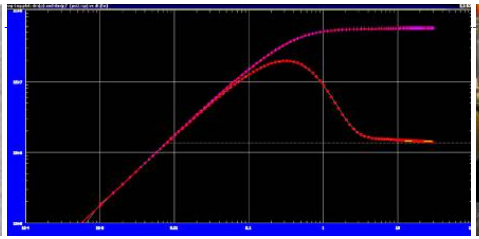
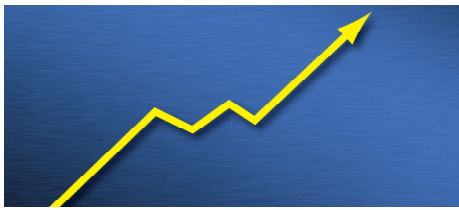
Schlumberger-Public

Intelligent Electronic Firing Heads Deep Water Applications - SLAP-39





Daniel Werneck

Plinio Bicego

Awad William

Schlumberger

Agenda

- ✓ Deep Water TCP Perforating Challenges
- ✓ TCP Firing Heads
- ✓ Case Histories
- ✓ Benefites

Schlumberger Public

Deep Water TCP Perforating Challenges

- Reservoir
  - Long Intervals
  - Muti zones reservoirs
  - Exploration conditions (Need for Foramtion Tests)
  - Deep wells (>6000 mt)
  - Deep Water Depth
- Long running time (Subsea Wellheads)
- Complex Completions
  - Intelligent
  - Several Valves operated by pressure

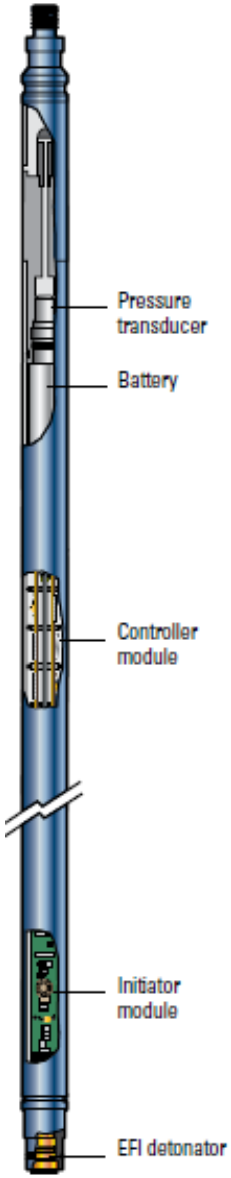
Schlumberger Public

Deep Water TCP Perforating Challenges

- Controled / Redundand firing systems to fire more than one interval at the same run
- Limited Pressures to activate firing heads
- Ensurance of firing guns independently in combined intervals production strings and / or in Shoot and Pull Operations

Schlumberger Public

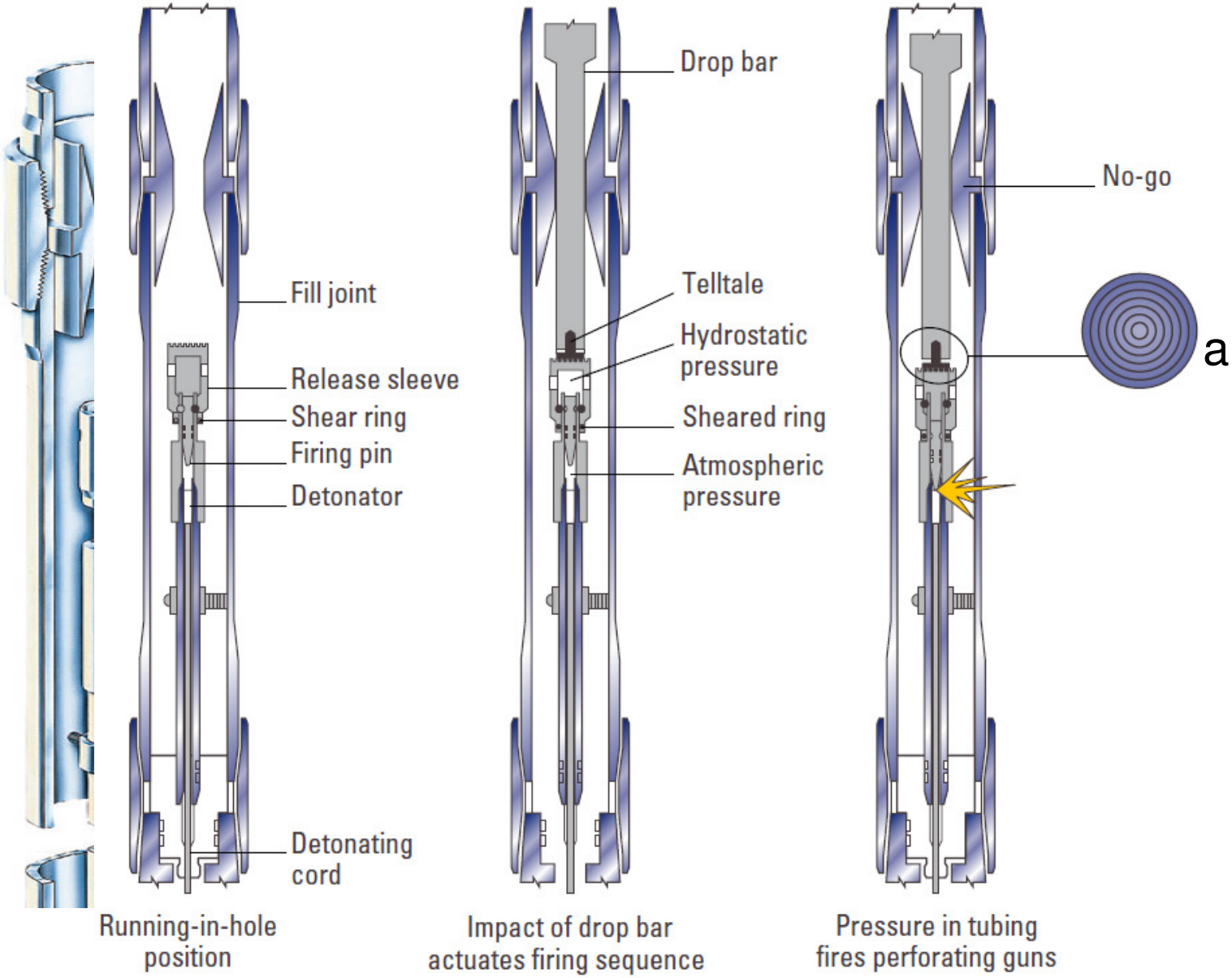
Intelligent Electronic Firing Heads



- Electronic Firing Head, utilizes the IRIS Technology;
- Safety Mechanism:
  - Activated only at 75% of expected wellbore static pressure;
  - Secondary Explosives;
- Precise Delay Time;
- No mechanical moving parts, imuned to solids in the well
- Deviated wells with partial cushions;
- Work as memory gauge with hi definition for pressure data triggered by gun firing

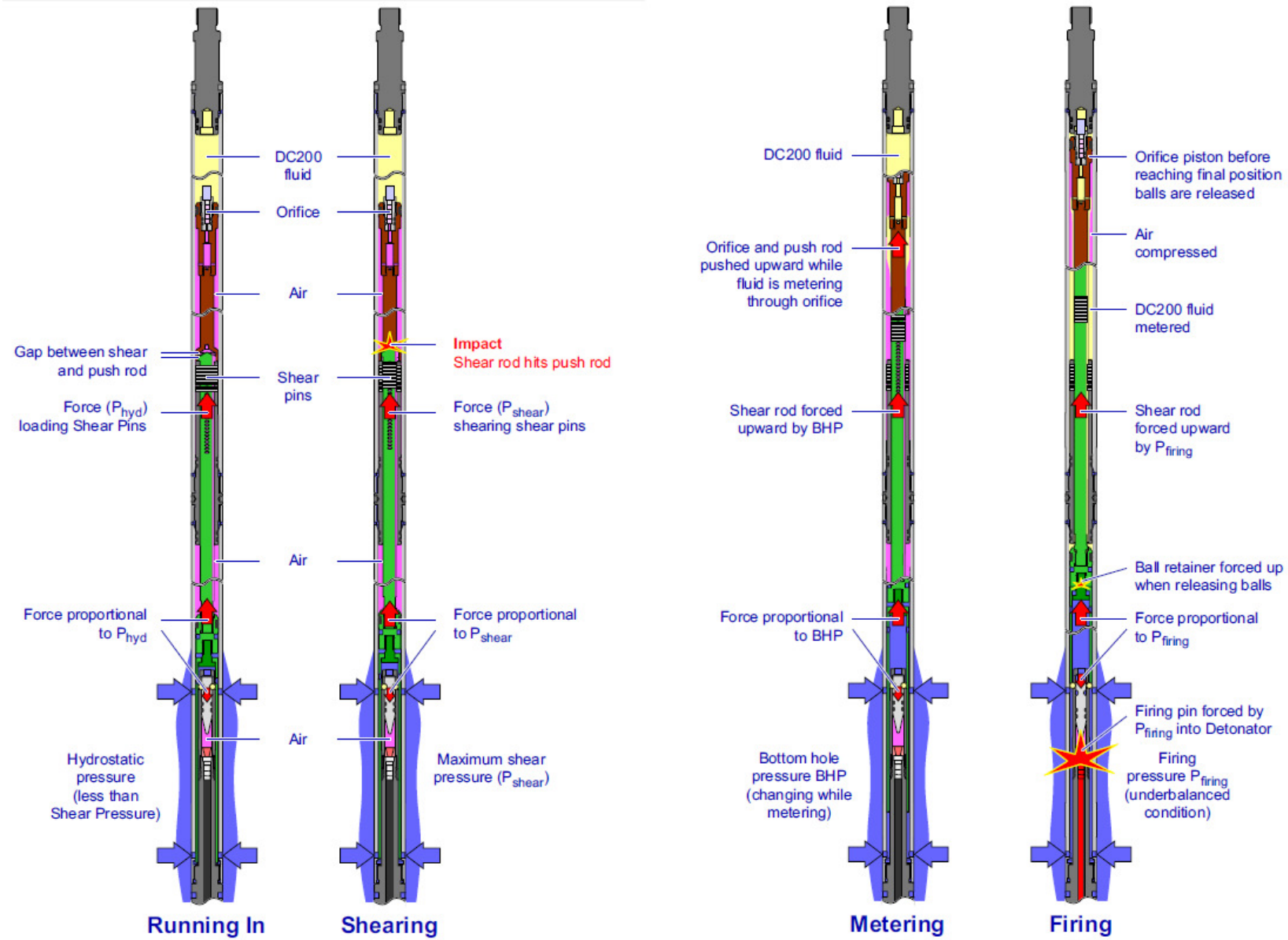
Schlumberger Public

BHF – Activated by Drop Bar



Schlumberger Public

HDF – Absolute Pressure



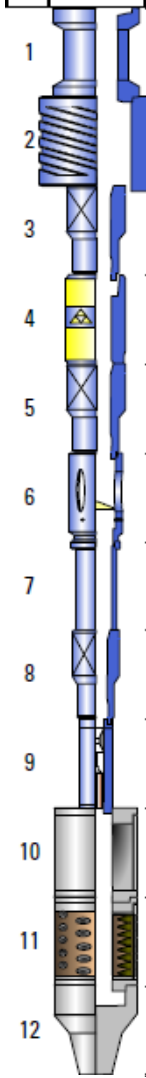
Schlumberger Public

Case History Well # A

- Well to be completed in separate formations
  - Formation X : Single interval of xx Mt
  - Formation Y : 2 Intervals combined of xxx Mt
  - Formation X & Y separted by 200 Mt
- Shoot & Pull Operations in Deep water well
- No Packer required
- Poor GR signal for correlation

Schlumberger Public

String Diagram



#	Tool	Description		Diameter OD (in.)	Diameter ID (in.)	Threads Top	Threads Bottom
1		5" Drill Pipe **Tubing**	**BR**	5.50	4.00	4 1/2 IF Box	4 1/2 IF Pin
2		Raspador 10 3/4" **Raspador**		10.75	2.25	4 1/2 IF Box	4 1/2 IF Pin
3		Cross over reducer **X-Over**	**BR**	5.00	2.25	4 1/2 IF Box	3 1/2" IF Pin
4		RA Marker Sub **RA** From top to RA=0.25m	**SLB**	5.00	3.75	3 1/2" IF Box	3 1/2" IF Pin
5		Cross over reducer **X-Over**	**BR**	5.00	3.00	3 1/2" IF Box	3 1/2" EUE Pin
6		Long Slot Debris Sub **FIS** 15.97 in2 flow area (ports)	**SLB**	4.50	2.98	3 1/2" EUE Box	3 1/2" EUE Pin
7		3 1/2" Tubing 9.3 lb/ft N-80 **Tubing** 2 tubos	**BR**	3.50	2.99	3 1/2" EUE Box	3 1/2" EUE Pin
8		Cross over reducer **X-Over**	**SLB**	4.00	2.25	3 1/2" EUE Box	2 7/8" EUE Pin
9		Cabeça de Disparo Redundante **HDF/BHF**	**SLB**	2.88		2 7/8" EUE Box	5" API Pin
10		High Shot Density **7" - Spacer** Espaçador de segurança	**SLB**	7.00		5" API Box	5" API Pin
11		High Shot Density **7" HSD** PowerJet Omega 4505 12spf	**SLB**	7.00		5" API Box	5" API Pin
12		Lower Adp 7" x 2 7/8" EUE **Bull Nose** Blank plug	**SLB**	7.00	0.01	5" API Box	2 7/8" EUE Pin

- Scrapper 10 ¾”
- Production Valve
- Redundant Firing Head IEF/HDF
- RDT Firing Head BHF/HDF
- Interval X Lower

Schlumberger Public

HDF – Absolute Pressure

3000 psi / 2 min

12000 psi

HSV

Pressure to Shear - with Cushion
Surface - Pump applied

Low Shear Value at Surface	1415 psi
Pressure to Shear at Surface (HSV + OverKill)	2961 psi

3 min

9942 psi

10142 psi

LSV

Downhole - Pump applied + $P_{cushion}$

Low Shear Value at Downhole	9942 psi
Pressure to Shear at Downhole(HSV+OverKill)	11489 psi

Pressure to Shear - with Cushion
Surface - Pump applied

Low Shear Value at Surface	1230 psi
Pressure to Shear at Surface (HSV + OverKill)	2798 psi

2 min

Downhole - Pump applied + $P_{cushion}$

Low Shear Value at Downhole	10142 psi
Pressure to Shear at Downhole(HSV+OverKill)	11709 psi

8527 psi

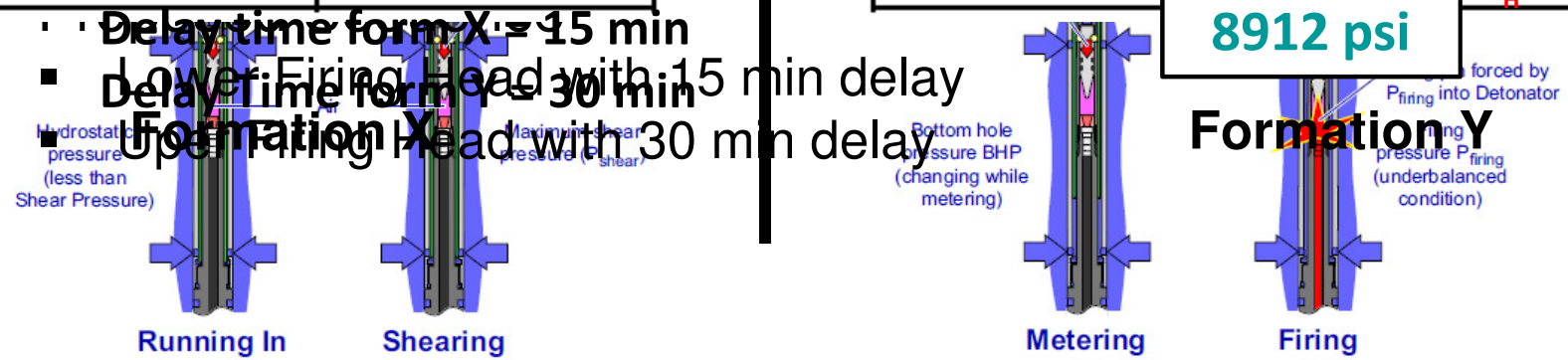
8912 psi

P_H

- **Delay time form X = 15 min**
- Lower Firing Head with 15 min delay
- **Delay time form Y = 30 min**
- Upper Firing Head with 30 min delay

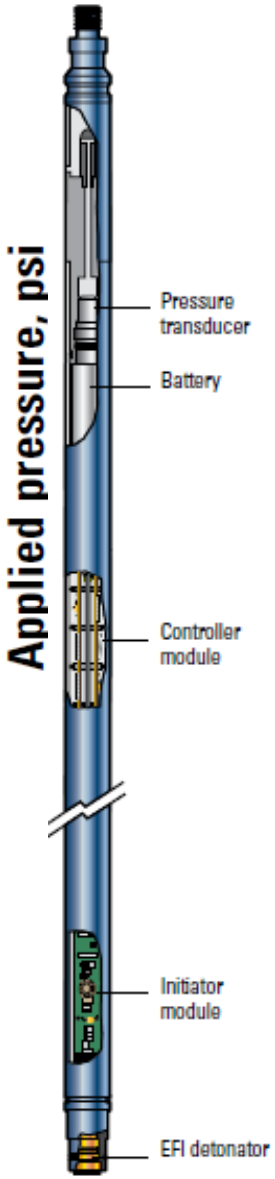
Formation X

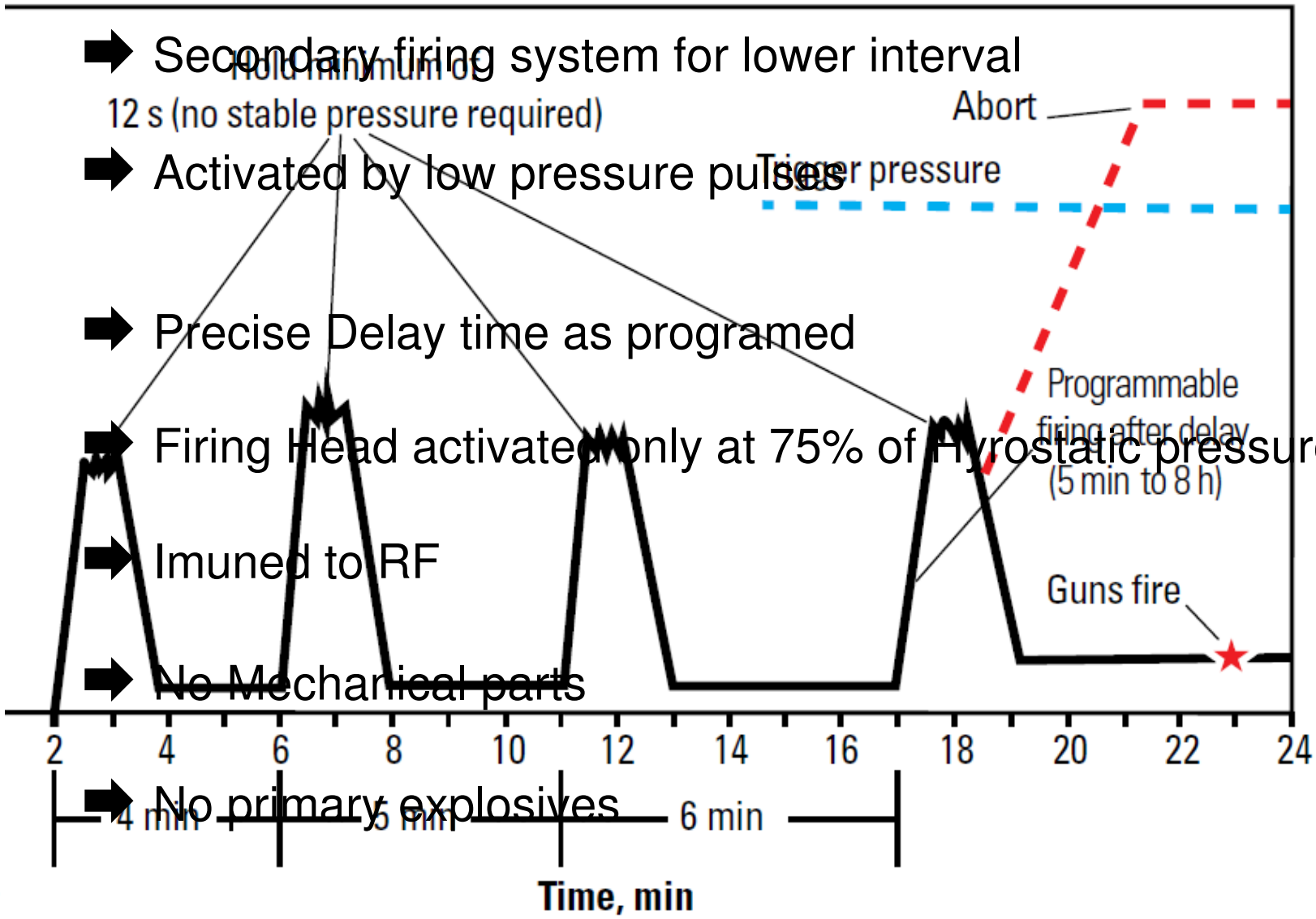
Formation Y



Schlumberger Public

IEF – Pressure Pulses





- Secondary firing system for lower interval
- Activated by low pressure pulses
- Precise Delay time as programed
- Firing Head activated only at 75% of Hyrostatic pressure
- Imuned to RF
- No Mechanical parts
- No primary explosives

Schlumberger Public

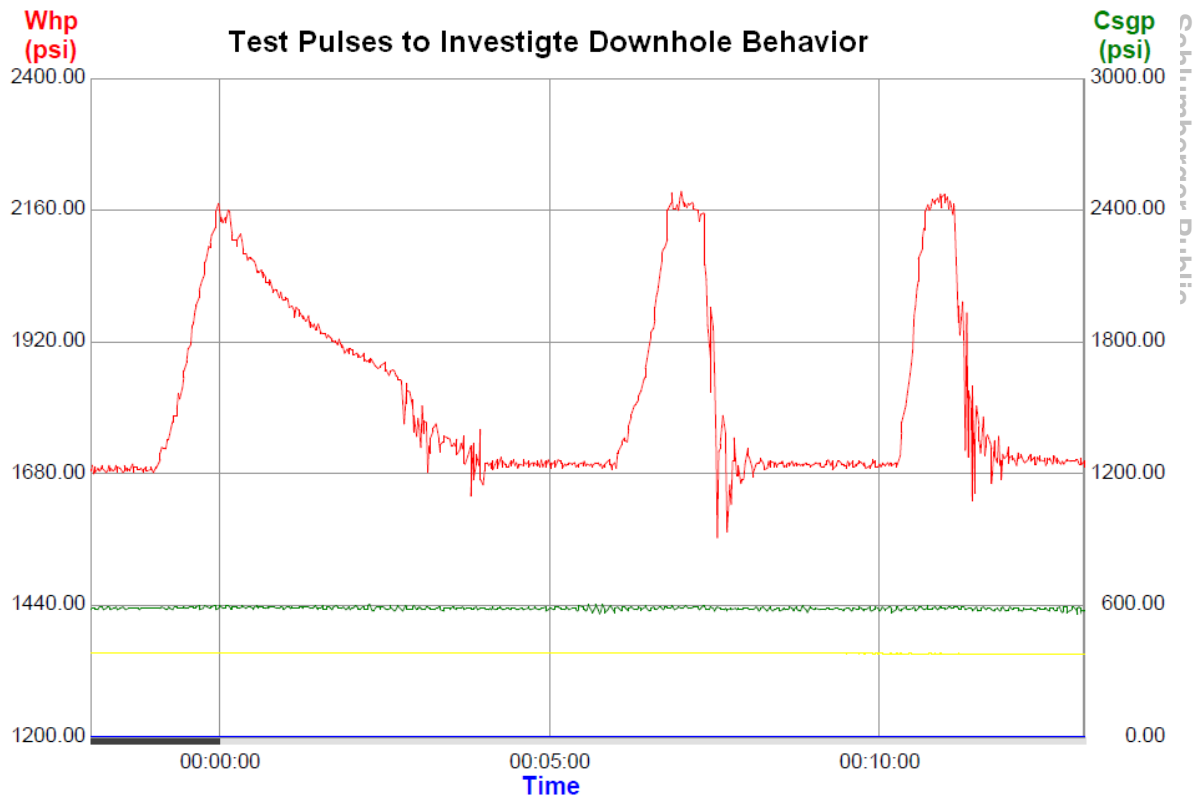
Case History Well # B

- Well to be completed in one formation
- Downhole full test string run with the guns to evaluate the well
- Well had cementing issue in which cement squeeze job been performed

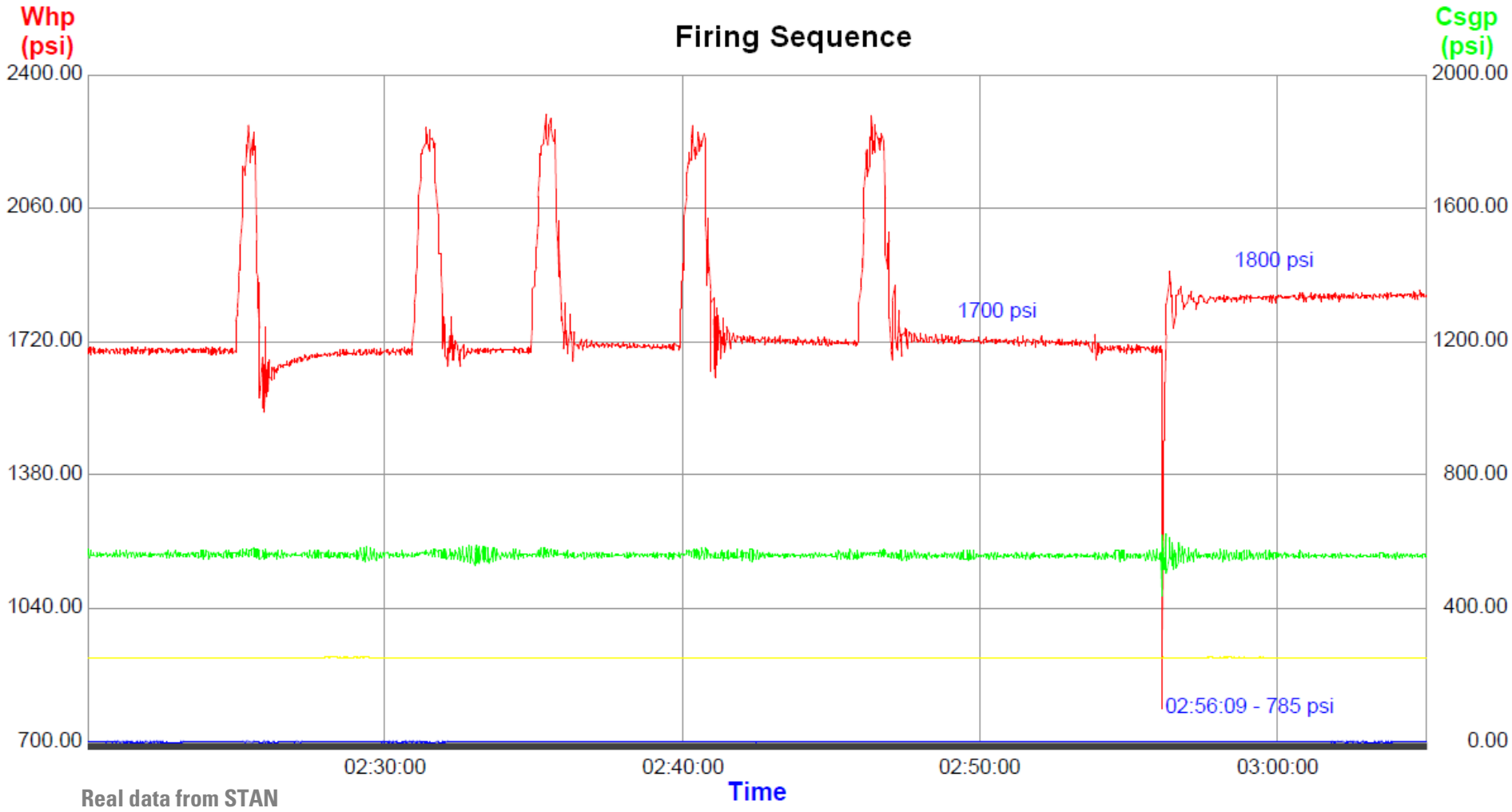
Schlumberger Public

IEF – Case History Well # B

- After setting the packer and circulate xxx bbls of diesel to obtain the required UB, the IRDV (multi function valve) been circulated to close the circulation valve and open the downhole shut in valve. At this moment observed well head pressure of 1700 psi indicating formation communication suspecting the squeezed interval
- Several Attempts proved leak in the squeeze
- Can not hold pressure



Case History Well # B



Schlumberger Public

Benefits

- ✓ Guns in Multiple zones with long spacing can use redundand selective firing systems resulted in spacers cost reduction (~200 M)
- ✓ Improved operations relability:
  - ✓ Reduced spacers connections risk
  - ✓ Redundant controlled Firing heads even with open perfs operations
  - ✓ Reduced pressure pulses vs high pressure operations
- ✓ Impact on Efficiency ⟷ $$$:
  - ✓ Combine 2 runs into one run ~~~~ 72 hrs Rig time
  - ✓ Reduce making up time for spacers utilizing tubing

Schlumberger Public

Qustions

Schlumberger Public