



Have you heard of or had problems with polished rod damage?

Such as scratching, scoring, excessive packing wear, stuffing box damage...

Have you ever wondered if there was *any* way to guide a polished rod?

Considering the polished rod is the most expensive rod in the string, yet most other rods are guided...

**Now there is a way!**

**A proactive and preventative product that provides centralization and protection, for the polished rod, the wellhead and surface components of the Artificial Lift oil production process.**

The background of the slide features a silhouette of an oil pumpjack against a vibrant red and orange sunset sky. The pumpjack is the central focus, with its long arm and walking beam clearly visible. Other pumpjacks are faintly visible in the background, creating a sense of an oil field. The overall mood is industrial and dramatic.

# **SENTINEL** Polished Rod Protection System

Prevention is always better than reaction!

# What is it?

It is a revolutionary, patent pending, two part bushing designed for the protection of the polished rod, stuffing box, packing and wellhead components.

They are size matched for the production tubing, tubing hanger, BHP and polished rod dimensions.

- 1. A landing sleeve for the insert bushing**
- 2. An insert bushing**

# Properties

TYPICAL PROPERTIES of PTFE				
ASTM or UL test	Property	PTFE (unfilled)	PTFE (25% glass filled)	PTFE (25% carbon filled)
PHYSICAL				
D792	Density (lb/in <sup>3</sup> )	0.078	0.081	0.075
	(g/cm <sup>3</sup> )	2.16	2.25	2.08
D570	Water Absorption, 24 hrs (%)	< 0.01	0.02	0.05
MECHANICAL				
D638	Tensile Strength (psi)	3,900	2,100	1,900
D638	Tensile Modulus (psi)	80,000	-	-
D638	Tensile Elongation at Break (%)	300	270	75
D790	Flexural Strength (psi)	No break	1,950	2,300
D790	Flexural Modulus (psi)	72,000	190,000	160,000
D695	Compressive Strength (psi)	3,500	1,000	1,700
D695	Compressive Modulus (psi)	70,000	110,000	87,000
D785	Hardness, Shore D	D50	D60	D62
D256	IZOD Notched Impact (ft-lb/in)	3.5	-	-
THERMAL				
D696	Coefficient of Linear Thermal Expansion (x 10 <sup>-5</sup> in./in./°F)	7.5	6.4	6.0
D648	Heat Deflection Temp (°F / °C) at 264 psi	132 / 55	150 / 65	150 / 65
D3418	Melting Temp (°F / °C)	635 / 335	635 / 335	635 / 335
-	Max Operating Temp (°F / °C)	500 / 260	500 / 260	500 / 260
C177	Thermal Conductivity (BTU-in/ft <sup>2</sup> -hr-°F)	1.70	3.1	4.5
	(x 10 <sup>-4</sup> cal/cm-sec-°C)	5.86	10.6	15.5
UL94	Flammability Rating	V-0	V-0	V-0
ELECTRICAL				
D149	Dielectric Strength (V/mil) short time, 1/8" thick	285	-	-
D150	Dielectric Constant at 1 MHz	2.1	2.4	-
D150	Dissipation Factor at 1 MHz	< 0.0002	0.05	-
D257	Volume Resistivity (ohm-cm)at 50% RH	> 10 <sup>18</sup>	> 10 <sup>15</sup>	10 <sup>4</sup>

- Virtually resistant to all chemicals
- Excellent wear resistance and provides low coefficient of friction
- Extremely wide temperature range
- Dimensions cover all polished rod and tubing sizes available.
- Sleeve ID is designed to allow well servicing operations without having to remove sleeve.

# Benefits

- Available in all common size combinations of tubing versus polished rod installations
- Cost effective **repair** and **preventative** measure for polished rod scoring and stuffing box wear.
- Provides polished rod centralization through wellhead.
- Helps prevent premature and excessive stuffing box packing wear avoiding **environmental** release concerns.
- Helps prevent wear of wellhead components (tubing hanger and tubing below ground).
- Assists in maintaining polished rod stability above and below ground by providing a second point of support to the polished rod.
- Low cost of installation and maintaining for the life of the well.
- Built in wear indicators to let the operator know it is time to change insert bushing.
- Helical “fluting” allows for production flow and maintains polished rod support.
- Once installed, the polished rod only needs to be watched for brass wear indications.

# Case History

- In the four wells, that the **SENTINEL** *Polished Rod Protection System* is presently installed, there were indications of slight deviations between the surface casing and the casing bowl and multiple polished rods were required.
- The surface casing bowls were welded to the casing level with the ground. This created a deviation point and contact point for the polished rod due to a deviation of the surface casing.
- It was discovered that any deviation with the wellhead equipment and casing over 1° at or below ground, may **and** has caused other failures creating more costly repairs. (ie. Stuffing box wear, hole in tubing, damaged tubing hanger, etc)

# Well #1

Well Start up date: *January, 2013*

Polished rods changed prior to **SENTINEL** system installed, July 2015: *8 polished rods (1 original and 7 replacements)*

The attempts to solve the issue were:

- **Replacement polished rod #1** – Polished rod, levelled wellhead and aligned pumpjack.
- **Replacement polished rod #2** - add roller guides and align pumpjack. (level wellhead)

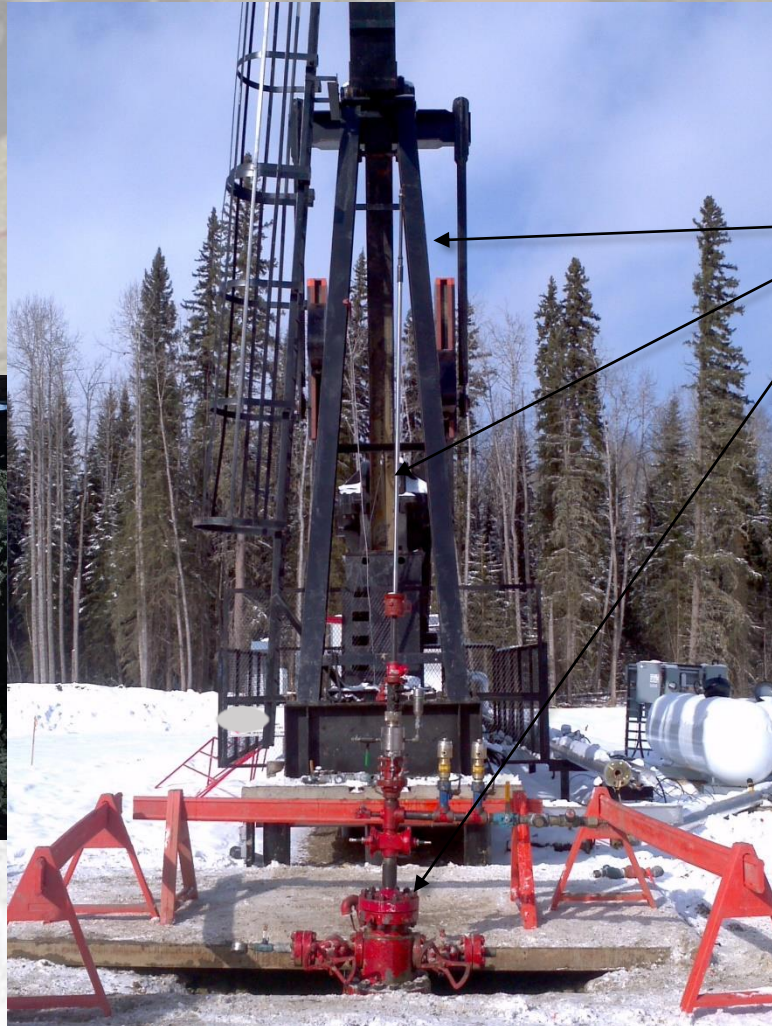


- **Replacement polished rod #3** – Replace top two joints tubing, polished rod rollers, ponies and adjust pumpjack.



- **Replacement #4** – replace with coated polished rod

- **Replacement #5** – remove and replace wellhead, and install hydraulic pumpjack.



Notice how much deviation is apparent over a distance of 4m once the bowl welded straight with the casing.

- **Replacement #6** – hydraulic ram required replacement. Hydraulic jack not aligned.
- **Replacement #7** – install **SENTINEL Polished Rod Protection System** and to date no further work done to well.

Total approximate cost spent to date eliminating polished rod scoring: **>\$1 million**

## Well #2

### New well

Start up: **Nov , 2014**

The company tried to change out the polished rod and installing roller guides after the original scored. They changed out 2 polished rods prior to the **SENTINEL**

*Polished Rod Protection System* install,

Date of SENTINEL install: **Jan, 2015**

No further polished rods changed since install.

Approximate spent: **<\$30K**

*This well has the first insert bushing developed and has been **8 months in service** without issue.*

## Well #3

### New well.

**Start up date:** Jan, 2015

The pumpjack stroked less than one day and scored the polished rod and the jack was shut down.

The company decided on changing the polished rod, adding roller guides below and aligning pumpjack to test and confirm the credibility of the **SENTINEL Polished Rod Protection System**.

Scored a second polished rod.

The **SENTINEL Polished Rod Protection System** was installed with a new polished rod and no more scoring indicated.

Cost prior to install **+/- \$13K**. No further polished rod changes since install.

***8 months in service since install.***

## Well #4

This well was a problem well from the beginning. It is very similar to well #1, but not to the extent. It had the top two joints tubing replaced with 73.0mm and wellhead upsized to 73.0mm equipment.

The well had 6 polished rods changed since it's start-up in March 2013. Each time following a system of checks and balances to diagnose for repair with some success but over a short period of time, the well needed attention.

It was found that the guides below the polished rod, when brand new, would support the polished rod enough to prevent scoring. Then over time the scrapers wore down and contact was made scoring the polished rod.

The **SENTINEL Polished Rod Protection System** was installed in June of 2015 and is continuing to give extremely positive results, much the same as the three previous installs.

*Workover and related costs on this well prior to **the SENTINEL** installation = **>\$90K***

***5 months in service***

Average cost of changing a 10.97m X 31.75mm N-50 or XM-19 polished rod, including equipment, crews and material +/- \$11K.

Average cost of replacing the same polished rod and requiring to surface the BHP +/- \$17K.

(data provided from Oil Company Production Engineer, depending on equipment replacement requirements.)



Measurement from top of stuffing box to tubing hanger at the bottom of the pumpjack stroke.



Measurement indicating tubing hanger position on polished rod and the top of the scoring.

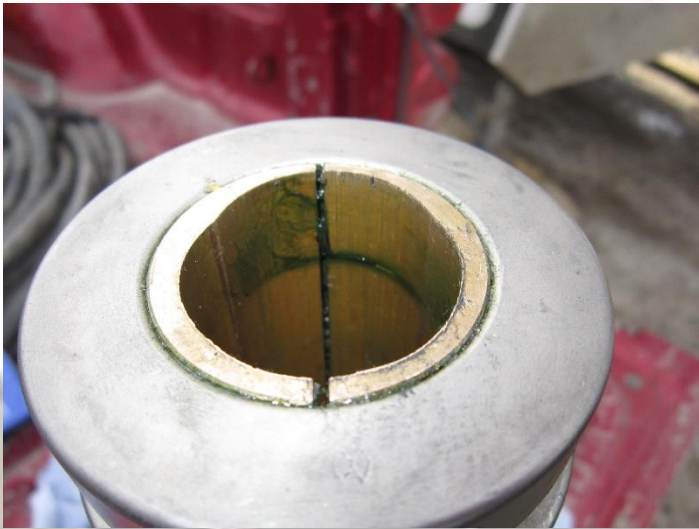


Measurement indicating total length of scoring on polished rod.



## Other Benefits

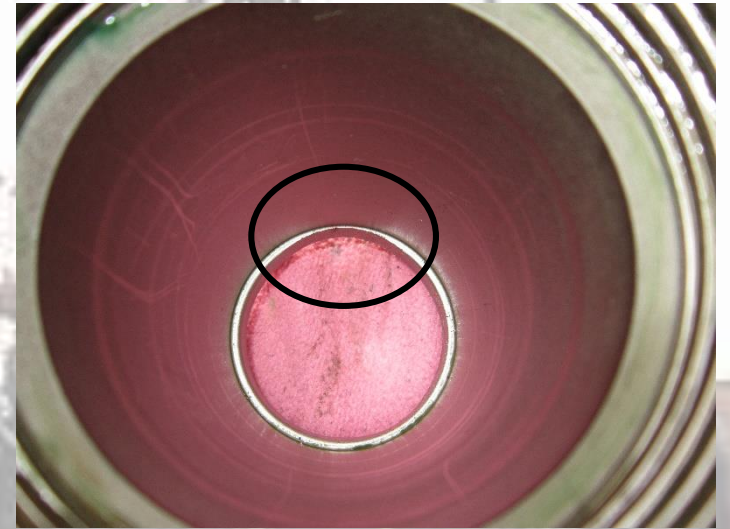
- **Cost effective means of polished rod centralization.** Sucker rods are guided to prevent wear on tubing and rods. There are no other means of polished rod centralization other than the stuffing box.
- **Minimal production restriction** inside the wellhead. Field tests showed  $<100\text{kPa}$  @  $100\text{litres/min}$  ( $144\text{m}^3/\text{day}$  equivalent)



Top packing nut on Nelgar Stuffing box



Knuckle flange on Nelgar Stuffing box



Packing chamber on Nelgar Stuffing box

The **SENTINEL** *Polished Rod Protection System* provides a second point of support on the polished rod providing a more stabilized rod through the wellhead and into the tubing.

This creates a buffer between the alignment of the pumpjack and travel of the beam which, based on design, needs to be level side to side and front to back in order to stroke the polished rod true vertical.



The **SENTINEL** *Polished Rod Protection System* also gives an additional buffer between wellhead and casing deviation, helping to prevent the polished rod wearing through the tubing below the tubing hanger which increases the cost of repair considerably.



# SENTINEL Polished Rod Protection System

## Sleeve

The **SENTINEL** sleeve provides a landing and latching point for the second piece (Insert Bushing).

The sleeve is installed into the tubing hanger, below all other wellhead equipment and has a large enough ID that any wireline tools that may need to be run in the future, **can be run without it's removal.**

Machined with EUE threads to API specifications. The sleeve can be custom machined to meet the customers needs.

Basic tools required to install and only needs to be snug, not torqued.

Easily installed in minutes, and can be installed into a new well prior to installing the pumping section of the final wellhead assembly or in to producing wells.



# SENTINEL Polished Rod Protection System

## Insert Bushing



- Machined from PTFE for its characteristics
- Designed with a no go Profile that will not pass through sleeve.
- Designed with a collet latching system for easy installation and retrieval
- Helical fluting to allow for fluid by-pass yet maintain polished rod support over the length of the bushing
- Brass wear indicators, to indicate when fluting has worn +/-50%
- Brass indicators leave a vertical brass discolouration on polished rod that does not get wiped off by stuffing box packing.
- Available in assorted sizes and matched to the sleeve.
- Fluid passages are maximized to prevent backpressure (<100kPa pressure drop @ 144m<sup>3</sup>/day)
- Installed below isolation equipment to prevent interference with their operation. (ie. radigan and stuffing box)



# New well installation procedure

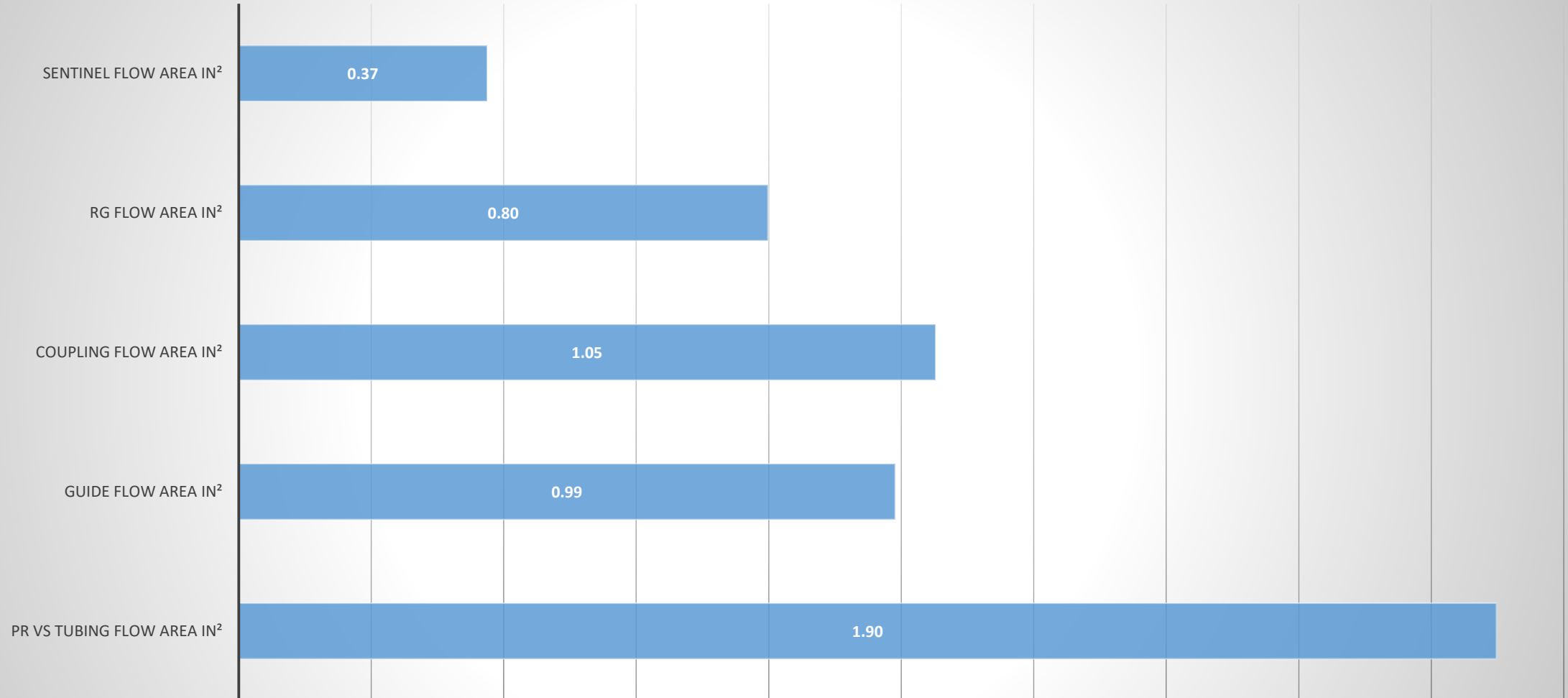
1. Kill well using suitable and sufficient kill fluid.
2. Remove wellhead used for completion and flow back.
3. Install **SENTINEL Polished Rod Protection System Sleeve**.
4. Install adapter flange and pumping section of wellhead.
5. Run BHP and rod string as per design and space out for polished rod.
6. Pick up polished rod with **SENTINEL Polished Rod Protection System Insert Bushing** installed BELOW the stuffing box.
7. Make up polished rod connection to rod string and lower the polished rod connection to below tubing hanger.
8. Slide **SENTINEL Polished Rod Protection System Insert Bushing** down polished rod through wellhead components and tap into place. (1/2 pipe of sufficient length and dimension to fit through wellhead)
9. Lower rod string and continue to seat, pressure test and hang rods from carrier bar. Install warning tag.
10. Put well into production and save.



# Existing well installation procedures

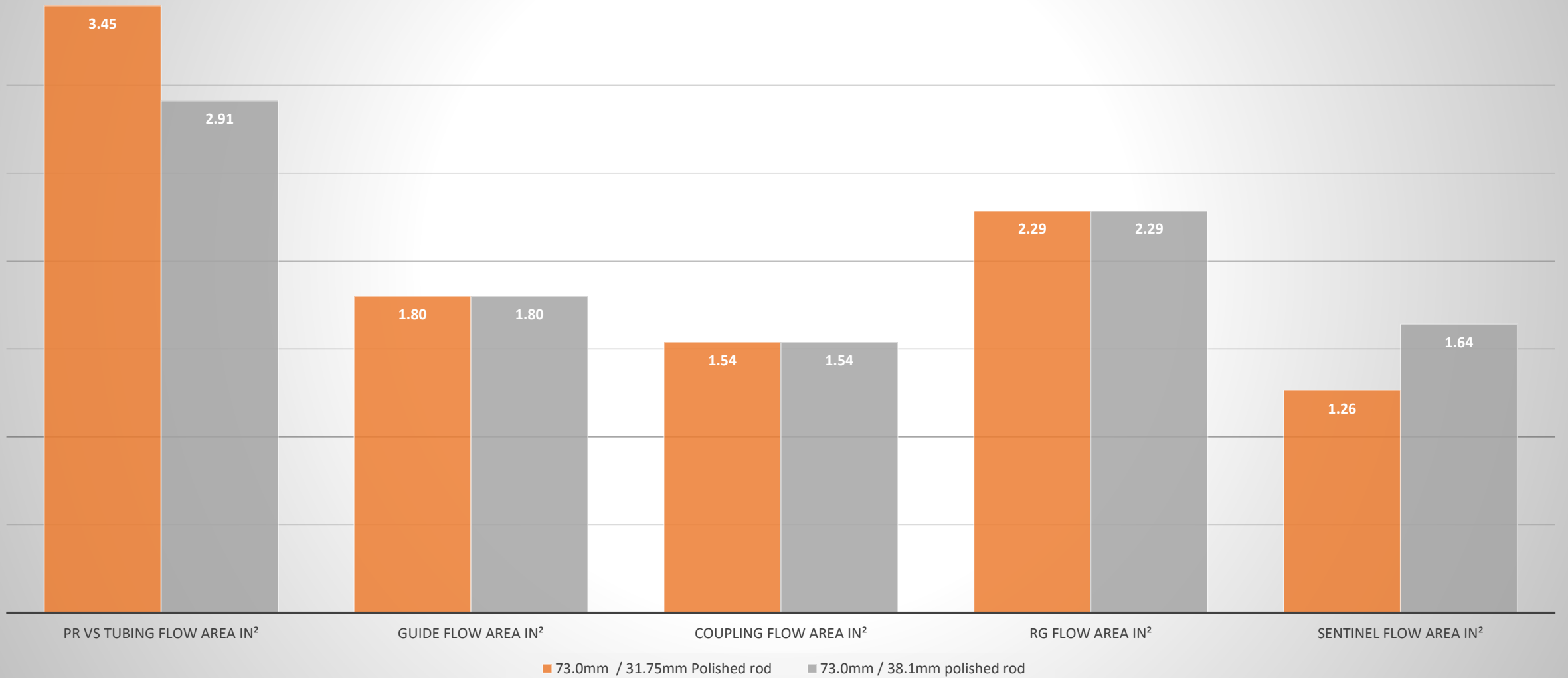
1. Pick up on the polished rod and unseat BHP.
2. Pump suitable and sufficient kill fluid down tubing.
3. Break out stuffing box and hoist rod string to access lower polished rod coupling. Install rod elevator and break connection.
4. Remove rod elevator and lower rod string.
5. With all the string weight set on bottom, back off the polished rod and lay out. Install safety valve into wellhead.
6. Ensure the well is dead and remove wellhead flange bolts for pumping section of the wellhead.
7. Lift the pumping section free of tubing head and install the **SENTINEL Polished Rod Protection System** Sleeve into the tubing hanger. Replace pumping section and tighten the flange studs.
8. Pick up the polished rod with the **SENTINEL Polished rod Protection System** Insert Bushing installed below the stuffing box.
9. Lower the polished rod into the well to the top of the rod string and thread back onto the rods. Pull the rod string to surface and tighten the connection.
10. Lower the polished rod connection to below the tubing hanger and slide the **SENTINEL Polished Rod Protection System** Insert Bushing down the polished rod through the wellhead components and tap into place.
11. Lower rod string and seat the BHP. Continue with spacing out and hanging rods from the carrier bar.
12. Start the well back up and save.

## Comparisons of Flow Areas in 60.3mm Tubing

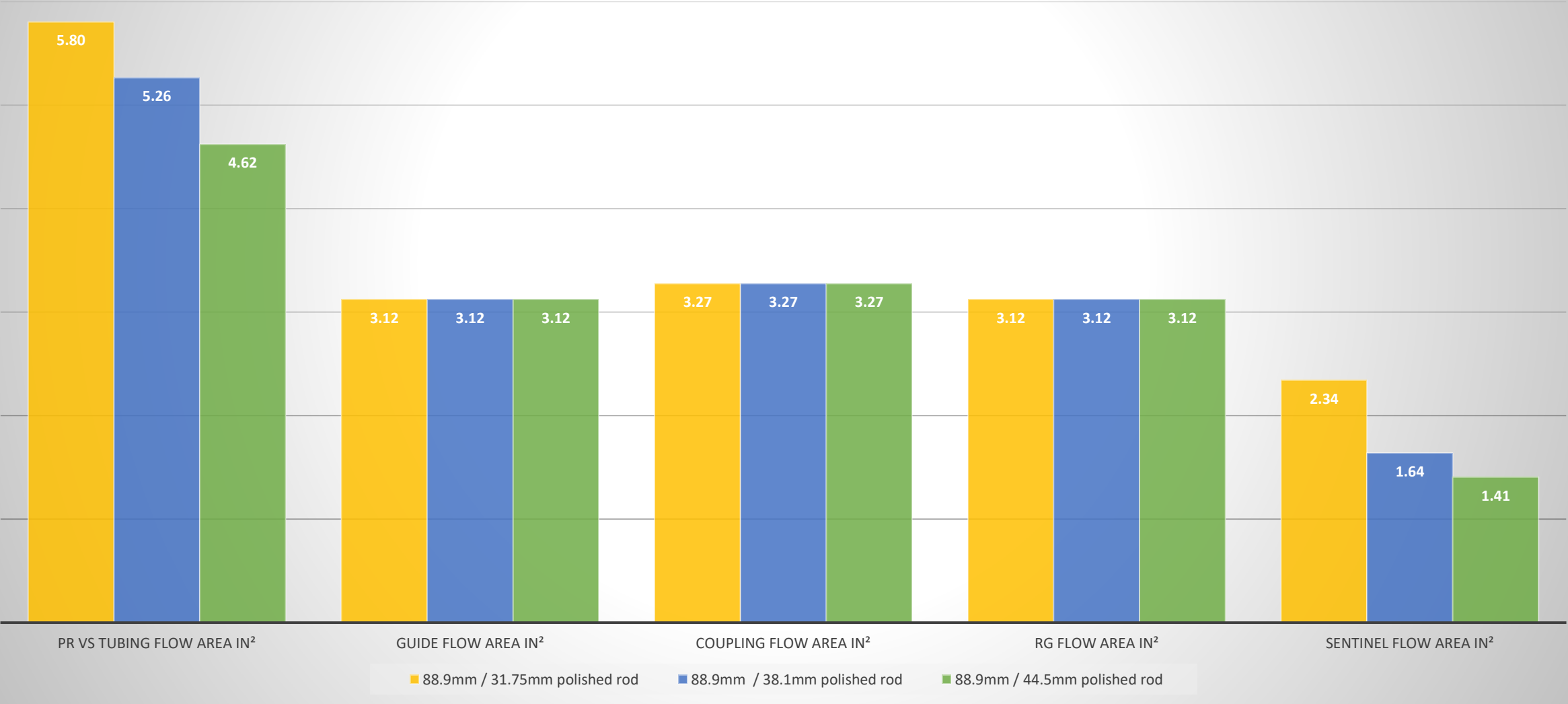


■ 60.3mm / 31.75mm polished rod

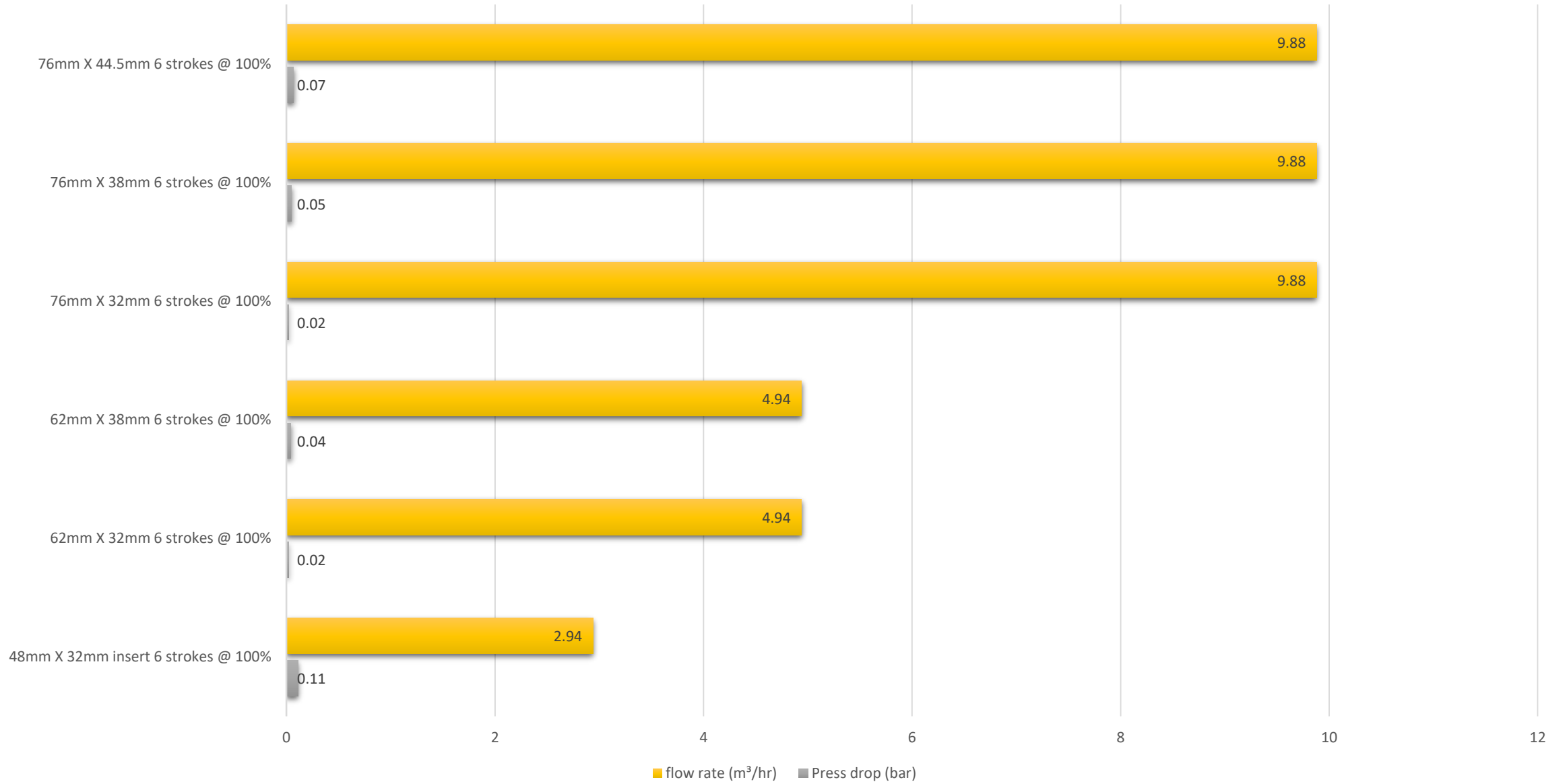
## Comparisons of Flow Areas in 73.0mm Tubing



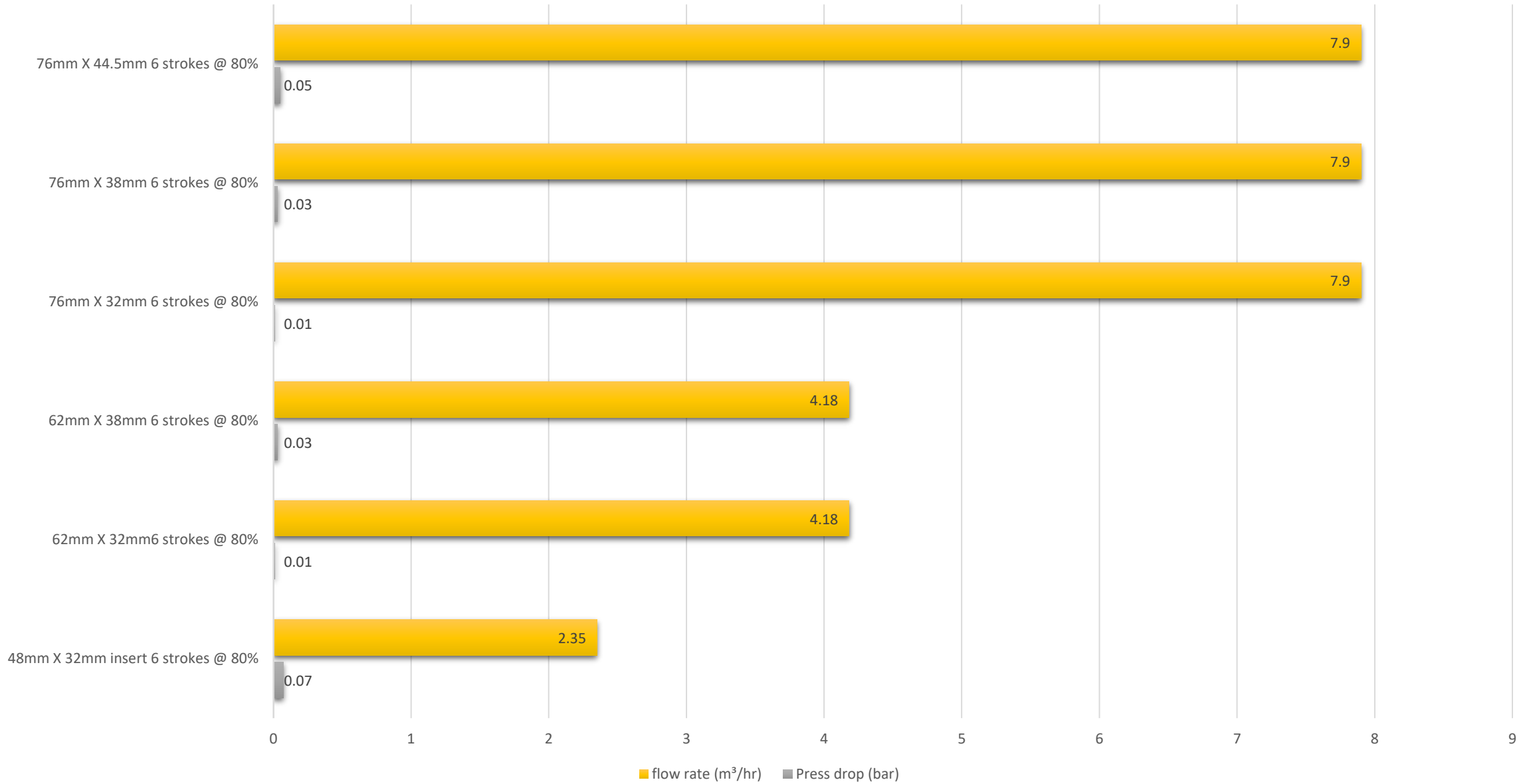
# Comparison of Flow Areas in 88.9mm Tubing

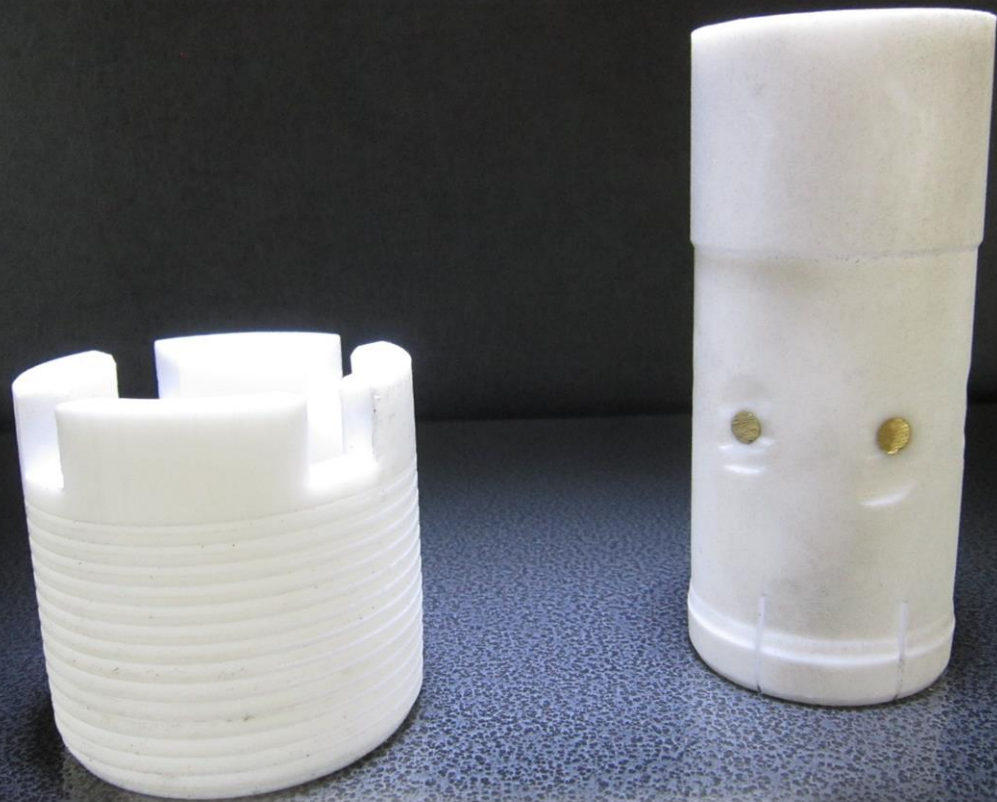


## Flow Rates versus Pressure Drop at 100% Pump Efficiency @ 6 strokes /min



## Pressure Drop Across Insert Bushing VS Flow Rate @ 6 strokes/min and 80% Efficiency





Thank You. Any questions?