The intent of this technical bulletin is to look at best practices on pressure work for longer cable life, from a cable manufacturers perspective. Many wireline operations are performed when the well is “live” or when the wellbore pressure exceeds the atmospheric pressure. Live operations are performed for several reasons including: to lower cost of operations, to reduce formation damage, to minimize lost production due to downtime, and to perform pump-down operations. Armored lines (wireline) by design have interstices between armor wires and armor layers which cannot be packed off in a direct manner. In order to maintain well control during “live” operations a grease head and lubricator are employed. The wireline is passed through several closely fitting flow tubes (picture below and to the right) prior to the rope socket being attached. Viscous grease is injected into the assembly at pressures exceeding wellbore pressure and fills the space between the wireline and the inner diameter of the flow tubes. The grease packed in the tight annular space provides significant resistance to wellbore pressure by adhering to the surfaces of the cable and the flow tubes; while permitting the wireline cable to travel into and out of the wellbore. Each subsequent flow tube creates compounding pressure drop so there is no residual pressure drop as the wireline exits the flow tubes. Pressure is maintained higher than wellbore pressure with a grease pump. The tighter the annular space the higher the force (pressure) required to displace the grease. This principle is the same for both braided wireline and slickline.

A pack off is mounted at the top of the lubricator to seal the well in the event of losing pressure control through the grease head. This should not be used as a line wiper because the packing rubbers are a harder compound and can cause damage to the wireline. These devices also prevent the wireline from rotating which causes the armor to loosen and may result in a birdcage below the pack off. In addition; wear on the pack off rubbers can limit their ability to seal the wireline effectively in the event the flow tubes are not able to hold back the wellbore pressure. In reality, many operators do use the pack off to wipe the line, particularly when the flow tubes are oversized and pressure control with grease is difficult to maintain. The argument for wiping the line is that the wireline equipment stays cleaner as well as the wellsite which provides both a better work area and more responsible environmental stewardship. In fact more and more operators working offshore and in environmentally sensitive areas are requiring line wipers. If a line wiper is required, or going to be used, it is highly suggested that a line wiper is used in addition to the pack off. In other words do not use the pack off for this purpose. Supplemental line wipers are available and can be purchased with softer rubber. A proper set up will allow the pressure on the line wiper to have more sensitive control than a pack off to minimize the force on the wireline. The line wiper should never be used to control pressure only to clean the line. However the user should always be aware that there is the possibility of damaging the wireline whenever a line wiper is being employed.

New Cables are particularly risky for pressure work. During manufacture a cable is subjected to only a few hundred pounds of tension, so there is essentially no torque in a new cable as delivered. When installed on a truck the spooling tensions are significantly higher than during manufacturing, and the cable is not free to rotate so the cable will develop significant torque. When making the first field operations this new cable will try to rotate to equalize this built up torque, as well as to support the weight of the tool string. To illustrate the magnitude of this
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(a Wireline Manufacturers Perspective)  

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problem consider a new 7/32" cable deployed in a straight 20,000 ft well. The total rotations that a new 
cable end would need to rotate to equalize the torque could be over 400 rotations. Until the cable is well 
seasoned it is recommended that flow tubes be on the high end of the industry standard (3 to 8 
thousands of an inch) to allow for changes in line diameter and cable rotation. This seasoning is critical 
to the life of a wireline cable: a review of Technical Bulletin 2 `New Cables` is recommended. The 
Technical Bulletin discusses lines speeds, and operational practices for new cables.

Pressure work also slows the seasoning process by lubricating the cable and preventing 
corrosion from forming in the armors spaces. This wellbore fluid and grit, combined with corrosion helps 
preserve the cable from spinning and is an important part of the seasoning process. Once seasoned the 
lubrications from grease jobs is good for the cable. The first time a cable is used for grease injection a 
substantial amount of extra grease will likely be required to fill the interstices between the armors.

New flow tubes should always be used on new cables. Used flow tubes may have wear and it is not 
necessarily even around the diameter of the flow tube. This non-uniform wear can cause a high friction 
spot in the flow tubes and a non uniform annulus between the flow tube and cable. These circumstances 
are not ideal and not worth risking cable damage, particularly on a newer cable when you should 
anticipate additional spin and changes in diameter.

Sizing Flow Tubes Prior to starting a pressure job it is important to understand the diameter of the 
cable and the amount of wear on the cable. As a general practice it is a good idea to caliper the wireline 
every couple of thousand feet and record the readings in the line record book for future reference when 
selecting flow tubes. A good rule of thumb is if the wireline varies in diameter more than 0.006” it is not a 
good candidate for pressure work. If you are running deeper than normal or the line has been cut off or 
shortened, you could be getting to a part of the wireline that has never been off the drum. This is the 
same as a new cable. Now you have a mixture of used seasoned cable and brand new cable. You must 
treat it as if the cable is new.

Industry standard for flow tube selection has been 3 to 8 thousands of an inch larger than the maximum 
OD of the wireline entering the well. A wireline cable will vary in size along the entire length of a cable 
due primarily to wear and stretch. Flow tubes also wear causing their inside diameter to increases in size. 
Understanding your cable and flow tube diameters is critical in getting a good seal during pressure work 
without compromising the possibility of getting stuck in the flow tubes and potentially breaking the cable.

Crossed Armor Wires A common problem that results from the use of flow tubes that many times goes 
unnoticed is “crossed” armor wires. To insert the wireline through the flow tubes the rope socket is cut 
off and the armor wires twisted together. It is during this step that the armor wire can be unintentionally 
crossed as shown in the picture to the right. This crossed armor may cause problems by getting stuck in 
the flow tubes on that first run or it may get milked up the cable and show up many runs later thousands of 
feet up the cable. The crossed armor wire could also be forced back through the flow tubes by indenting the 
outer armor into the inner armor and plastic conductor, again going unnoticed. However, in this case the 
crossed armor by its very nature will take most of the wear as the wireline slides through the flow tubes. 
Eventually the wire will break and potentially ball up below the flow tubes. This condition can also result in 
an electrical short where the inner wire has been forced though the plastic to the copper.
The best practice to prevent crossed armors is to stop and check the cable after the first flow tube has been installed. Slide the first tube back and forth then run your hand down the cable in front of the flow tube feeling for any irregularities. If a crossed armor wire is found near the tool end it and it has not been forced through the flow tubes then it can sometimes be milked back to the tool end. If however the crossed wire is hundreds or thousands of feet up the wireline then the best practice would be to go to the nearest authorized service center to have them return the wireline to operational condition. When a crossed armor has been forced through a flow tube and then found, the wireline needs to be cut off to prevent the possibility of either a broken armor or electrically shorted cable.

**Sinker Bars** In order to enter a live well the force created by the pressure in the well must be overcome. This is accomplished by adding sinker bars to the end of the tool string. The weight of sinker bar can be calculated using the formulae below or alternatively going to [www.qualitywireline.com](http://www.qualitywireline.com) and use the sinker bar calculator under “technical support”.

The force pushing the cable out of the well is a function of the pressure in the well and the cross sectional area of the wireline. It can be calculated as follows:

Cross Sectional Area \( A = \pi r^2 \)

Where \( r \) is the cable radius and \( \pi \) (Pi) is 3.14

Example: Wireline 7/32” (0.224”) with tool string weight \( T \) of 175 pounds

\[ r = \frac{0.224}{2} = 0.112” \]

\[ A = 3.14 \times (0.112)^2 \]

\[ A = 0.0394 \text{ in}^2 \]

The Balance Weight \( F = P \times A \)

If the wellbore pressure \( P \) is 7,500 psi

\[ F = 7,500 \text{ psi} \times 0.0394 \text{ in}^2 \]

\[ F = 295 \text{ pounds} \]

This force or balance weight will counterbalance the wellbore pressure. In order for the wireline to be pulled into the well an additional weight (over balance) needs to be applied. Generally that is about 20% of the force, but each operator may have their own rules of thumb in this regard.

\[ F_{t} = F + (20\% \times F) = 295 + (0.2 \times 295) = 354 \text{ pounds} \]

Sinker Bar Weight \( = F_{t} - T = 354 - 175 = 179 \text{ pounds} \)