Penetration not a limiting factor for hydraulic fracturing...
Horizontal Completions
Perforating Choices for Hydraulic Fracture?

- Hole Size
  - To calculate friction pressure
  - To calculate rate
  - Proppant size
- Gun Phasing
- Shot Density
- Penetration
  - How much?
Perforating Choices?

EH = 0.37”
Pen* = 35.6”

EH = 0.37”
Pen* = 35.6”

EH = 0.43”
Pen* = 2.6”

* API Sect I data
Where Does the Fracture Initiate?
An Operator Asked,

For a solution requiring

- 0.45” Entry hole
- Minimal Formation Penetration
- 180° Phasing (Preferred Frac Plane at 6 & 12)
Gun/Charge Selection – Step 1

Well Casing = 5.5”, 26#/ft, L-80
- 2 3/4”, 3 1/8”, 3 3/8” Perforating Guns

Gun Performance Software
- Allowed us to narrow down the choices
- 3 1/8” OD Gun
- 10 gram Big Hole Charge

Coupon Testing
- At 6 o’clock, EH = .56” & TTP = 2.75”
- At 12 o’clock, EH = .30” & TTP = 2.60”

APPS-13-023
Orientation – Step 2

- Eccentric weight bars
  \[0^\circ - 44^\circ\] Error in Orientation

- Finned Subs and Swivels
  \[31^\circ\] Error in Orientation
Orientation – Step 2

- Internally oriented via eccentric weight 8° Error
- Allows for selective firing
- Patent Pending
Combined Results

- 19 stages of 4 clusters each

1500 psi lower breakdown pressure for Stages 12 & 14 as compared to Stage 13 shot with 60° DP charges

- 12 o’clock shots display common burrs
- 6 o’clock shots show no burrs
Summary

Hydraulic Breakdown and Treating Pressures Reduced when….

- Perforations oriented in direction of max. stress v. 60 degree
- Unique orienting gun achieved accurate placement of perforations over conventional orienting techniques
  - Swivels
  - Eccentric weight bars
- Charges selected on entrance hole performance in actual casing
  - *Penetration was only 2.7” in cement*
  - Explosive weight was 10g v. typical 23 gram