SPE Calgary Section – October 2011

Best Practices for Multizone Isolation Using Composite Plugs

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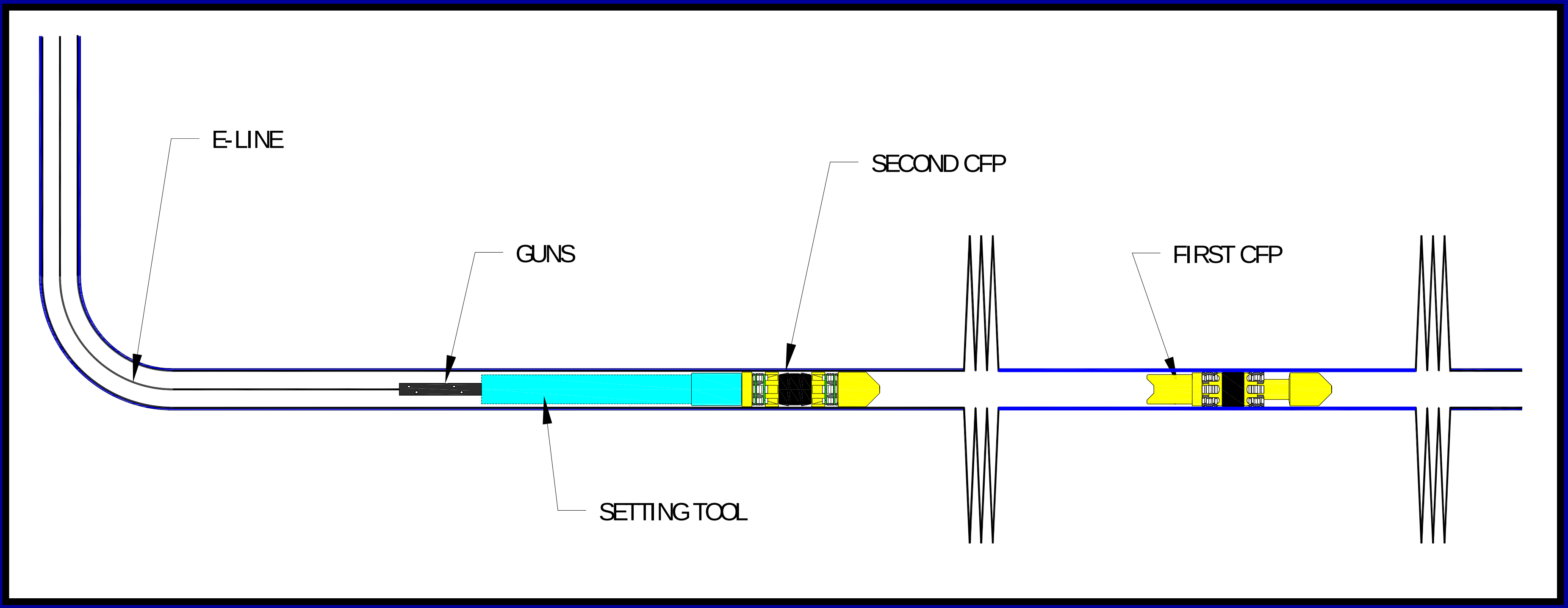
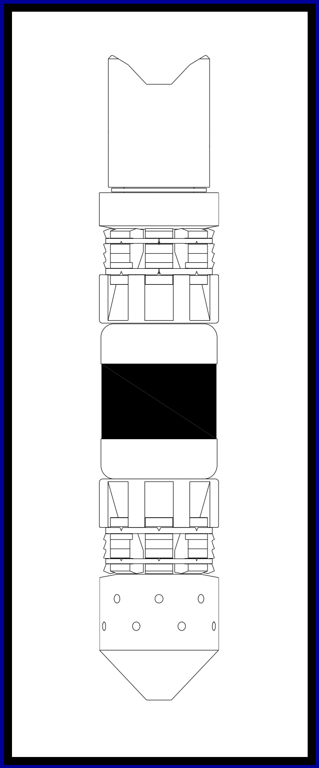
Based on SPE Paper 142744

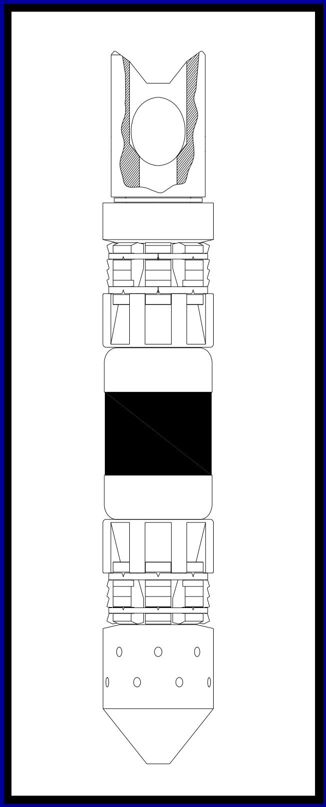
Plug N Perf – Multizone Isolation



Bridge Plugs vs. Frac Plugs



Bridge Plug



Frac Plug

A.K.A. "Flow Through Plug"

Global Need

Next Challenge - International Unconventional

Argentina…Neuquen Basin…774 TCF

Australia… Beetaloo Basin…23 TCF

Eastern Europe…50 basins…700 TCF?

China, Indonesia, Russia – CBM and shale

Today's Presentation

Why Determine Best Practices?

Methodology

Selected Survey Results

Selected Best Practices

Q & A

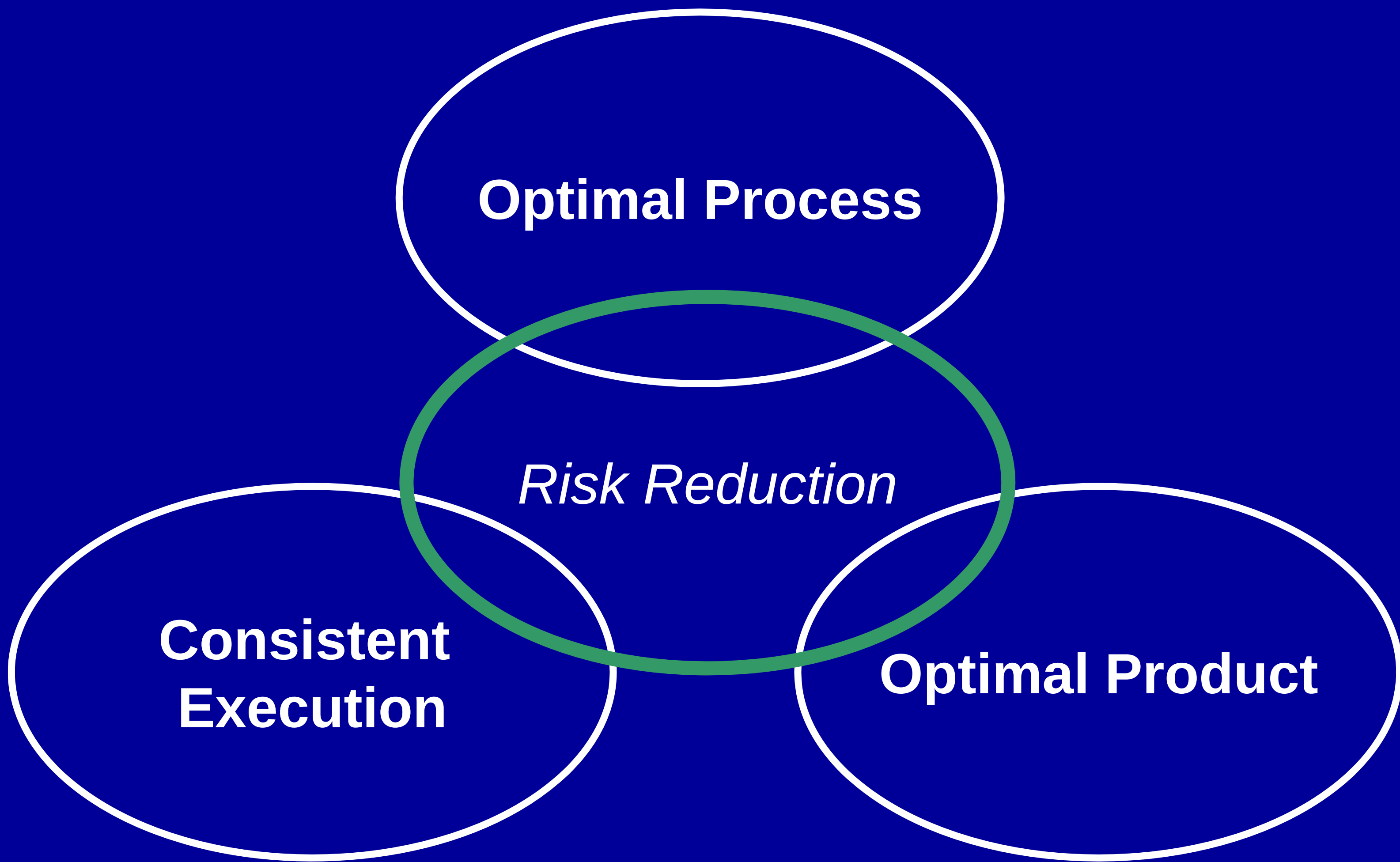
Definition of Best Practice

A process or method…

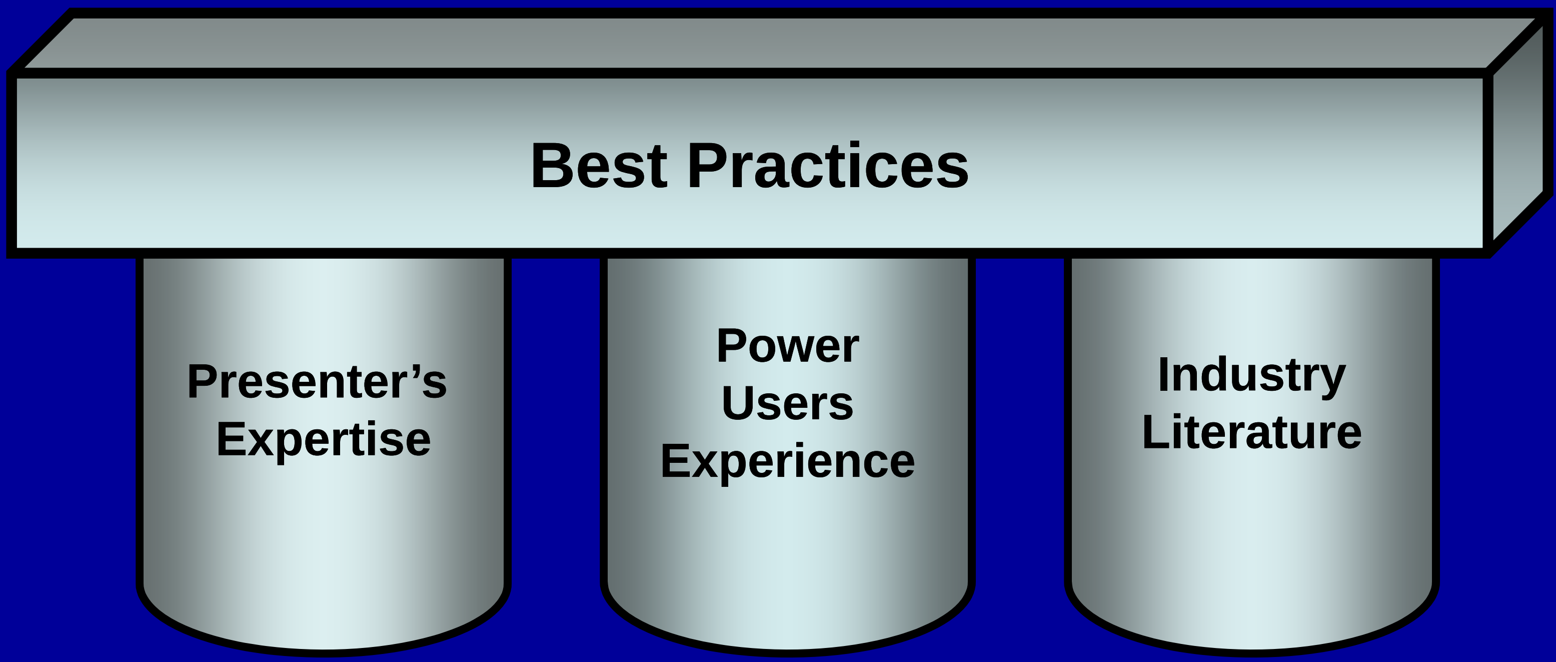
Customary or routine…

The highest probability of success

Why Determine Best Practices?



Best Practices Methodology



Selected Survey Results

Table 1: Ratio of Positive-to-Negative Responses (P/N)	
0.3 or less	Very Strong Disagreement
0.4 - 0.5	Strong Disagreement
0.6 - 0.	greement
0.9 – 1.	ment
1.1 – 2.0	Mild Agreement
2.1 - 3.0	Strong Agreement
3.1 or more	Very Strong Agreement

Agree/Disagree = (P/N) = Ratio

Definitions & Abbreviations

CP = Composite Plug

CFP = Composite Frac Plug (Flow Through)

Perf = Perforation

Stim = Stimulation or Hydraulic Fracturing

CT = Coiled Tubing

PnP = Plug and Perf

Power Users = Respondents in Industry Survey

Selected Best Practices

Product Selection

Determining the Plug Pressure Requirement

Wellsite QA/QC

Wellbore Preparation

Perforating above the CP (Composite Plug)

Special Operational Situations

Test Your PnP (Plug and Perf) Knowledge

…Trivia Question #1

Approximately how many composite plugs were run in the United States in calendar year 2010 ?

Is the answer…

A 60,000 – 80,000

B 100,000 – 140,000

C 160,000 – 200,000

Product Selection Criteria

Which Golf Ball do I Choose?

Golf Ball Selection and Purchase Guide

Now in its 8th year, **GolfBallGuide.com** has been helping golfers all over the world choose the **best golf ball** for their games.

Due to the speed at which new product enters the market, you will find up-to-date golf ball reviews and ratings in the new 2011 version of our **Golf Ball Selection Guide (below)**.

A full range of golf balls for players from the highly skilled to high handicap golfers are covered.

Special emphasis is placed on understanding the formula for increased distance, especially for golfers with slower driver swing speeds.

The **best golf ball for seniors** will maximize carry distance with optimal roll resulting in maximum total distance for a golfer's swing speed, equipment, physical limitations, etc...

In fact, today's products are nothing short of incredible, especially when combined with the amazing advancements in driver and iron designs. It is indeed a great time in history to be playing this great game!

The correct golf ball with explode off the "trampoline-like" faces of today's drivers, resulting in maximum compression and ball speed (see our video and impact compression images inside the Guide).

All the top brands including Titleist, Nike, Srixon, Taylormade, Bridgestone, etc.. are referenced including a breakdown of the composition of the various models.

Low compression, 2-Piece (a core and cover) golf balls on up to 5 piece, "Tour" balls are discussed in detail.

Join 1000's of golfers worldwide benefitting from the most unique and up to date resource on the internet.

Grab your copy of the *2011 "Golf Ball Guide"*

Absolutely *FREE*!

Objective feedback required !

Product Selection Criteria

	Yes	No	Don't Know	P/N Ratio
Length of exposure?	9	19		0.5
Combined pressure & temperature rating?	20	8		2.5

Corrosive Environments

Elastomeric Materials < 30 days exposure

Material	Temp, ° F	Environmental Compatibility							
		H_2S	Oil Base/Diesel Completion	Light Brine Completion	Bromide Completion	Amine Inhibitors	Acids Max exposure time, hrs	Solvents Max exposure time, hrs	High pH Fluids, pH > 10
Nitrile	To 175	YES	YES	YES	$CaBr_2$ /$NaBr_2$ OK to 250°F; NO for $ZnBr_2$	YES	8	6	YES
	400						6	4	24 hrs.
Viton	To 200	YES	YES	YES	YES	YES	24	24	NO
	350					NO	4	4	
Aflas	To 175	YES	NO	YES	YES	YES	48	4	YES
	350						8	NO	
EPDM	To 500	YES	NO	YES	YES	YES	YES	NO	YES

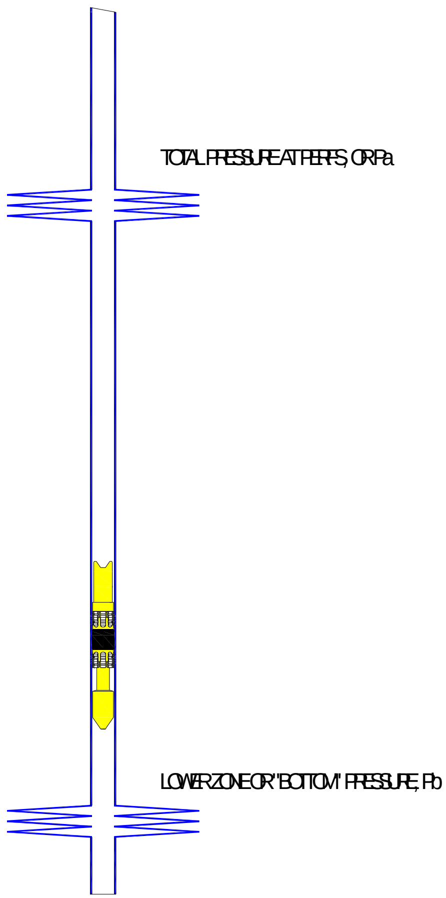
Composites - H_2S, CO_2 & H_2O – blistering, disbonding, leaching

Best Practices - Product Selection

Optimal Product

- Combined pressure & temperature rating.
- Require database of installations.
- Corrosive Environments - manufacturer estimates CP life

CP Pressure Requirement



Negative Test	Positive Test	Stimulation	Flowback
P_{SI} = 7500 psi	P_{SI} = 7500 psi	P_{SI} = 7500 psi	P_{SI} = 7500 psi
ΔP = -9097 psi	ΔP = +4466 psi	ΔP = +3172 psi	ΔP = -7752 psi

The

4 Scenario Method

Best Practices
CP Pressure Requirement

Optimal Product

CP - calculate using 4 Scenario Method.

CFP - positive test, zonal stimulation scenarios.

Wellsite QA/QC – Survey Results

Documentation Required	Yes	No	Don't Know	P/N Ratio
Electric line setting tool servicing records?	22	5	1	4.4
Traceability - size, part number, serial number?	18	9	1	2
Plug dimensions?	23	5		4.6
Pre-run checks - plug, setting tool, CCL?	23	4	1	5.8

Wellsite QA/QC – Quick Check

Wireline setting / CCL tools – redress– <u>Document!</u>

CP – *Document Everything!*

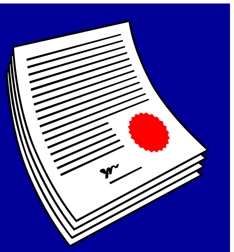
Brand…style…rating…color

Dimensions

Traceability markings

Condition before RIH

Best Practices - Wellsite QA/QC



Consistent Execution

- **Operators – drive this process - information & format**
- **Check lists – manufacturer or service company.**
- **Archive all available CP information**

Test Your PnP Knowledge

…Answer to Trivia Question #1

Approximately how many composite plugs were run in the United States in calendar year 2010 ?

The answer is…

A 60,000 – 80,000

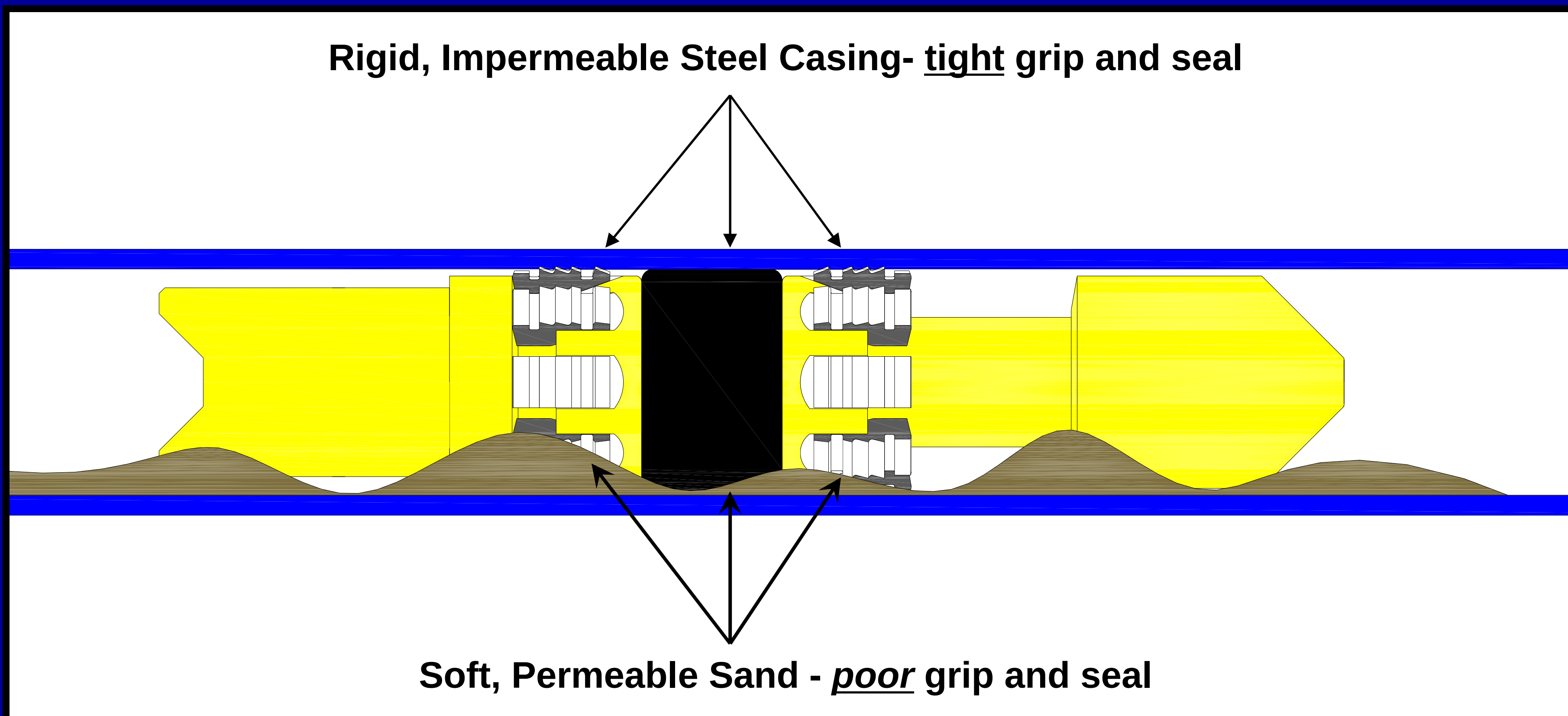
B 100,000 – 140,000

C 160,000 – 200,000

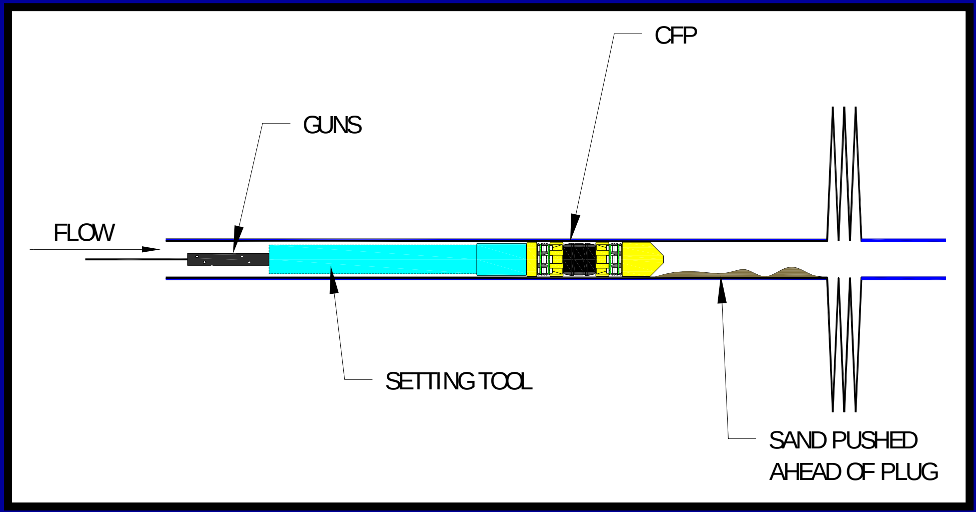
Wellbore Prep – Survey Results

Power Users - wellbore preparation is a success factor

<u>Bottom line</u> … avoid sand in casing!



Options for Clean Wellbore



Begin with End in Mind

Avoid Flowback Between Stages

Size the flush to aid cleaning

Pump-Down Method

Intrinsic Advantage

Flow pushes sand ahead of CFP

Coiled Tubing (CT)

Remove debris between stages

CT setting tools remove debris

Best Practices - Wellbore Preparation

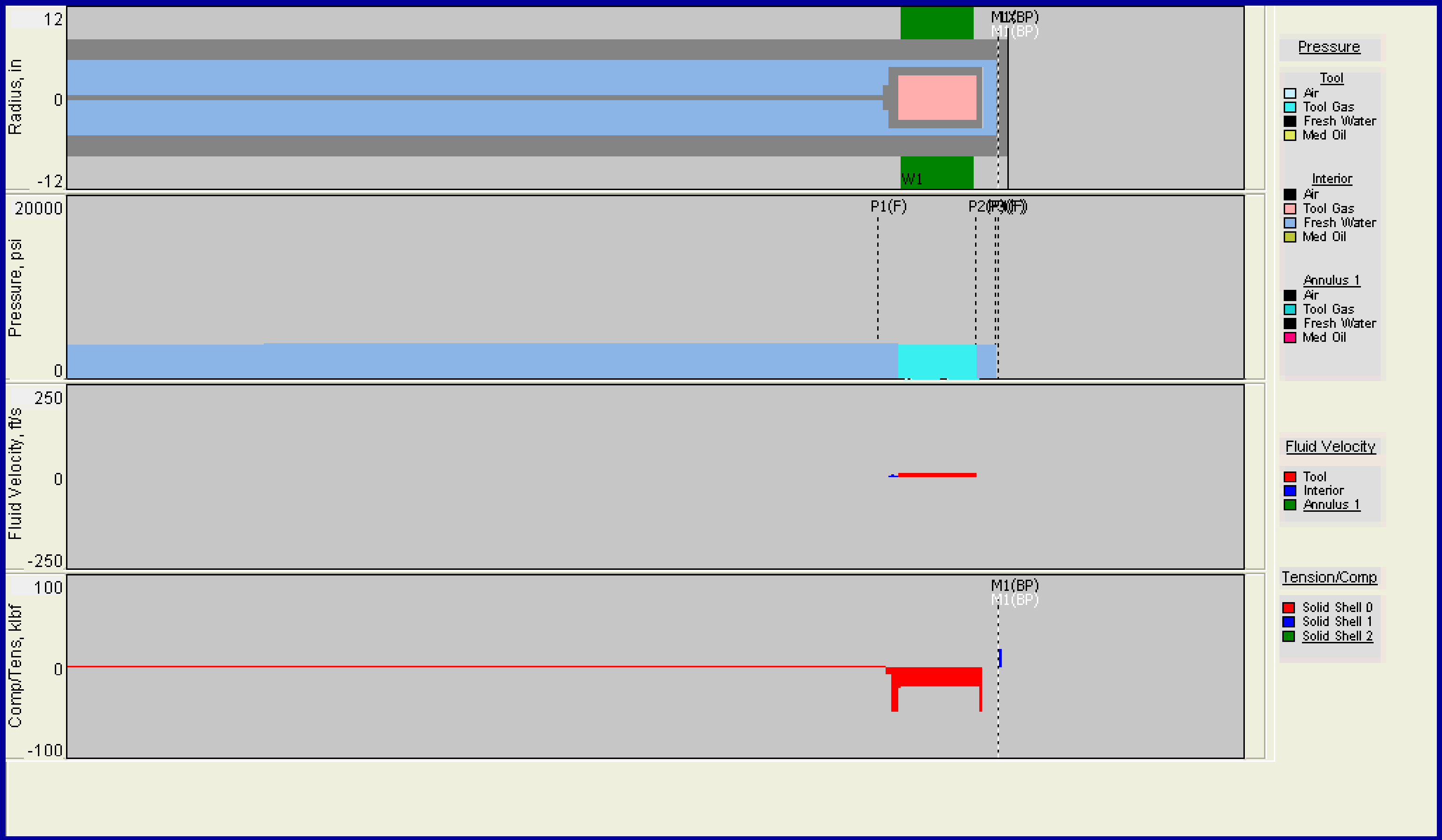
Optimal Process

- ➢ **Execute stimulation job to prevent debris**
- ➢ **Avoid flowback between stimulations**
- ➢ **Pump-down method - intrinsic advantage**
- ➢ **Coiled tubing - if flowback between stages is used**

Perforating Above CP – Survey

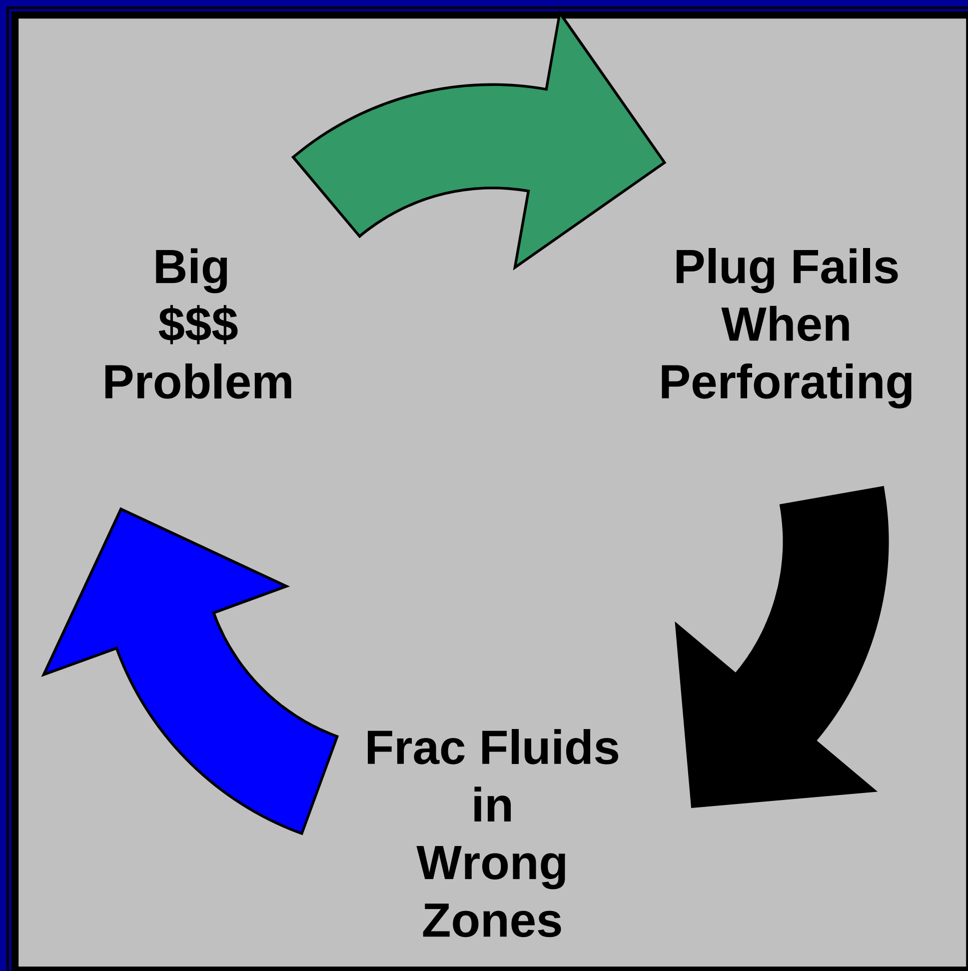
Is This a Best Practice ?	Yes	No	Don't Know	P/N Ratio
Perforate at least 75 ft. above plug?	8	15	4	0.5
Perforate at least 100 ft. above plug?	9	14	4	0.6
Use Shock-wave software to determine safe perforating distance?	7	7	13	1
Use field experience and shock-wave software (S/W)?	15	4	7	3.8

Shockwave Simulation Using S/W



Sample Simulation Using 5 ½” CP

When CP Fails During Perforating



Best Practices - Perforating Above CP

- Shock wave intensity ⬆ gun length, rock stiffness, etc.
- Simulate, then compare to plug rating
- Pressure wave is bigger problem for CPs.
- When possible, use software to make the decision

Special Operational Situations

Is This a Best Practice?	Risk	Yes	No	Don't know	P/N Ratio
Tag plug with setting tool	Stuck setting tool	15	13		1.2
Low fluid level wells	Damage plug	20	8		2.5

Is This a Best Practice?	Yes	No	Don't Know	P/N Ratio
Set plug in perforated casing joint?	14	10	4	1.4
Set plug where packer had been removed?	14	9	5	1.6

Tagging Plug with E-Line Setting Tool

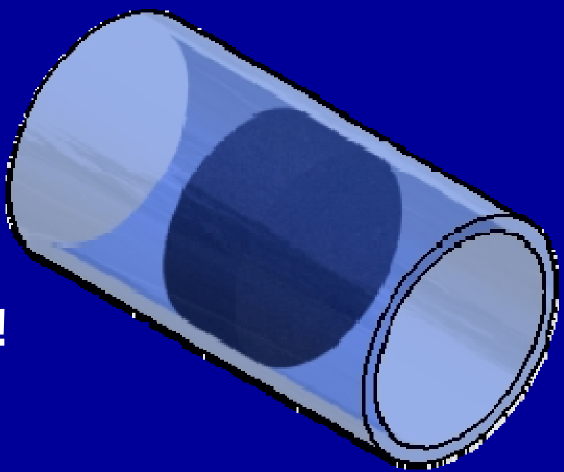
Assume 5 ½" 20 ppf casing (ID = 4.778) & test pressure = 10,000 psi

ID area of casing = 17.93 $in.^2$

17.93 $in.^2$ x 10,000 psi = 179,300 lbs.-force

Setting tool + CCL + perf gun = 500 lbs

Partially set plug resists with 2,000 lbs.-force !



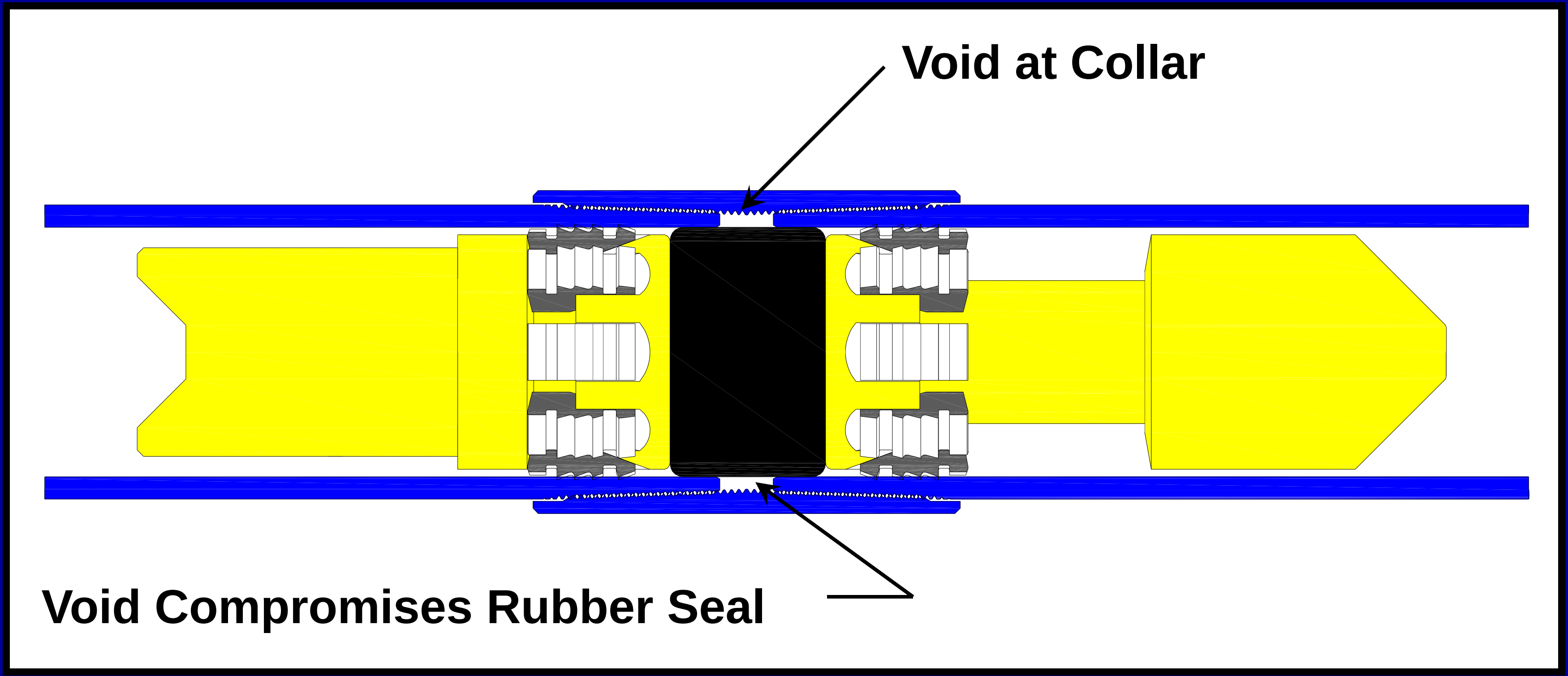
<u>Conclusion</u>: 500 lbs. vs. 179,300 lbs. is NOT a valid test

***<u>Risk</u>*: Stuck E-Line tools and fishing job**

<u>Solution</u>: Use a pressure test will confirm proper set

Casing Irregularities

Plug Set in Casing Collar, Perforated, or Drilled-In casing joint …



Same result…<u>Any</u> gross discontinuity in casing compromises plug

Best Practices
Special Operational Situations

“Problem Casing”

- **Avoid collars, perforated or drilled-in casing**

⇨ ***Use pressure test to assess plug condition***

Review
Plan for Success & Minimize Risk

1 Pick the right product.

2 Avoid over-pressuring the plug.

3 Emphasize documentation.

4 Prepare the Wellbore.

5 Perforate for Plug Survival.

6 Avoid "Special Operational Situations".

End of Presentation

Thank You!

Thanks to the Management of ConocoPhillips &

Baker Hughes who provided support for SPE 142744.

Questions & Answers