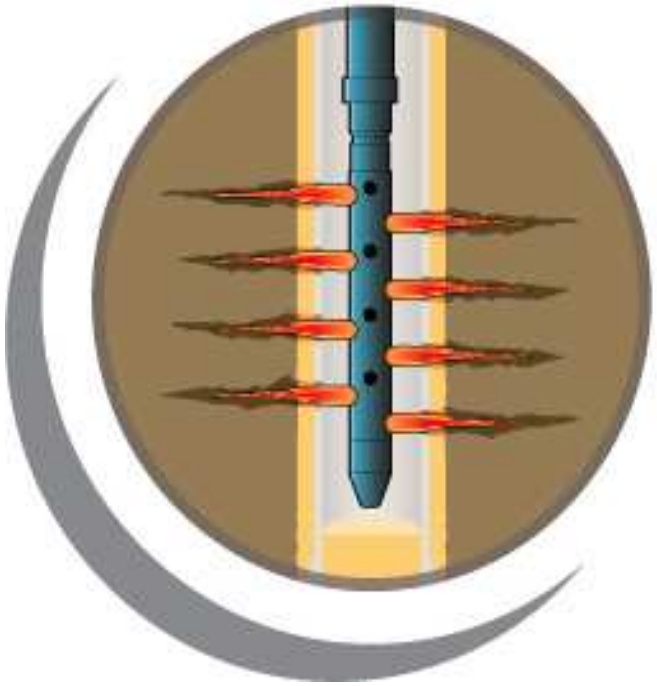
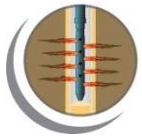
API RP19B Section 1 Data: Food for Thought



Andy Martin, Rodger Anderson,

Bob Ference, Oliver Han

IPS 14-15



Schlumberger

API RP19B Section 1 Data

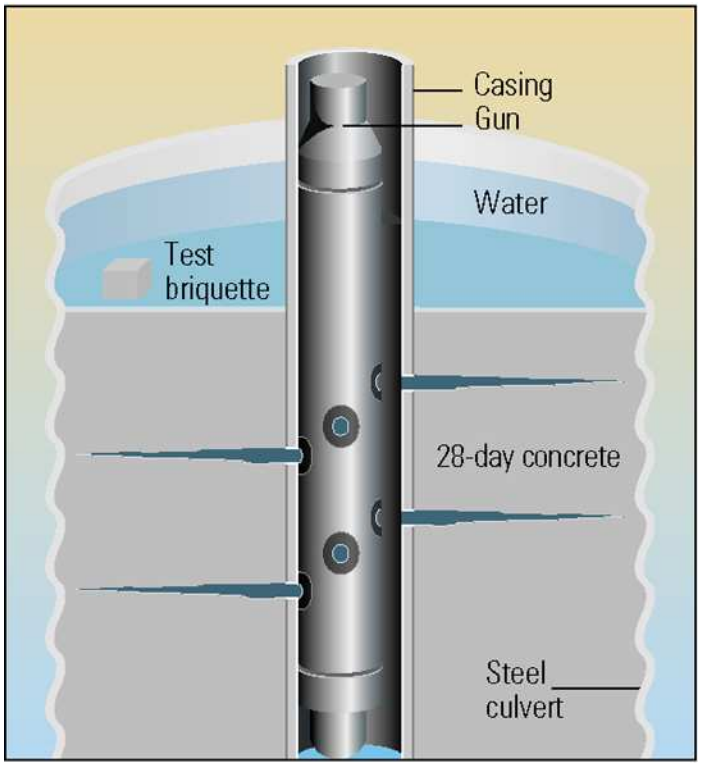
- Overview of Section 1
- Concrete: Sand
- Registered Section 1 Data
- Discussion

API RP19B: Recommended Practices for Evaluation of Well Perforators

API RP 19B Timeline

2nd Edition—Section 1

- The ONLY test of a complete gun system: shot density and phasing
- 5000 psi Concrete Target
  - Briquette strength ≠Target strength
  - Briquette strength much higher
  - Used only as a go-no go test
- Minimum run 1000 charges
- Aged 28 days
  - Target and charges
- System test minimum 12shots



2nd Edition—Section 1

Test Site

Casing

Gun positioned in target

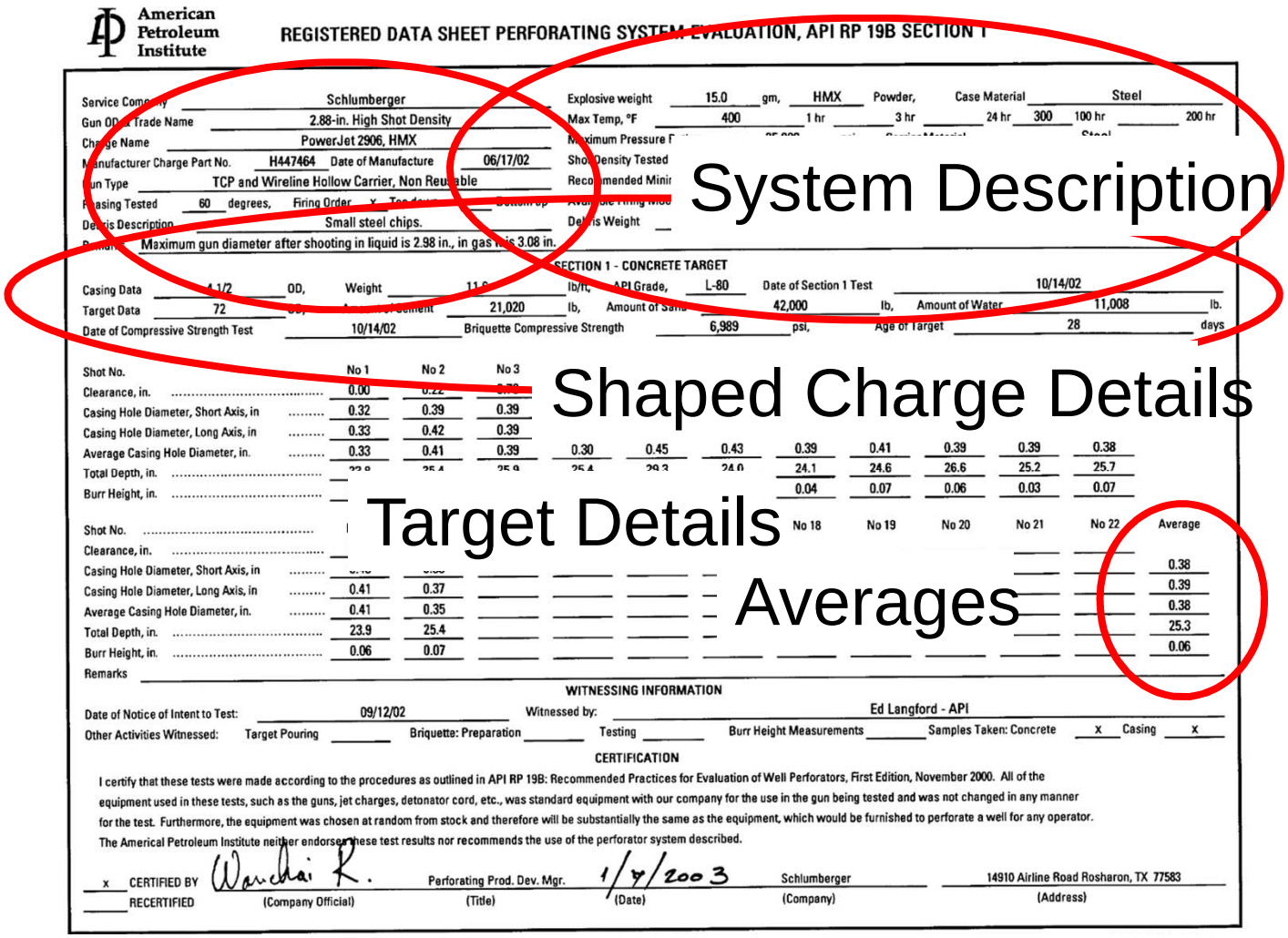
Shot gun

Target Ready for API Witness

Target split open

Witness monitors
and records data

Typical API Data Sheet



American Petroleum Institute

REGISTERED DATA SHEET PERFORATING SYSTEM EVALUATION, API RP 19B SECTION 1

Service Company: Schlumberger
Gun OD & Trade Name: 2.88-in. High Shot Density
Charge Name: PowerJet 2906, HMX
Manufacturer Charge Part No.: H447464 Date of Manufacture: 06/17/02
Gun Type: TCP and Wireline Hollow Carrier, Non Reusable
Phasing Tested: 60 degrees, Firing Order: x
Debris Description: Small steel chips.
Remarks: Maximum gun diameter after shooting in liquid is 2.98 in., in gas is 3.08 in.

Explosive weight: 15.0 gm, HMX Powder, Case Material: Steel
Max Temp, °F: 400 1 hr 3 hr 24 hr 300 100 hr 200 hr
Maximum Pressure
Shot Density Tested
Recommended Minimum
Debris Weight

System Description

SECTION 1 - CONCRETE TARGET

Casing Data: 4 1/2 OD, Weight 11.6 lb/ft, API Grade, L-80 Date of Section 1 Test: 10/14/02
Target Data: 72 21,020 lb, Amount of Sand 42,000 lb, Amount of Water 11,008 lb.
Date of Compressive Strength Test: 10/14/02 Briquette Compressive Strength: 6,989 psi, Age of Target: 28 days

Shaped Charge Details

Shot No.	No 1	No 2	No 3								
Clearance, in.	0.00	0.22	0.39								
Casing Hole Diameter, Short Axis, in	0.32	0.39	0.39								
Casing Hole Diameter, Long Axis, in	0.33	0.42	0.39								
Average Casing Hole Diameter, in.	0.33	0.41	0.39	0.30	0.45	0.43	0.39	0.41	0.39	0.39	0.38
Total Depth, in.	23.8	25.4	25.9	25.4	29.3	24.0	24.1	24.6	26.6	25.2	25.7
Burr Height, in.							0.04	0.07	0.06	0.03	0.07

Target Details

Shot No.	No 18	No 19	No 20	No 21	No 22	Average
Clearance, in.						
Casing Hole Diameter, Short Axis, in	0.41	0.37				0.38
Casing Hole Diameter, Long Axis, in	0.41	0.35				0.39
Average Casing Hole Diameter, in.	0.41	0.35				0.38
Total Depth, in.	23.9	25.4				25.3
Burr Height, in.	0.06	0.07				0.06

Averages

Remarks

WITNESSING INFORMATION

Date of Notice of Intent to Test: 09/12/02 Witnessed by: Ed Langford - API
Other Activities Witnessed: Target Pouring Briquette: Preparation Testing Burr Height Measurements Samples Taken: Concrete x Casing x

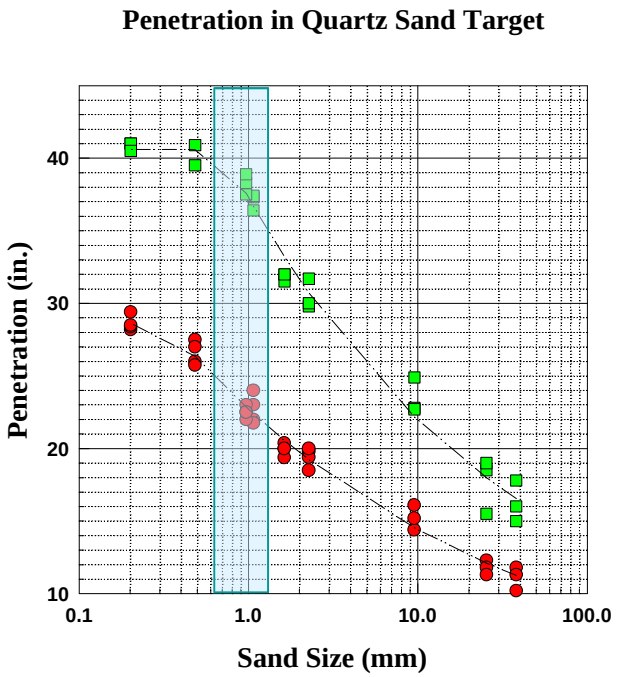
CERTIFICATION

I certify that these tests were made according to the procedures as outlined in API RP 19B: Recommended Practices for Evaluation of Well Perforators, First Edition, November 2000. All of the equipment used in these tests, such as the guns, jet charges, detonator cord, etc., was standard equipment with our company for the use in the gun being tested and was not changed in any manner for the test. Furthermore, the equipment was chosen at random from stock and therefore will be substantially the same as the equipment, which would be furnished to perforate a well for any operator. The Americal Petroleum Institute neither endorses these test results nor recommends the use of the perforator system described.

x CERTIFIED BY Wanchai R. Perforating Prod. Dev. Mgr. 1/7/2003 Schlumberger 14910 Airline Road Rosharon, TX 77583
RECERTIFIED (Company Official) (Title) (Date) (Company) (Address)

2nd Edition—Section 1

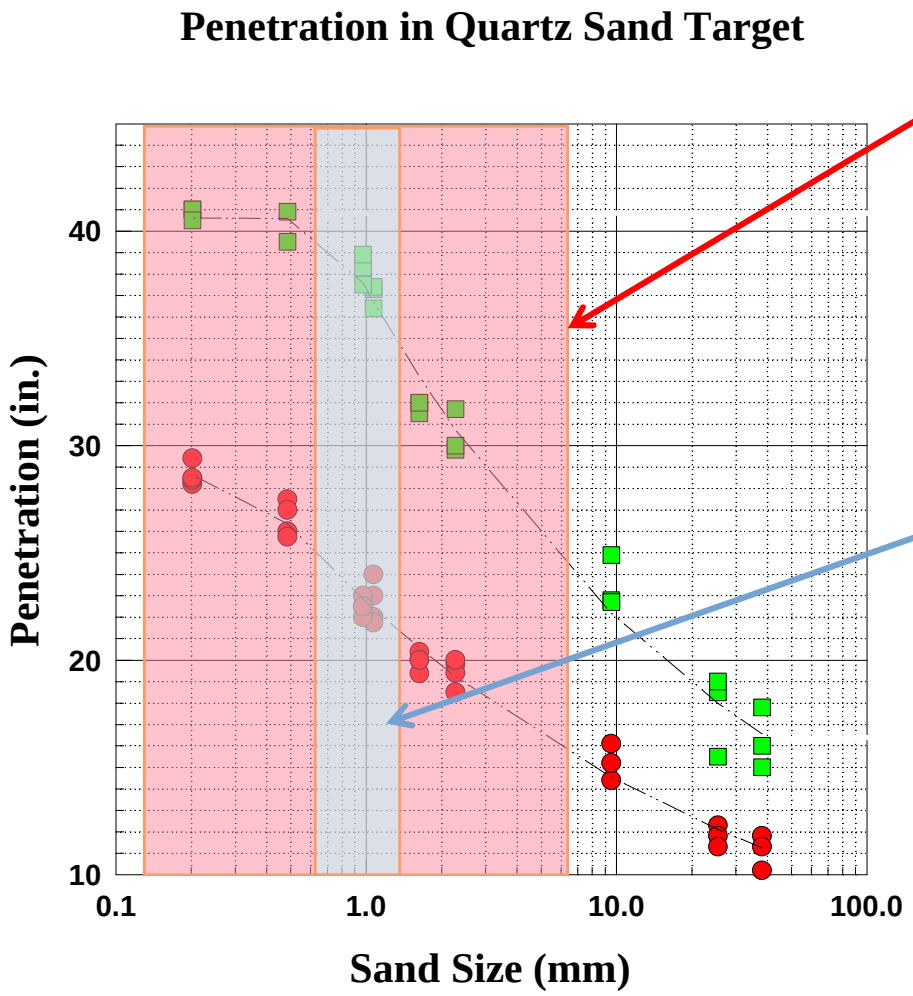
- Gun System test into a concrete target (16/30 frac sand, 1.2 to 0.6 mm) SPE 39457 (Brooks et al)
- Gun position important
- SPF & Phasing important
- Penetration & EH



Concrete: Sand Effect

Sand Size Effect – 2 different gun systems

SPE 39457 (1998)



RP19B Sand Range

Penetration range tighter but could still be affected by sand

RP43 Sand Range

Penetration could double by using fine sand which also has a higher UCS

Should be 99% Quartz

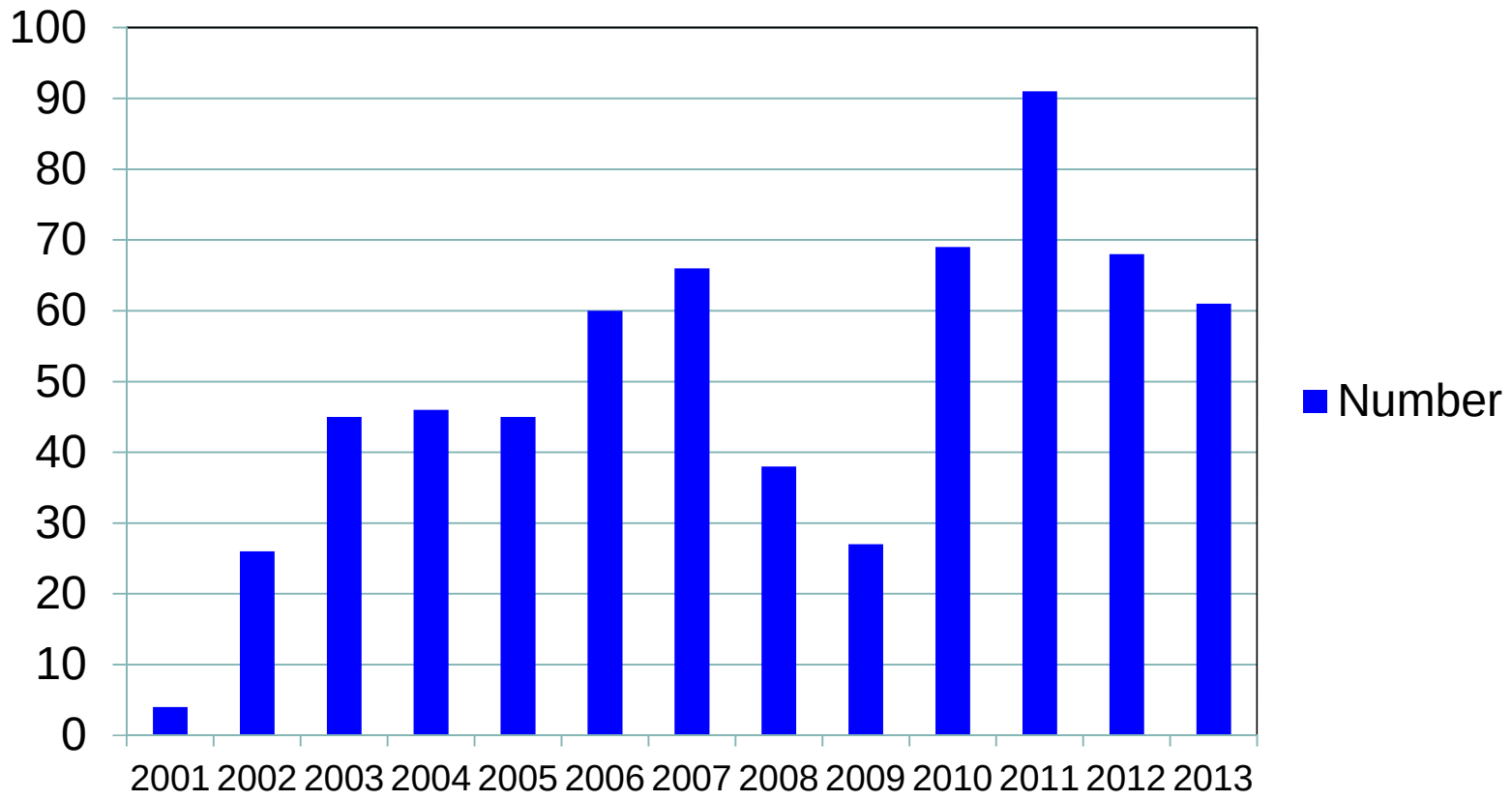
Registered Section 1 in Numbers

- 25 Registered Manufacturers
- 9 Chinese, 7 Russian, 6 North American, 1 German, Argentinian, Indonesian and Mexican
- 637 Registered Systems
- 462 Deep Penetrating, 142 Big Hole, 17 Good Hole, 6 Reactive shaped charges
- 589 Expendable Hollow Carrier, 55 Strip, 2 Pivot, 1 Port Plug guns
- 23 gun sizes

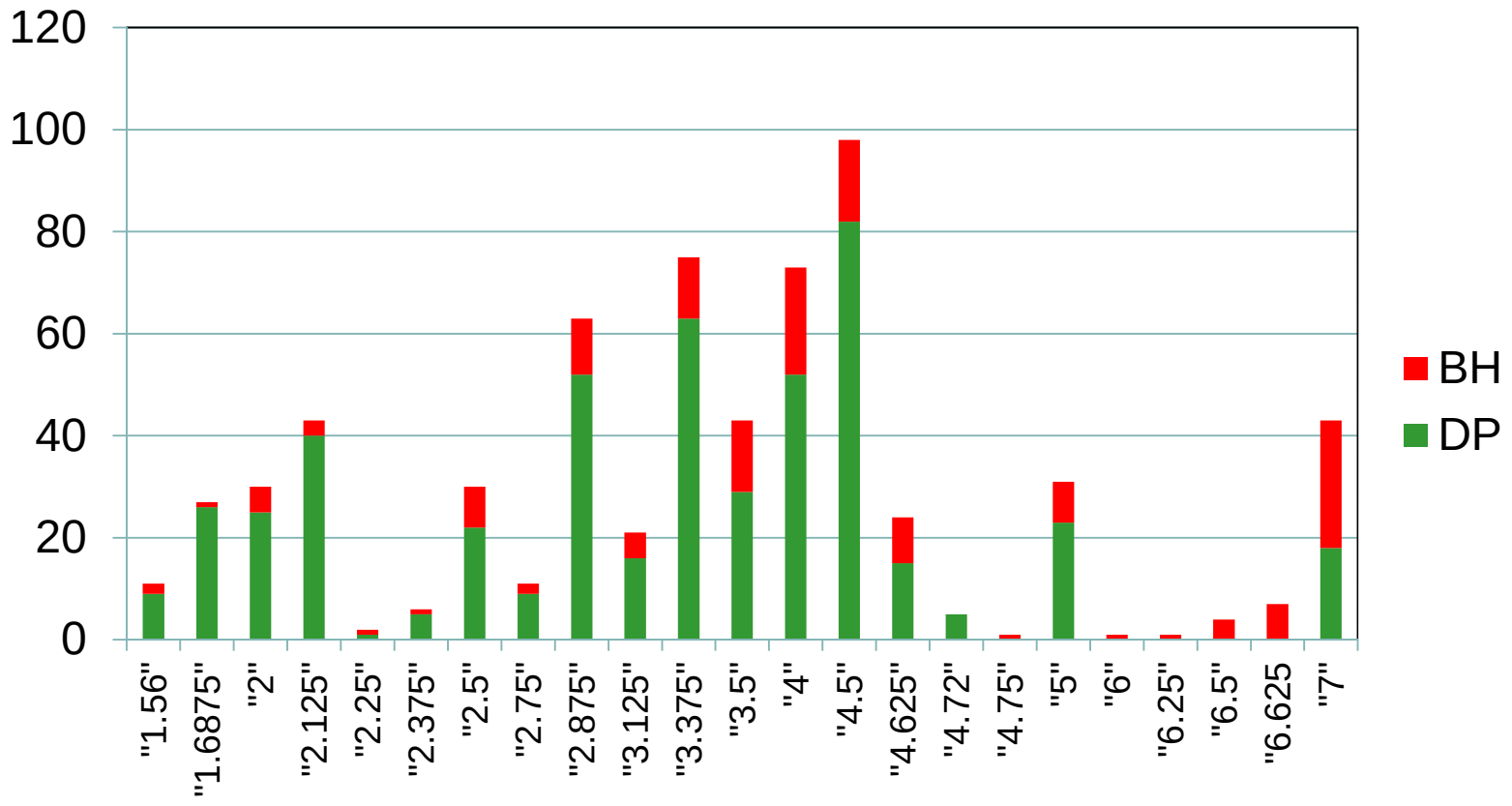
Registered Data

http://www.api.org/certification-programs/witnessing-programs/perforator-witnessing-program.aspx

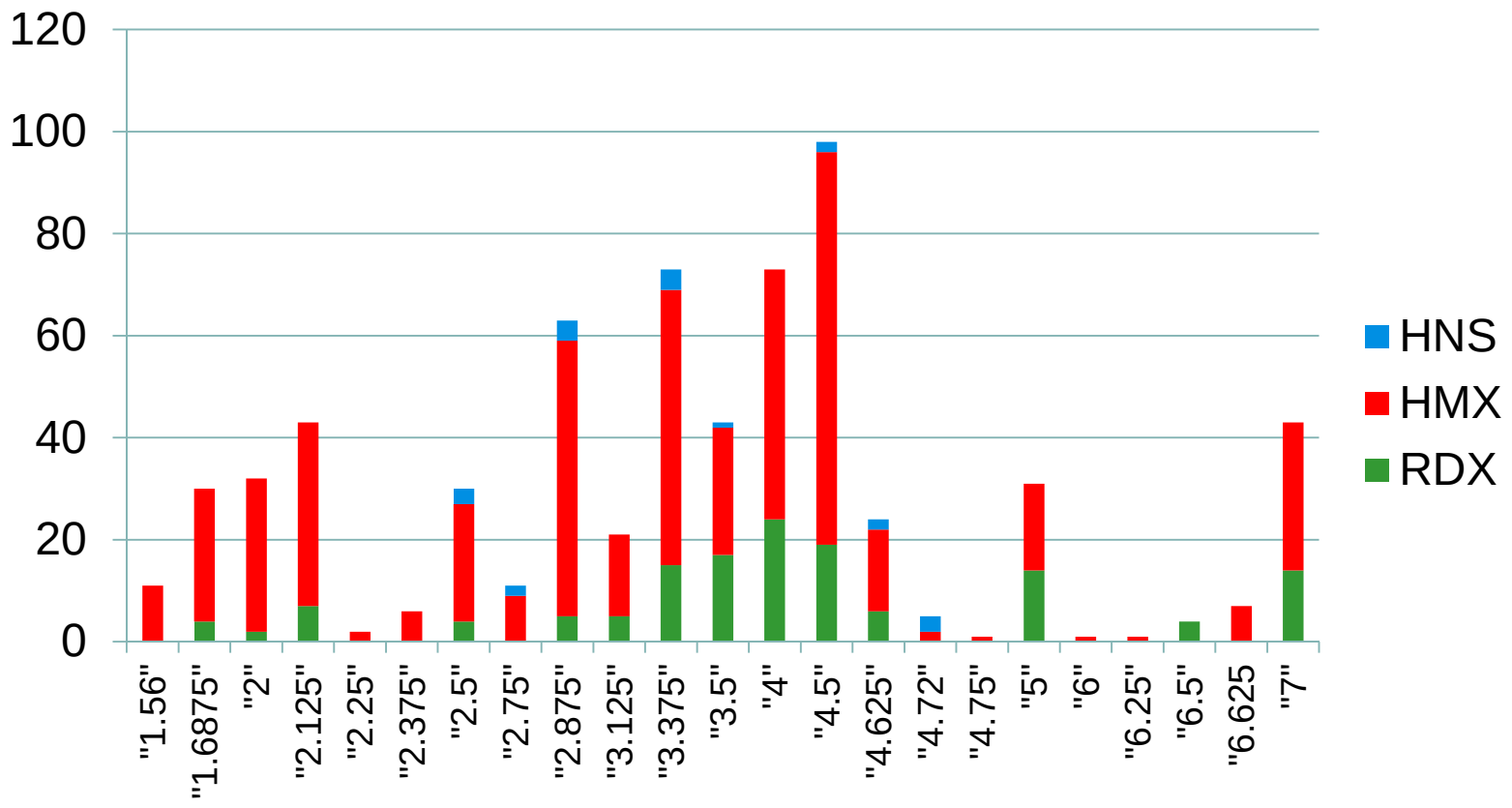
Registered Systems by Year



Gun Systems by Charge Type



Guns Systems by Explosive Type



Discussion Points

What Counts?

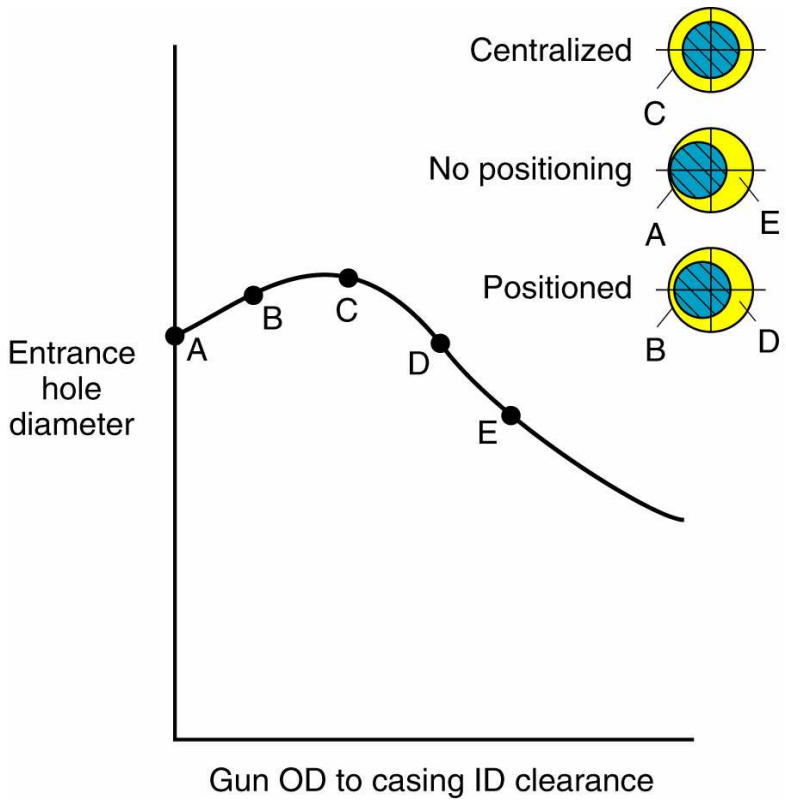
- There should be a minimum of 12 shots: two sheets show average of 10 shots
- All data should be included expect for shots out of target: 11 sheets deliberately excluded low shots in the average
- Some shots are reported lost or missing: 171 sheets report lost shots; 130 of these from only 5

(

No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	
0,00	0,24	0,86	1,25	0,86	0,24	0,00	0,24	0,86	1,25	
0,23	0,24	0,24	0,23	0,24	0,25	0,27	0,21	0,24	0,26	
0,25	0,26	0,26	0,24	0,26	0,26	0,27	0,27	0,24	0,27	
0,24	0,25	0,25	0,24	0,25	0,26	0,27	0,24	0,24	0,27	
25,20	23,20	24,40	21,30	lost	28,00	lost	24,00	26,80	23,20	
0,04	0,01	0,04	0,05	0,05	0,02	0,05	0,03	0,05	0,05	
No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No.18	No. 19	No. 20	Average
0,86	0,24	0,00	0,24	0,86	1,25	0,86	0,24	0,00		
0,23	0,24	0,21	0,25	0,24	0,24	0,24	0,26	0,25		0,24
0,25	0,24	0,22	0,25	0,26	0,26	0,24	0,27	0,26		0,25
0,24	0,24	0,22	0,25	0,25	0,25	0,24	0,27	0,26		0,25
24,80	28,30	lost	lost	20,90	23,00	lost	lost	lost		24,43
0,02	0,06	0,05	0,02	0,05	0,04	0,05	0,06	0,06		0,04

Gun Position: Centralization?

- Guns should be positioned as they are run in a real well: 64 sheets report guns perfectly centralized
- Water can have a big impact on both penetration and casing entrance hole diameter
- Big Hole charges for gravel pack are very sensitive to stand-off



Witness Program

- Witnessing is an important part of the process: several Russian companies report self assessed. One company used 3 American witnesses.

Manufacture's Certification

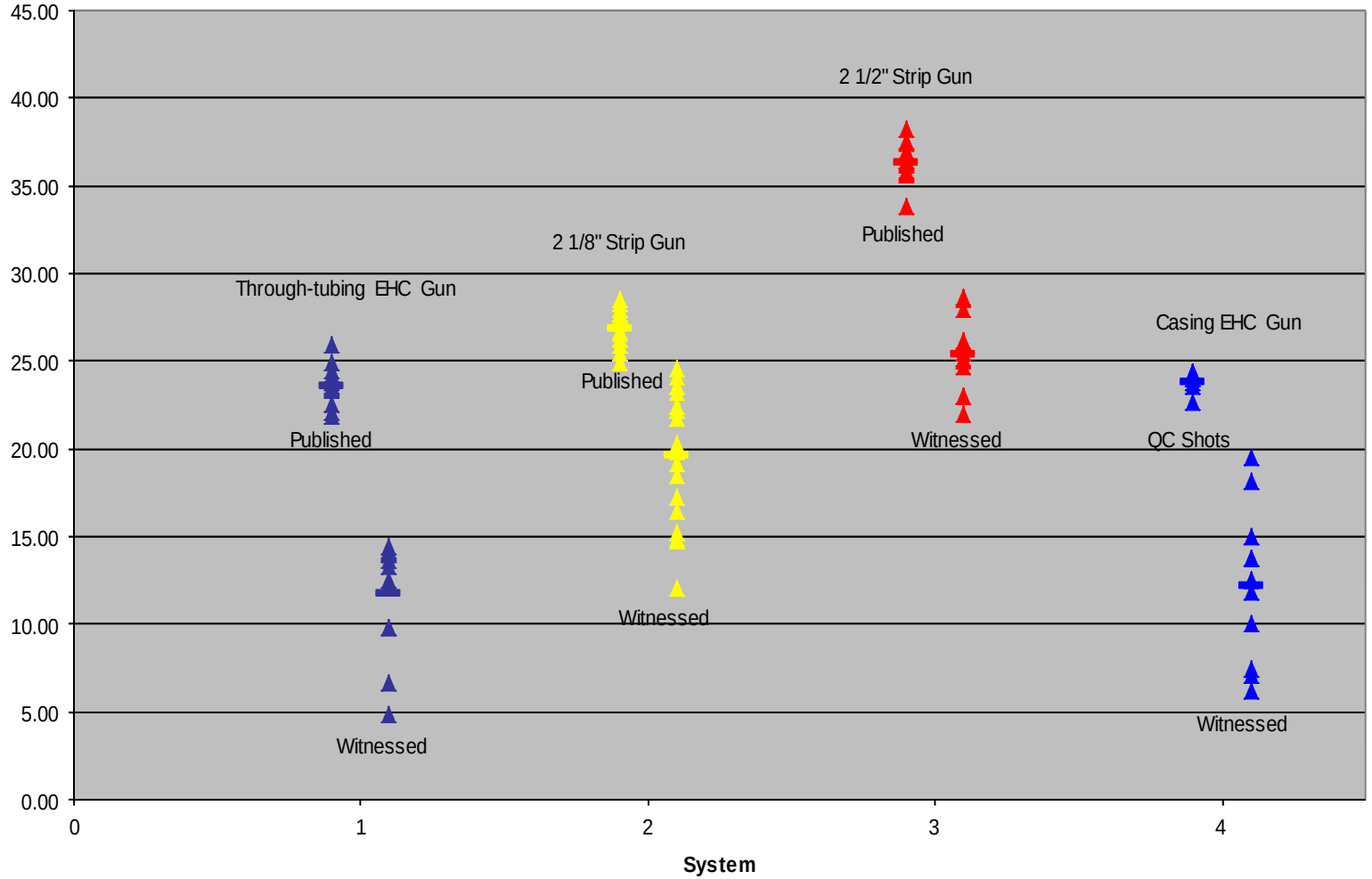
Type of Certification ____X____ Self _____ Third Party

I certify that these tests were made according to the procedures as outlined in API RP 19B: Recommended Practices for Evaluation of Well Perforators, Second Edi
our company for the use in the gun being tested and was not changed in any manner for the test. Furthermore, the equipment was chosen at random from stock and
test nor recommends the use of the perforator system described.

X CERTIFIED BY	G.M. Khamzin	Deputy General Director	31 May 2007
RECERTIFIELD	(Company Offcial)	(Title)	(Date)

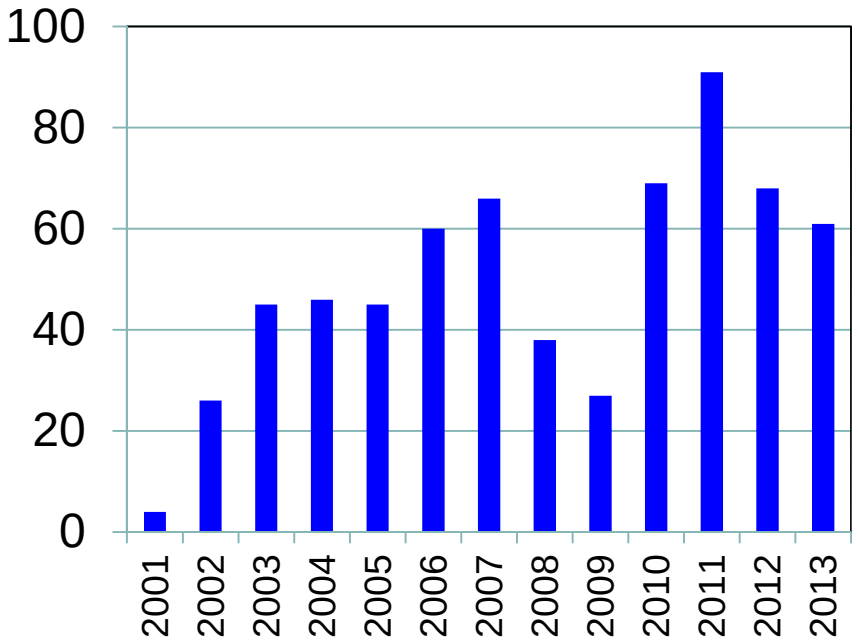
  - There are at least 10 reported North American witnesses that seem to witness tests for several companies.
  - There are witnesses outside of North America

Should Tests Be Repeated?



This is data from tests we did on 3rd party supplier

Good for Sales?



- Many tenders call for API section 1 test data
- One company shot data in one year only. Next year the company was sold. They have not shot data since

Normalization, 19B, 43, QC?

Total Target Penetration (in.)	Total Target Penetration (mm.)	Penetration Normalized to 5000 psi (5% per 1000) (in.)	Penetration Normalized to 5000 psi (5% per 1000) (mm.)	Data Type
10.50	266.7	10.58	268.7	19B
12.46	316.5	13.03	331	QC

Pen. (in.)	Pen. Norm @ 5000 psi (in)	Temp 1hr	Data Source
32.83	37.25	400°F	API RP 19B
15.30	15.95	330°F	API RP 43

- 19B briquette is go/no-go test
- 43 is not equal to 19B and expired in 1998
- QC data is not equal to 19B

- What about Rock Performance?

API RP19B Section 1 Data

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Questions