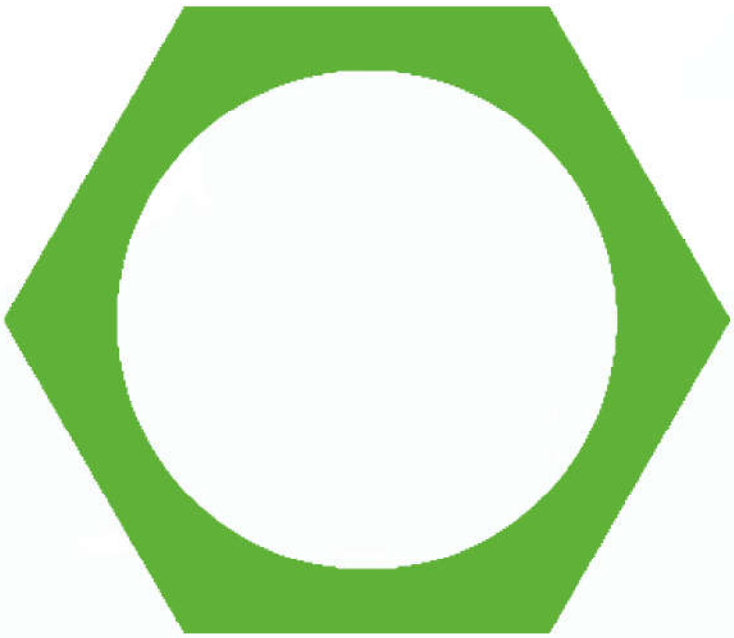
SLK Connect

05 SURFACE EQUIPMENT

Martin Decker Weight Indicator

WIRE ANGLE • CORRECTION FACTOR • PURGING

The traditional Slickline weight indicator, load cell, hydraulic hose and gauge, has in the main been superseded by the measurehead mounted integral tension device, but the traditional weight indicator is still often being run as a backup .....



Document no: slkc - 0078
Revision: rev02
Date 1st published: 31-Jan-2018

SLICKLINE CONNECT
Surface Equipment
Martin Decker Weight Indicator

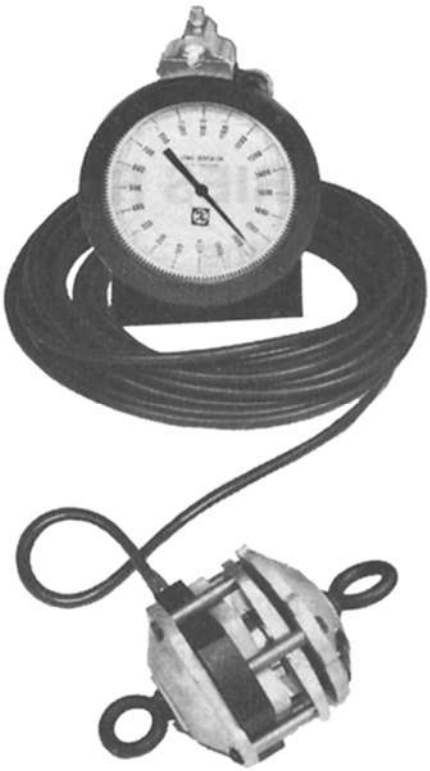
Introduction

The traditional Slickline weight indicator, load cell, hydraulic hose and gauge, has in the main been superseded by the measurehead mounted integral tension device, but the traditional weight indicator is still often being run as a backup due to its reliability, simplicity coupled to the accuracy, performance and reactive sensitivity of the needle movement. As simple a device as it is, it still requires constant attention and maintenance to ensure it performs accurately and consistently.

System

The slickline weight indicator comprises of three parts:

- The compression load cell is mounted below the lower hay pulley and tied down to a solid object by a chain or sling
- The hydraulic hose connects the load cell to the gauge, standard hoses are either 50ft, 75ft or 100ft long
- The gauge is 6" in diameter and fluid filled is mounted in the Slickline unit, close to the operating position.
- Weight indicators are available in different tension ranges, typically 2000 lbs, 4000 lbs and 5000 lbs.



Weight Indicator Complete System

Changes in wire tension, increases or decreases, are transmitted via the load cell to the hydraulic fluid in the system and to the gauge, where a bourdon tube converts the pressure change into a circular motion of a needle moving relative to a circular scale on the gauge back face.

The sensitivity of the needle movement can be adjusted with a hydraulic dampener. The closed hydraulic system is extremely sensitive to even the smallest load change on the wire and it is this feature that makes the traditional weight indicator often the preferred method of measuring line tension.

Critically a loss of hydraulic fluid and/or air in the system will affect the weight indicator performance. If there is a sufficient loss of fluid the load cell faces will close up and the system will stop functioning or registering tension changes on the wire or cable

It is very important when rigging up and throughout the operation to make continuous observations and checks of the weight indicator system, checking the hose for damage, checking the system for hydraulic fluid leaks, checking the load cell gap is maintained and checking the needle movement.

If the load cell gap is not maintained at the recommended gap (***Note: different manufacturers recommend different load cell gaps, check the OEM operations manual***) and reduces sufficiently the weight indicator

gauge reading will only show an increase in line tension up to the point where the load cell faces have closed up solidly. In effect additional line tension will not be seen, leading to a possibility that the wire could be over tensioned my error. This malfunction in the weight indicator system is one of the leading causes of wire failures.

Rigging-up

The weight indicator must be rigged up at or as close as possible to the well head. The load cell is fitted with two rotating eye clevis connections, the lower eye is used to connect to a chain or sling to tie the weight indicator to the well head or other solid object while a hay pulley / lower sheave is connected to the upper eye.

The tie down chain or sling must be certified and must be rated to at least three times the expected line loads that are going to be encountered in the operation.

It is important that the eye clevises rotate, this provides some protection for the hose and avoids it becoming wrapped around the load cell. The hose connection, specifically the end fitting which is crimped to the hose connector, is a significant weak point and it is common practice to loop the hose back and tape it to the tie down chain to protect it from potential damage due to movements of the weight indicator

Weight Indicator Correction Factor

If a Martin Decker Style weight indicator is being used the angle of the wire at the lower sheave pulley should ideally be at 90° to obtain an accurate tension reading. This table shows the correction factors to be used if the wire angle varies from 90°.

Wire angle – lower sheave pulley (degrees)	Tension Correction Factor (divide by)	Weight Indicator Reading	True Wire Tension	Gauge Percentage Error
75	1.12	550	491	11% High
80	1.08	550	509	7% High
85	1.04	550	528	4% High
90	1.00	550	550	0
95	0.96	550	598	7% Low
100	0.91	550	604	9% Low
105	0.86	550	639	16% Low
110	0.81	550	679	23% Low
115	0.76	550	723	31% Low
120	0.71	550	775	40% Low

Note: the possibility of over stressing the wire is greatest during rig operations, where the Slickline unit is positioned at the end of the cat walk and the wire passes through the vee-door and makes an angle at the hay pulley of >90°

The correction factor is a ratio of the wire angle to the calibrated angle and determined using the following equation, in this example the measured angle of the wire at the hay pulley is 110°. 90° is the angle that the weight indicator is calibrated to, and, is always used in the correction factor calculation

Correction factor = (cosine (measured wire angle ÷ 2)) ÷ (cosine (90÷2))
Correction factor = cosine (55) ÷ cosine (45) = 0.574 ÷ 0.707 = 0.81

Hose

Weight Indicator hoses are 1/4" high pressure hoses of a single wire braided construction. The hose should be laid out in a straight line from the load cell in the unit with no bends or loops. It should have sufficient slack to avoid applying tension to the hose end fittings. The hose should be protected and routed through areas where it cannot be damaged.

Gauge

The gauge is usually mounted adjacent to the winch operators position and in a position where it is in clear line of sight. The gauge is a precision instrument with a bourdon tube connected by a mechanism to the indicator needle and must be protected from external damage.

The gauge is fluid filled which provides protection and lubrication for the mechanism. The gauge is equipped with a damper which is used to adjust the sensitivity of the needle and a zero correction dial. For instance prior to picking up the tool string the operator would rotate the gauge dial so that the needle is positioned at zero.

Pre-Job Checks

Pre-jobs are to ensure the weight indicator is installed correctly and there is no damage to any of the components and through observation: -

- Check the gap in the load cell between the load faces, check the OEM manual for the correct gap
- Check the load cell is secured and correctly mounted and any shackles are equipped with a safety clips
- Check the bleed off port fittings on both the gauge and the load cell are fully tightened
- Check the protector is fitted to the pump connection on the gauge
- Check the damper is functional
- Check the condition of the hose over its full length with a focus on the hose end fittings
- Check the overall system for any indications of hydraulic fluid leaks
- Verify that a weight indicator pump and spare fluid is available on location

Purging & Pumping Up Hydraulic System

Weight Indicator maintenance mainly revolves around the hydraulic system and ensuring there is no air in the system and that the gap in the load cell is set correctly. Using the correct hydraulic fluid is key and all manufacturers of this type of weight indicator recommend a high grade, generally red in colour hydraulic fluid which is suitable for a wide range of ambient temperatures. Operating range of a weight indicator is -29° C to 49° C.

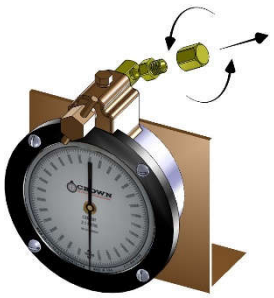
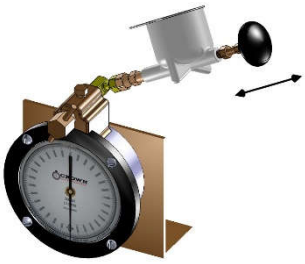
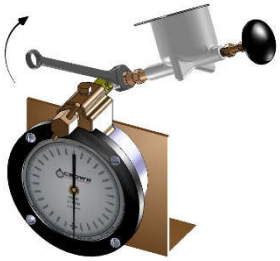
The hydraulic fluid recommended by manufactures is selected for many reasons, one of which is its low coefficient of expansion. However it can be the case that substitute hydraulic fluids are used which in extreme conditions where the system is exposed to elevated temperatures or the hose is in contact with a hot steel deck the fluid expansion can be sufficient to fully expand the load cell faces and potentially causing it to block out.

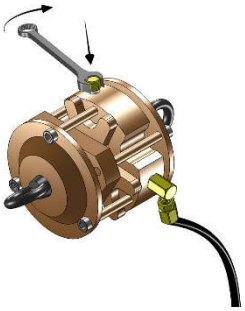
Recommended hydraulic fluids, examples: -

Wagner	WF100
Crown	Equivis XLT
Martin Decker	W15 Red

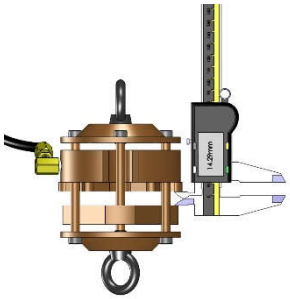
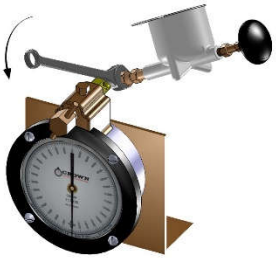
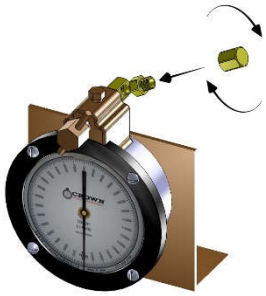
Purging

Is the method of pumping through the hydraulic system to replace the hydraulic fluid and pump out any air that may be in the system. The required equipment for this operation is, a hand pump, spanner, sufficient hydraulic fluid and a means to check the load cell gap

1. Ensure all components in contact with the hydraulic fluid are clean Prior to starting, the first task is to ensure the hand pump is clean		2. Remove the protective cap from the filler port on the weight indicator gauge	
3. Install the pump, endeavour to have the pump reservoir positioned horizontally, to avoid spilling the hydraulic fluid during the purging operation		4. Before fully tightening the hand pump connection, add a small quantity of hydraulic fluid to the pump reservoir and stroke the pump handle a few times to expel any air	
5. Open the bleed off plug on the load cell and remove completely		6. Position the load cell higher than the pump and slowly pump hydraulic fluid through the weight indicator system until all the air is removed	

7. When all the air has been purged, re-install the load cell bleed off plug and tighten. Ensure the bleed off plug threads have been cleaned and new Teflon tape has been used			

Setting up the Load Cell Gap

Continue to slowly pump hydraulic fluid into the weight indicator while observing the gap in the load cell load plates, they should be expanding with every pump stroke		Pump open the load cell gap to above the desired gap	
Crack open the bleed off plug on the load cell and bleed off the excess fluid to close up the load cell to the desired gap		Carefully remove the hand pump to avoid spilling any excess hydraulic fluid	
Re-install the protective cap		Adjust the needle to zero against the scale	

Note: During operations it may be necessary to purge the weight indicator system and it is important to have the correct tools available and sufficient hydraulic fluid to replace the complete weight indicator systems fluid.

Validating Weight Indicator Performance

A weight indicator must have its readings validated at least annually. No adjustments can be to made to calibrate or re-calibrate the weight indicator and the most that can be done is a validation of the weight indicators performance.

This can be done in the workshop either using known weights or a calibrated inline load cell.
Below is an example of a setup for validating the weight indicator against known weights.

Procedure

Assuming the rig-up as shown in the above diagram, hay pulley and weight indicator tied down to a certified anchor point, and an upper pulley suspended in a position where weights can be added to the wire

1. Perform any maintenance, system purging or gap setting prior to rigging up
2. With the rig-up completed and no weights added to the wire, determine the wire angle and calculate the wire correction factor
3. Set the weight indicator to zero
4. Add the first weight and record the reading on the weight indicator gauge
5. Repeat 4. above, making at least 5 separate readings in total
6. Tabulate and plot the results versus the applied weight

In the normal course of events the plot of the results will show no or a little deviation, and if the weight indicator is well maintained and the system is fully purged of air and the gap is maintained correctly it will perform as designed.