	ZGS-10056-1
Belts	
Drum Drive Belt	ZGS-10025-1
Vertical Drive Belt	ZGS-10040-1
Capstans and Cover	
Capstan Upper (orange) for 3/16" wire rope *(was ZGS-10113-20 is replaced by ZGS-12474-2)*	ZGS-12474-2
Capstan Lower (black) for 3/16" wire rope *(was ZGS-10113-20-1 is replaced by ZGS-12474-1)*	ZGS-12474-1
Capstan 1/8“ diameter wire rope	ZGS-10113-40
Capstan 5/32“ diameter wire rope	ZGS-10113-30
Capstan 3.5 mm diameter wire rope	ZGS-10340-1
Capstan Cover Assembly	ZGS-10328-1
Drum & Spooler	
Rotatub	ZGS-10022-1
Spooler	ZGS-10357-1
EC Hook Cable Spooler [For use only with the EC145 and EC135 Hook]	ZGS-11134-1
Plug for Rotatub	ZGS-10149-1
Encoders	
Encoder Assembly	ZGS-10301-1
Filters	
Oil Filter Cartridge - Donaldson P176565 Hydraulic Filter	ZGS-10069-2
Handles	
Tow Handle	ZGS-10111-1
Load Indicators	
Load Cell Assembly	ZGS-10316-1
Lubridryer	
Lubridryer Bushings	ZGS-10126-1
Lubridryer Pads (100 in the package)	ZGS-10104-10
Motor/Pumps	
Motor/Pump Assembly	ZGS-10017-1
Tensioning Wheels/Rollers	
Tension Release Pins	ZGS-10047-1
Pressure Roller Assembly	ZGS-10127-1
Exit Roller Assembly	ZGS-10294-1
Tension Wheel Small	ZGS-10258-1
Tension Wheel Large	ZGS-10259-1
Wire Guide	
Wire Guide	ZGS-10235-1

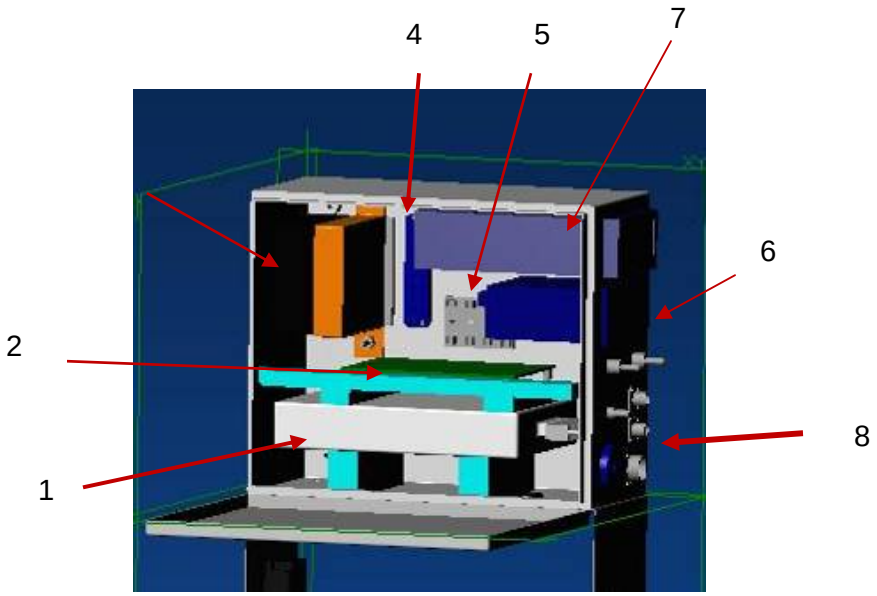
8.1) Illustrated Parts Breakdown



Major Assemblies

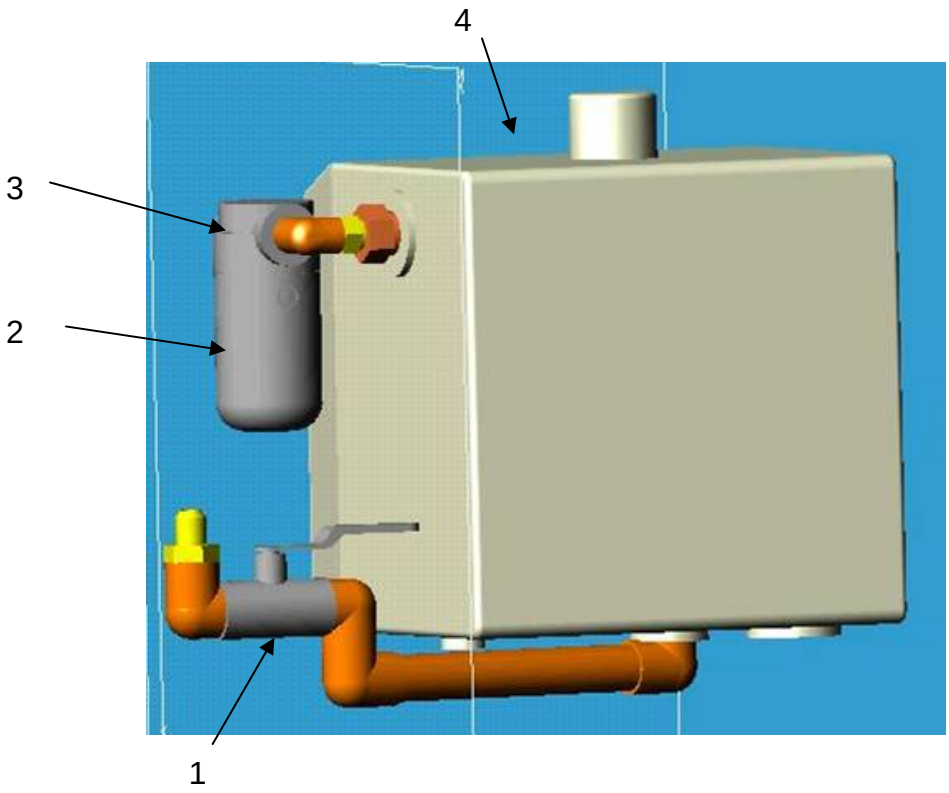
Item	Name	Number	
1	Control Station	ZGS-10308-1	
2	Hydraulic Tank Assembly	ZGS-10095-1	
3	Rotatub and Spooler	ZGS-10022-1 and ZGS-10081-1	
4	Hydraulic Motor and Fittings Assembly	ZGS-10102-1	
5	Hydrostatic Drive	ZGS-10133-1	
6	MagSens	ZGS-10200-1	
7	Lubridryer	ZGS-10048-1	
8	Capstan Drive and Upright Assembly	ZGS-10041-1	
9	Batteries	ZGS-10056-1 (2) required	
10	Mobile Base Assembly	ZGS-10118-1	
11	Compressor	ZGS-10052-1	
12	Capstan lt Cover	ZGS-10328-1	

Control Station ZGS-10308-1



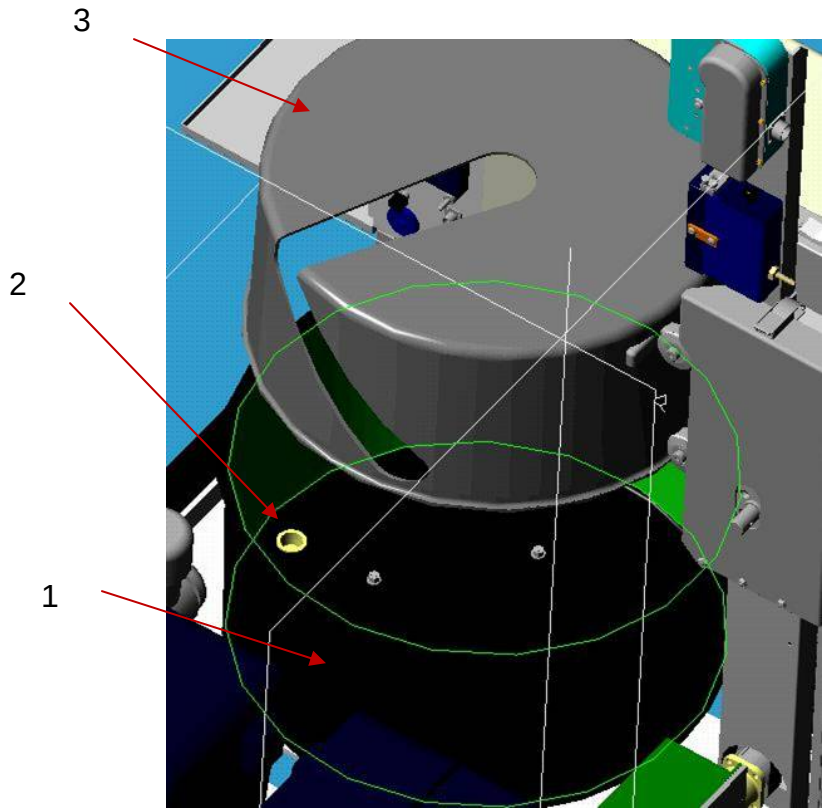
Item	Name	Number	Qty
1	Data Acquisition Box	ZGS-10152-1	1
2	Signal Conditioner Card	ZGS-10155-1	1
	deleted		
4	Terminal Board	ZGS-10165-1	1
5	Fuse Block	ZGS-10168-1	1
6	Length Indicator	ZGS-10192-1	1
7	Load Indicator	ZGS-12109-1	1
8	Box Machined	ZGS-10153-2	1
9			

Hydraulic Tank Assembly ZGS-10095-1



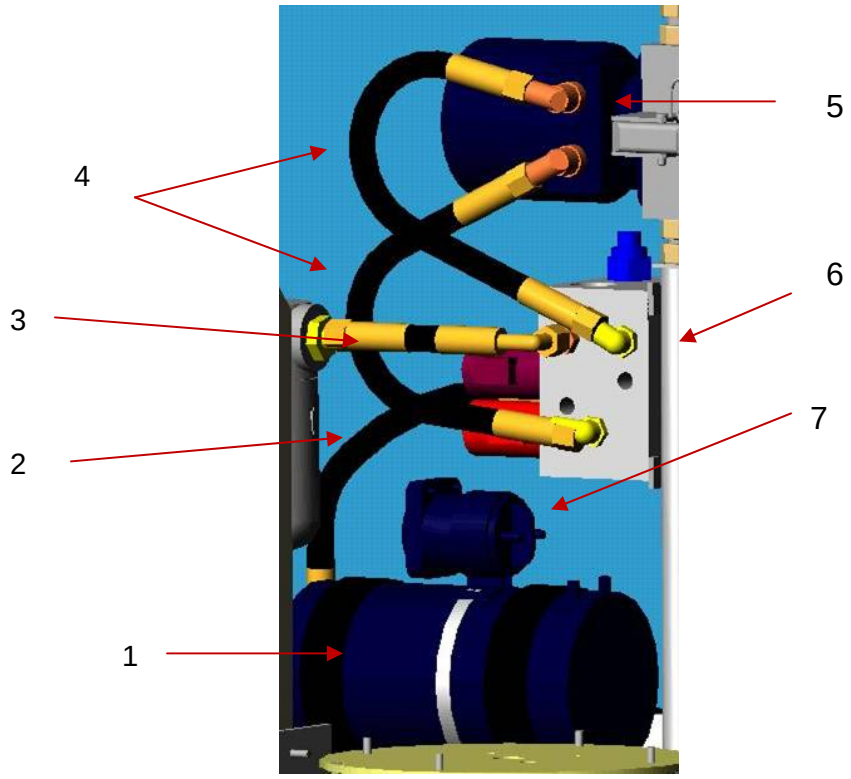
Item	Name	Number	Qty
1	Shut Off Valve	ZGS-10131-1	1
2	Filter Element	ZGS-10069-2 Donaldson P176565 Hydraulic Filter	1
3	Filter Assembly	ZGS-10069-1	1
4	Hydraulic Tank	ZGS-10070-1	1

Rotatub and Spooler



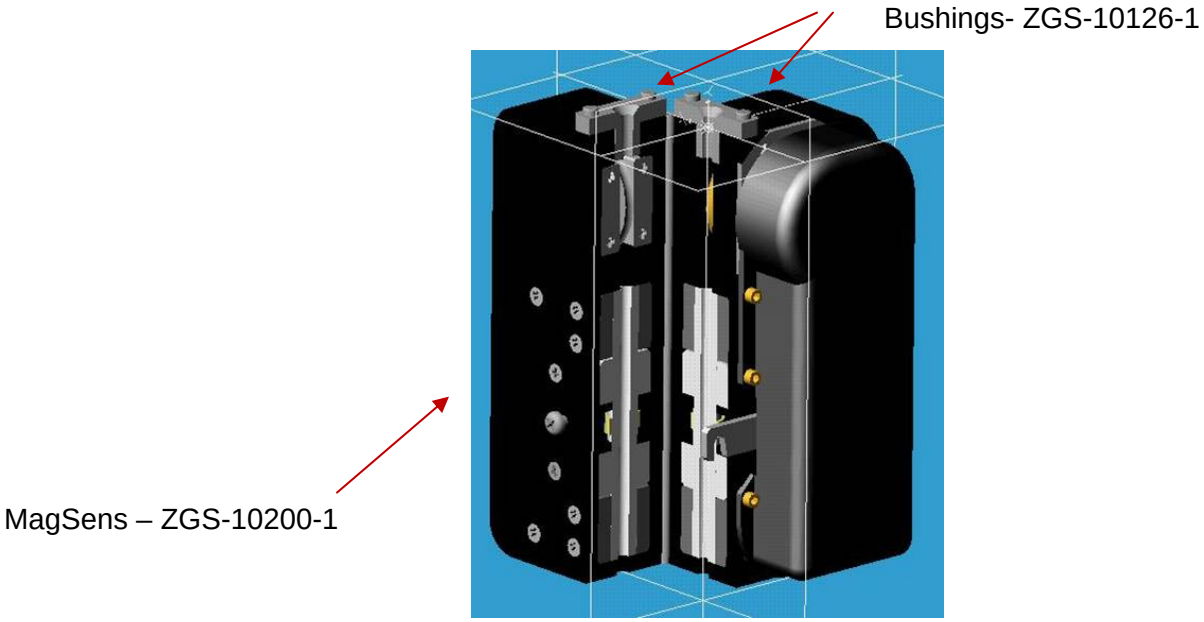
Item	Name	Number	Qty
1	Rotatub	ZGS-10022-1	1
2	Drain Plug	ZGS-10149-1 Niagra # WF-22	1
3	Spooler	ZGS-10081-1	1

Hydraulic Motor and Hydrostatic Drive

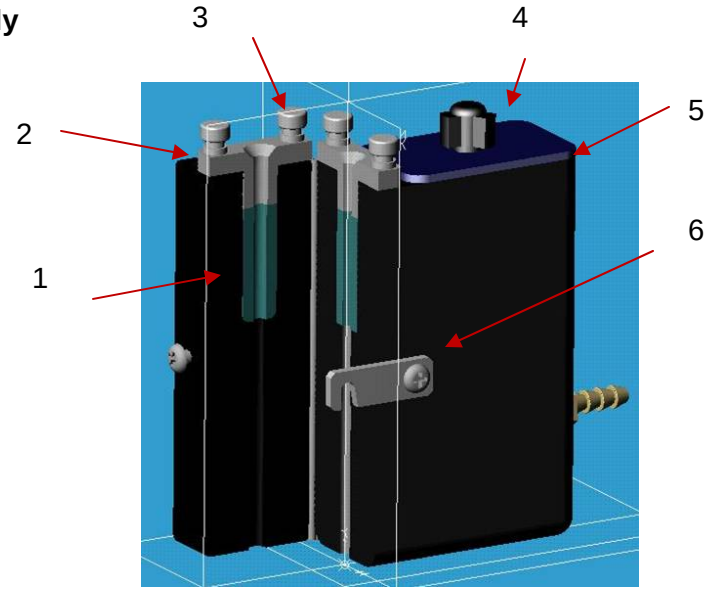


Item	Name	Number	Qty
1	Motor / Pump Assembly	ZGS-10071-1	1
2	Pressure Hose Assembly	ZGS-10077-1	1
3	Return Hose Assembly	ZGS-10076-1	1
4	Motor Hose Assemblies	ZGS-10072-2	2
5	Hydraulic Motor	ZGS-10067-1	1
6	Manifold Block Assembly	ZGS-10068-1	1
7	Motor /Pump Starter Solenoid	ZGS-10065-1	1
8	Inlet Hose (not shown) from shut off valve to pump inlet	ZGS-10075-1	1

MagSens Assembly

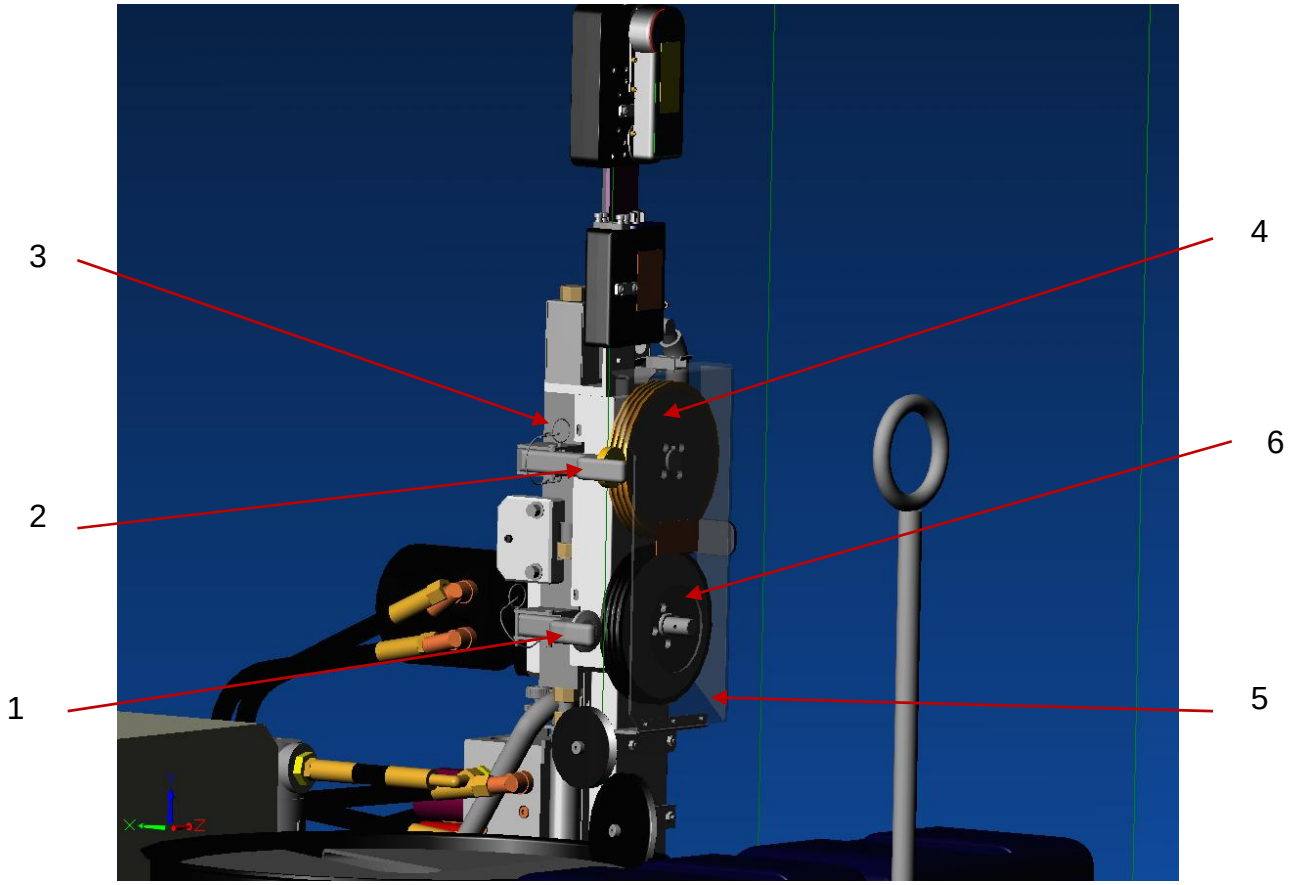


Lubridryer Assembly



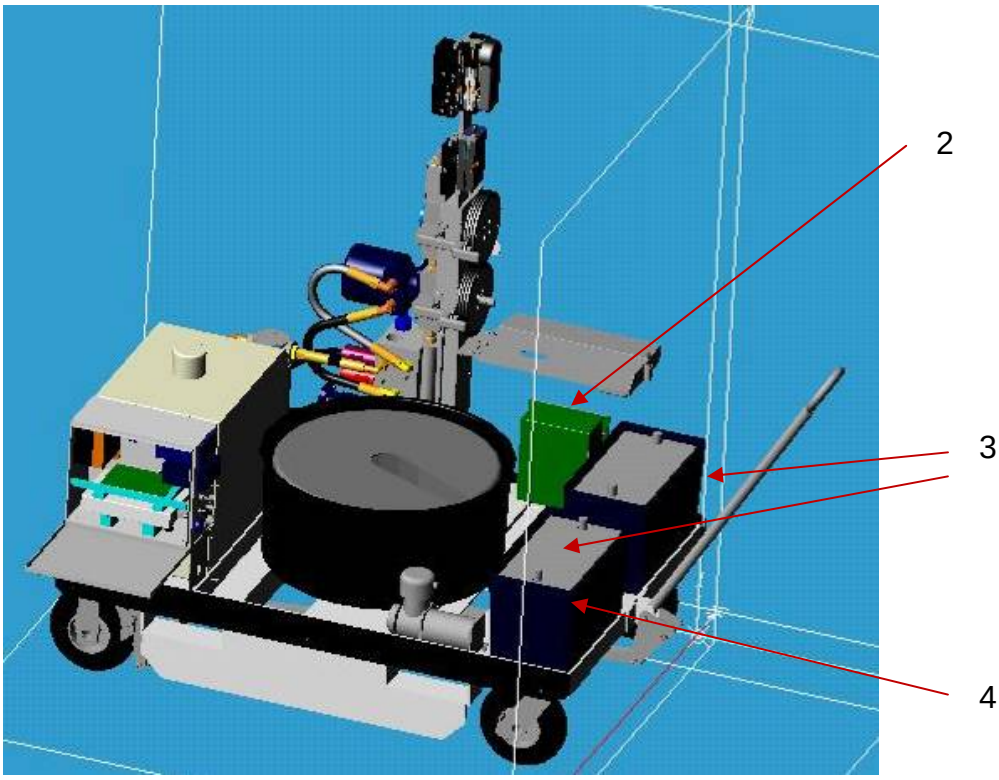
Item	Name	Number	Qty
1	Lubridryer Pad	ZGS-10104-1	2
2	Lubridryer Bushing	ZGS-10126-1	2
3	Thumbscrew	ZGS-10147-1	4
4	Cover Retaining Screw	ZGS-10137-1	1
5	Reservoir Cover	ZGS-10124-1	1
6	Latch	ZGS-10051-1	1

Capstan Drive and Upright Assembly



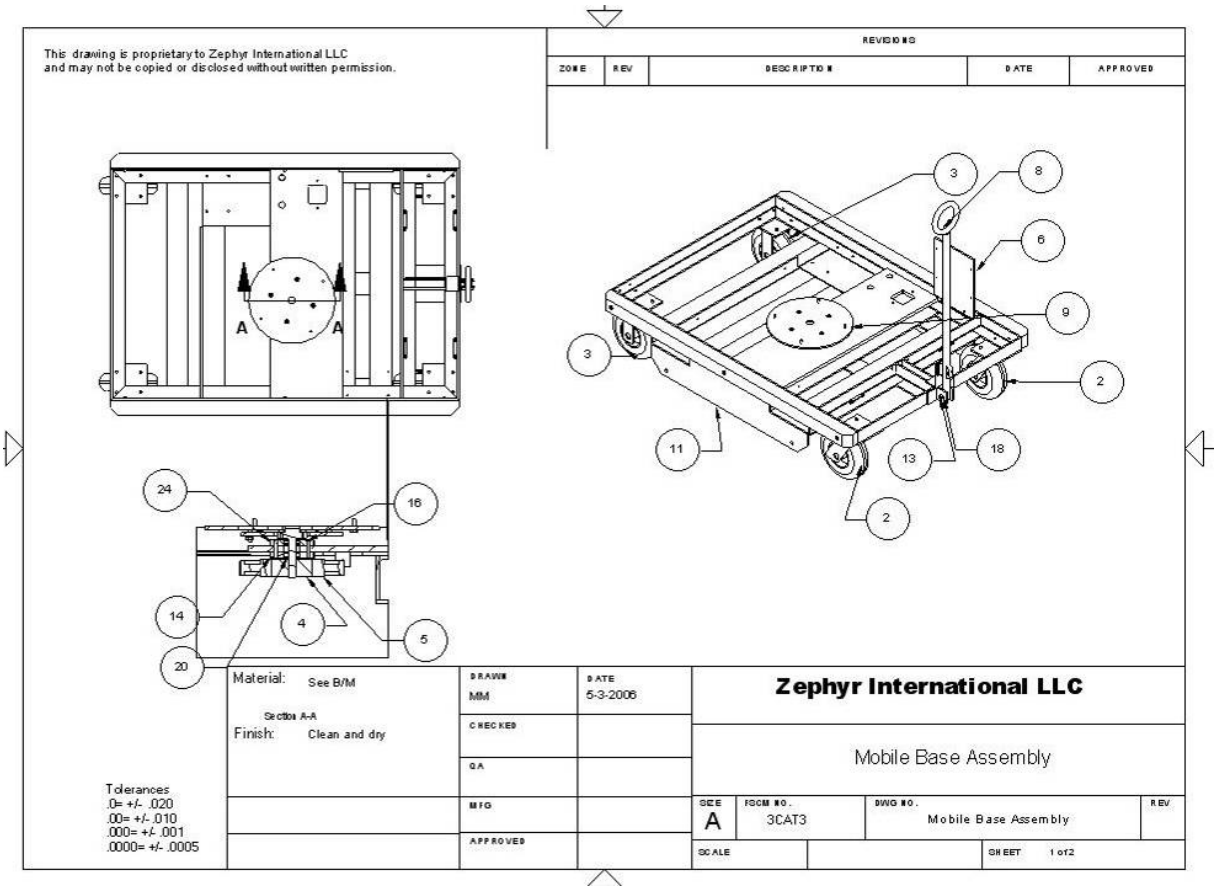
Item	Name	Number	Qty
1	Lower Pressure Roller Assembly	ZGS-10127-1	1
2	Exit Roller Assembly	ZGS-10294-1	1
3	Hitch Pin	ZGS-10047-1	2
4	Upper Capstan Roller	ZGS-12474-2	1
5	Vertical Drive Belt and Capstan Cover Assembly	ZGS-10328-1	1
6	Lower Capstan Roller	ZGS-12474-1	1

Batteries and Charging System



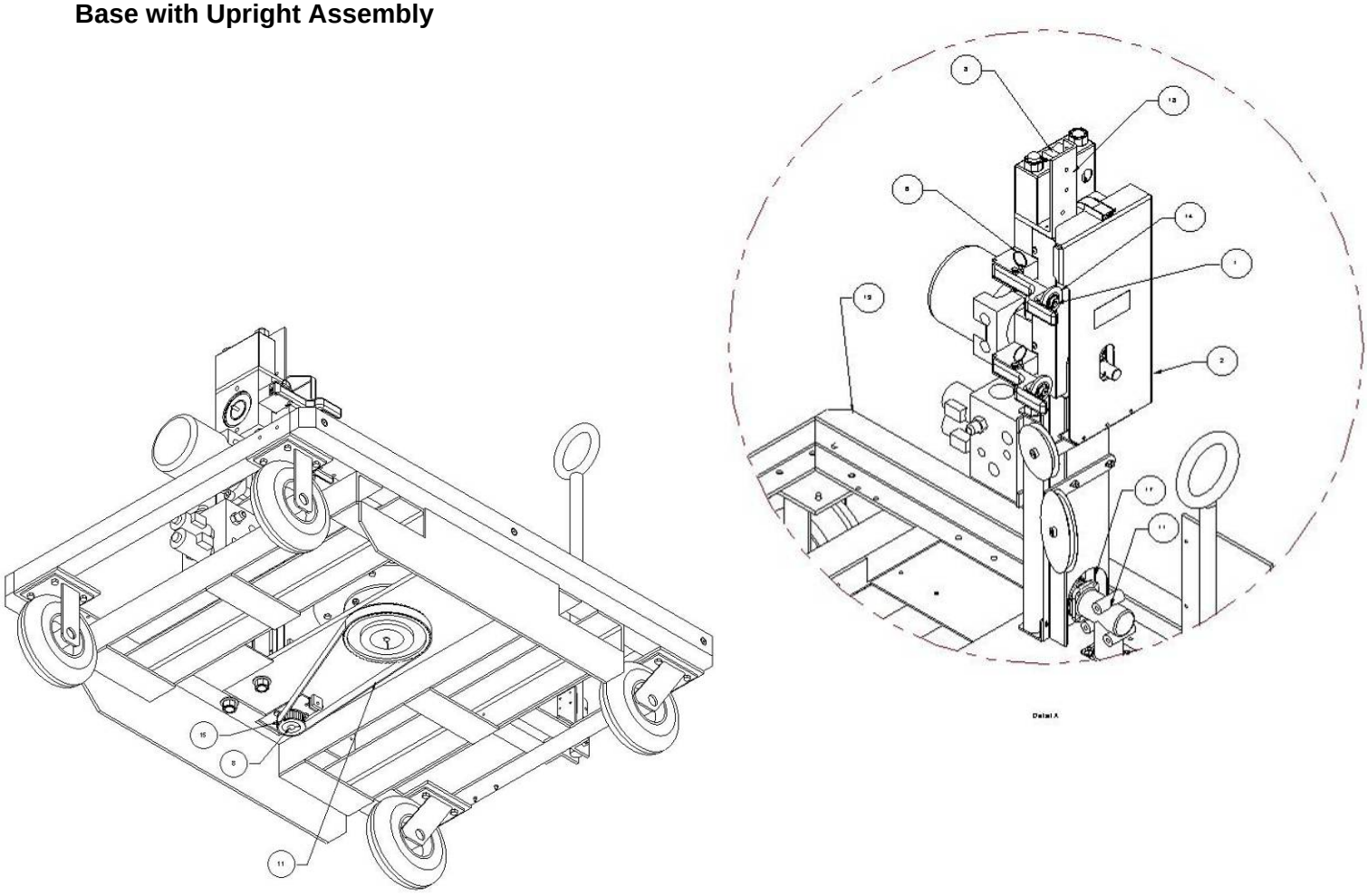
Item	Name	Number	Qty
1	deleted		
2	Battery Charger	ZGS-10057-1	1
3	Main Batteries	ZGS-10056-1 MK 8A31 DT	2
4	Battery Boxes	ZGS-10078-1 &-2	2

Mobile Base Assembly



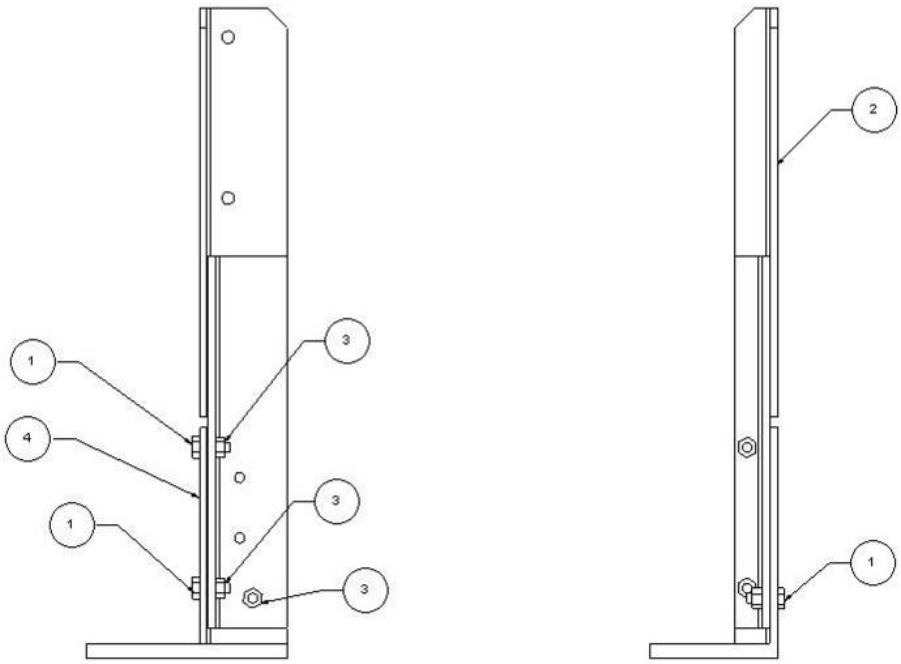
Item Number	Quantity	Part Number	Part Name	Revision
1	1	ZGS-10121-1	Axel Sleeve	
2	2	ZGS-10144-2	Swiveling Tornado Caster	
3	2	ZGS-10143-2	Rigid Tornado Caster	
4	1	ZGS-10024-1	Taper Lock 6 inch Pulley .5 inch bo	
5	1	ZGS-10023-1	Pulley , 6 inch	
6	1	ZGS-10097-1	Charger Support	
7	2	ZL-1031-1	Leg, Mounting Standoff	
8	1	ZGS-10111-1	Tow Handle	
9	1	ZGS-10248-1	Infinitly adjustable platen assy	
10	1	ZGS-10195-1	Side Guard	
11	1	ZGS-10001-2	Frame Assembly Basic	
12	1	ZGS-10265-1	Side Guard, Steel	

Base with Upright Assembly



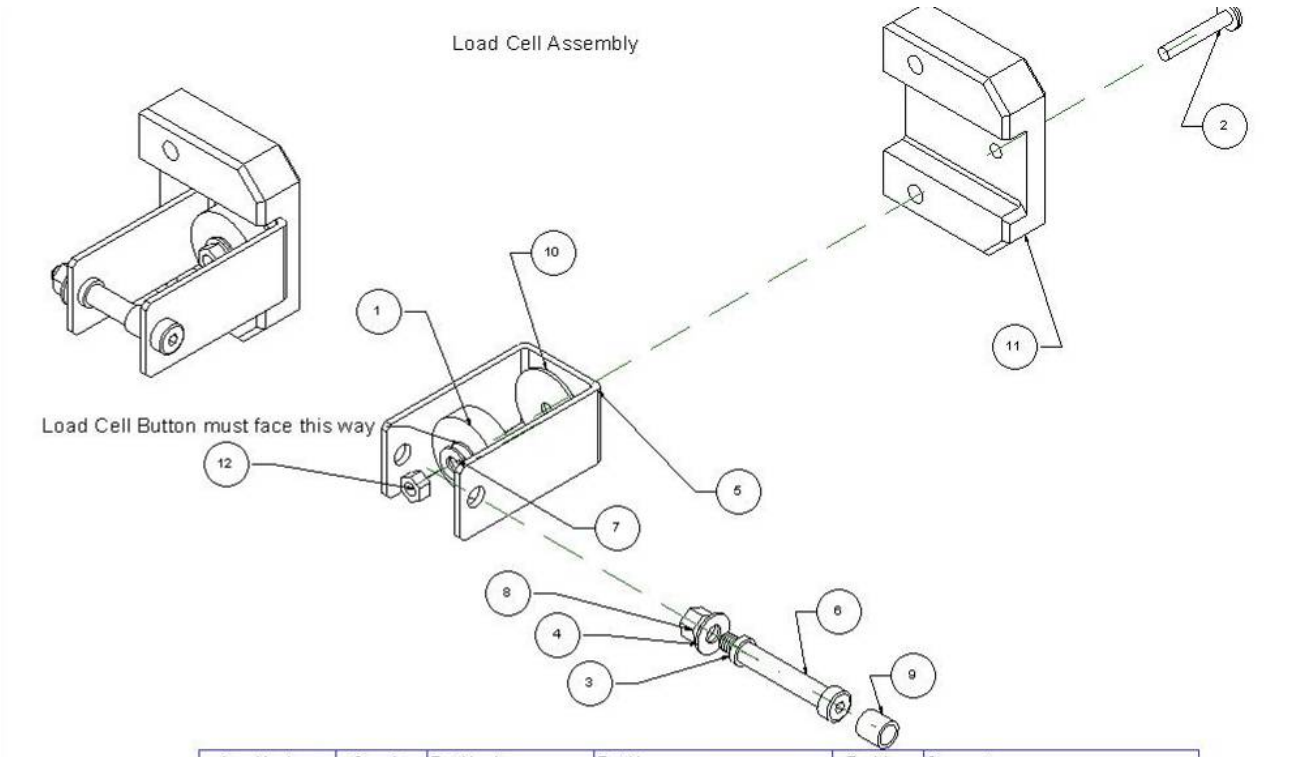
Item Number	Quantity	Part Number	Part Name
1	2	ZGS-10119-1	Tensioner Roller Shaft
2	1	ZGS-10045-1	Belt Guard and Cover Assembly
3	4	10-32 SHCS Hardened	10-32 x 1.5 SHCS
4	4		.25-20 x .75 long SHCS
5	2	ZGS-10047-1	Tension Release Pin
6	1	ZGS-10063-1	SW3823 Rocker Switch
7	1	ZGS-10013-1	AnglGear
8	2	ZGS-10027-1	Taper Lock .63 Shaft, 2 inch Pulley
9	2	ZGS-10044-1	Pressure Roller
10	1	ZGS-11066-1	Capstan Idler Rub Plate
11	1	ZGS-10025-1	Drive Belt, Drum
12	1	ZGS-10040-1	Drive Belt, Vertical
13	1	ZGS-10085-1	Upright Bracket
14	1	Mobile Base Assembly	Phantom Assy 1
15	2	ZGS-10026-1	Pulley, 2 inch

Upright Bracket Assembly



Item Number	Quantity	Part Number	Part Name	Revision
1	3	1/4-20 x .75" long Cap Screw	.25 x .75 cap screw	
2	1	ZGS-10245-1	Upright Upper assembly	
3	3		.25 nut	
4	1	ZGS-10085-1	Upright Bracket	

Load Cell Assembly



Item Number	Quantity	Part Number	Part Name	Revision	Comment
1	1	ZGS-11099-2	Thru Hole Load Cell		Assy with connector is ZGS-10316-1
2	1	ANSI B18.6.3	1-4 x 28 x 1.5 machine screw		
3	1		3-8 shaft spacer .12 long		
4	1		.312 Flat Washer		
5	1	ZGS-11113-1	Load reaction clevis		
6	1	ZGS-10190-1	.375 stripper bolt 2 long		
7	1		.25 Flat Washer		
8	1	5/16-18 Locknut	.312 locknut		
9	1		3-8 shaft spacer .5 long		
10	1	1/4- 1 1/4	Fender Washer		
11	1	ZGS-11112-1	Load Brake Support		
12	1	1/4 Lock Nut	.25 Lock nut		

10.0) Technical Support

Please contact Zephyr International LLC with any questions
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zephyrintl@rcn.com