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MIDDLE EAST AND NORTH AFRICA PERFORATING SYMPOSIUM

Enhance the Use of Shot Detection Acoustic Device in TCP Operations

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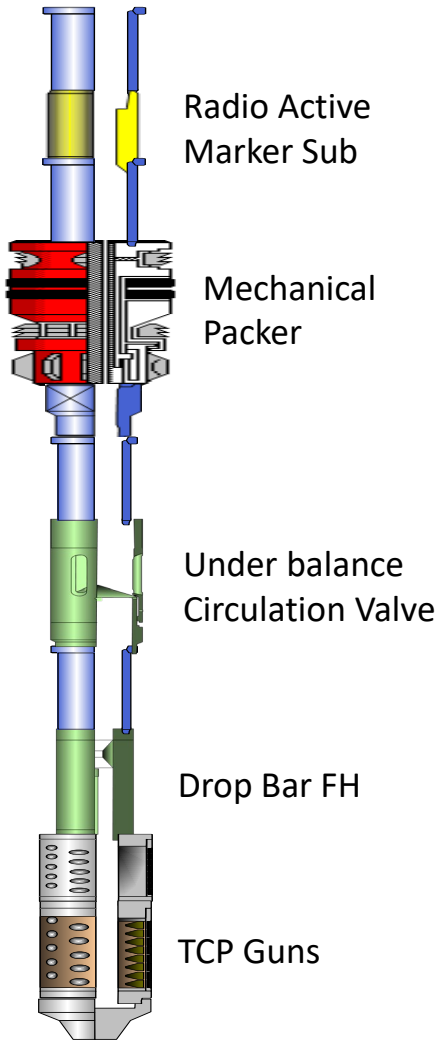
Background

- **TCP Shoot and Pull underbalance perforation strategy:**
  - Underbalance created with partially filled tubing string.
  - Retrievable packer to isolate annulus from rat-hole.
  - Bar-activated surge valves to function the UB concept.
  - Drop Bar Firing Head to fire the guns.



TCP drop bar risks

Drop Bar Firing heads will start failing when well conditions are not ideal; meaning:

- Wells are inclined over 45º.
- S-Shape wells that can disturb bar speeds.
- Tubular constant change of IDs.
- Debris settlement around the firing head sub.

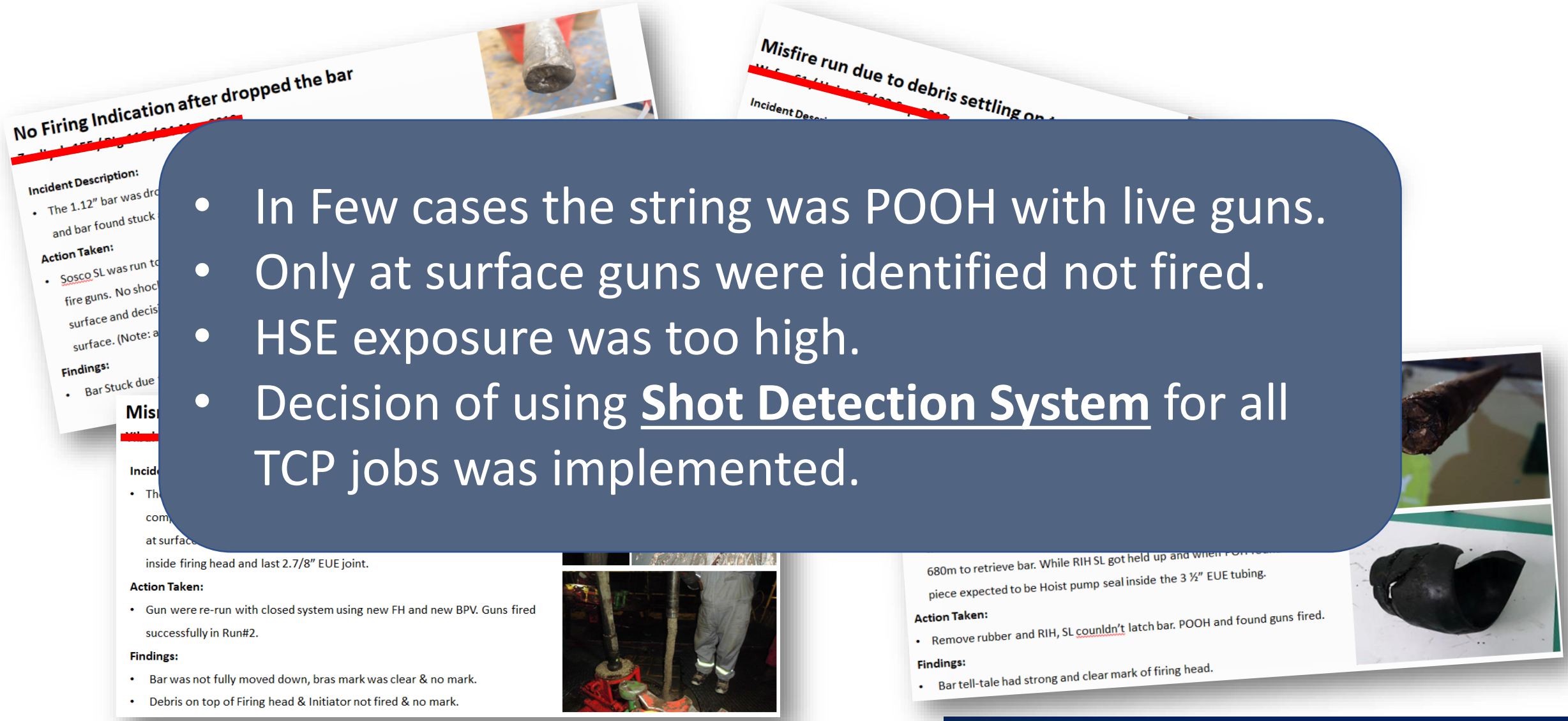
Live guns at surface cases

Unclear firing indications lead to POOH live guns:

- Due to deep wells and existing perforations.
- Fake firing indication from production valve opening.
- Wrong interpretation of data if Shot Detection Device is used.

Drop Bar not Reaching Firing Head Cases

Real cases with mis-runs due to bar not reaching firing head:

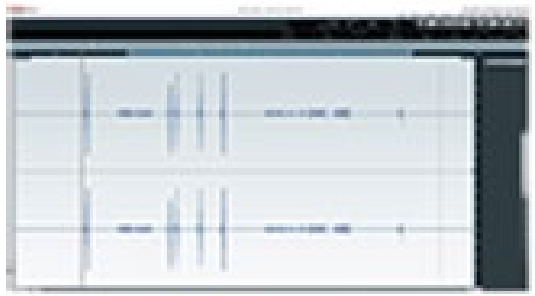


- In Few cases the string was POOH with live guns.
- Only at surface guns were identified not fired.
- HSE exposure was too high.
- Decision of using **Shot Detection System** for all TCP jobs was implemented.

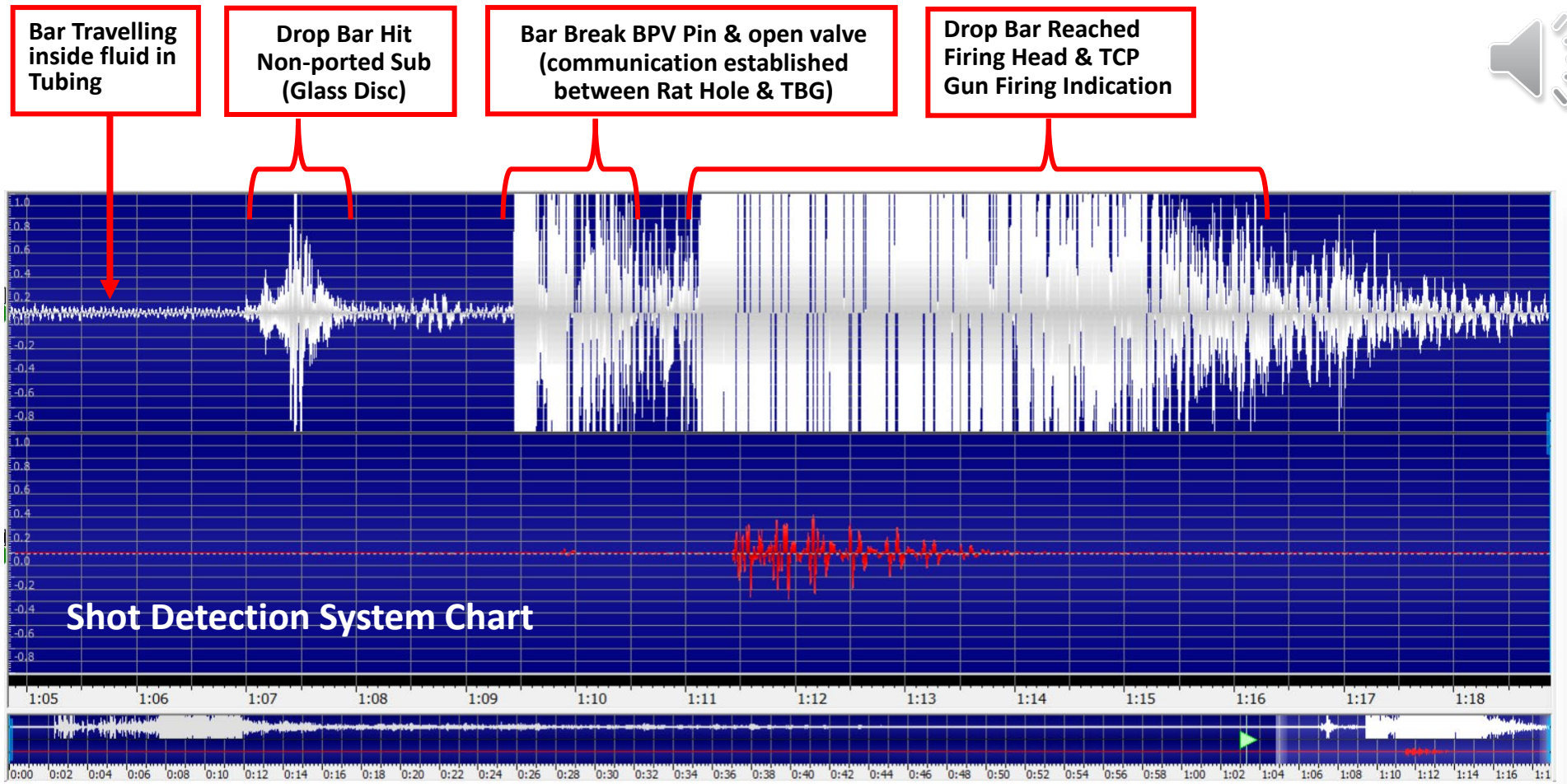
Introduction of Shot Detection System

TCP Shot Detection System benefits and features:

- Crisp and clear audio signals make easy identification of gun detonation.
- Rapid and informed decisions can be made real-time.



Analyzing different indications



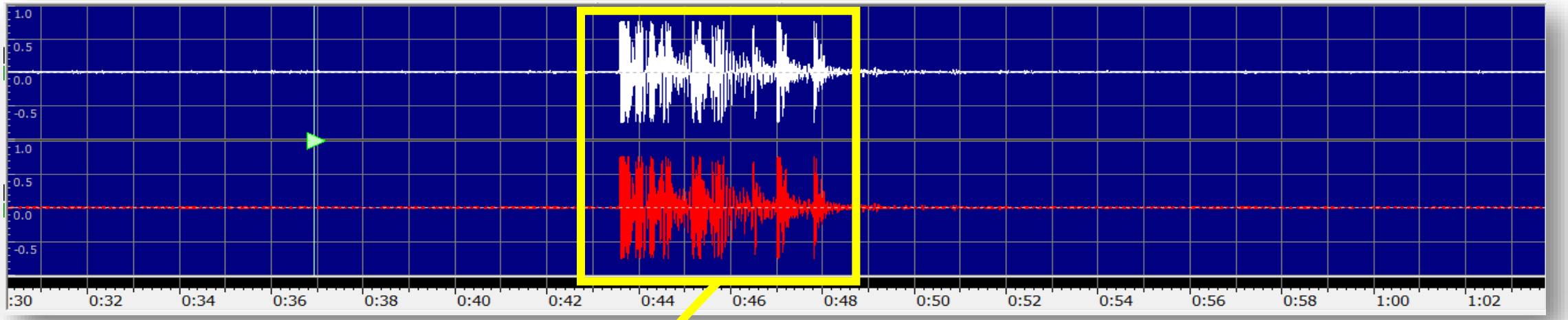
Tool String	Description	Length. (m)	Top Depth. (m)Mahbdf	Bottom Depth(m)Mahbdf
	Circulation Head	0.50	-1.67	-1.17
	3 1/2" EUE (9.3#) (86 jts) TBG to surface	847.66	-1.17	846.49
	3 1/2" EUE PUP Joint.	1.53	846.49	848.02
	3 1/2" EUE RA Marker SN#005 PIP TAG	0.14	848.02	848.16
	7" Mechanical Retrievable Packer SN#006	2.97	848.16	851.13
	X-O 2 7/8" EUE (P) * 3 1/2" EUE (B)	0.25	851.13	851.38
	2ea 2 7/8" EUE TBG Joints	18.79	851.38	870.17
	2 7/8" EUE Non-Ported Sub SN#006 (With 1/4" Glass & without O-Ring)	0.18	870.17	870.35
	2 ea 2 7/8" EUE TBG Joints	18.94	870.35	889.29
	2 7/8" EUE BPV (Bar-drop Production Valve) SN#007	0.43	889.29	889.72
	2 ea 2 7/8" EUE TBG Joints	19.01	889.72	908.73
	Short-Mechanical Firing Head (2-7/8") with Pup joint SN#005	0.91	908.73	909.64
	4.5" Safety Spacer	3.96	909.64	913.60
	4.50" HSD, DP, RDX, 12 SPF	6.10	913.60	919.70
	4.5" Blank Gun	25.10	919.70	944.80
	4.50" HSD, DP, RDX, 12 SPF	7.60	944.80	952.40
	4.5" Blank Gun	3.90	952.40	956.30
	4.50" HSD, DP, RDX, 12 SPF	11.60	956.30	967.90
	Bottom Plug	0.27	967.90	968.17

- **Firing Head Depth :** 909 meter (2,900 feet)
- **Deviation at FH Depth :** 17º
- **Gun Type :** 4.1/2” HSD Guns, 12 SPF, 22.7g DP RDX
- **Net Perforation Intervals :** 25.3 meters
- **Total No. Shots :** 996 Shots
- **Total Net Explosive weight in guns :** 22.6 kg

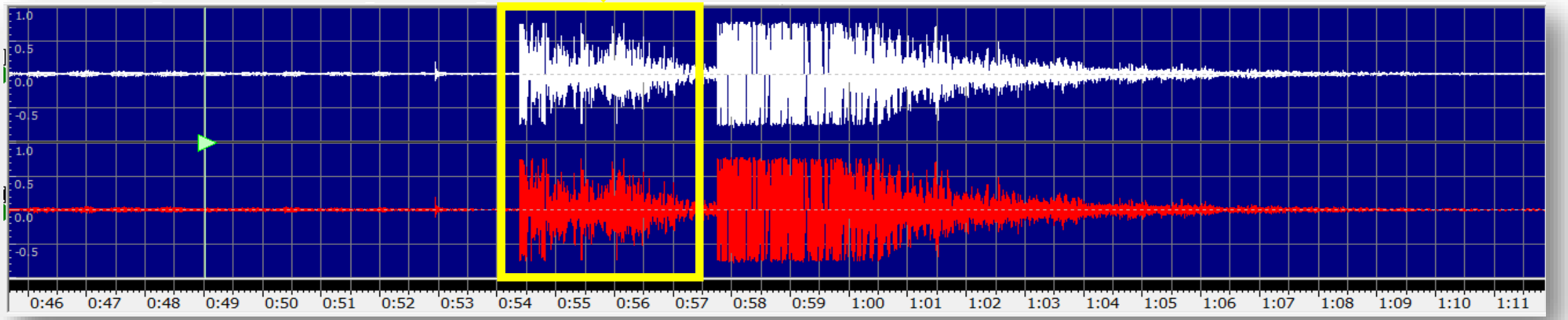
Indication of Mis-Fired/Fired Guns

Well-A Shot Detection Chart – (Mis-Fire)

- Bar Hit Opening the BPV but no detonation indication observed



Well-A Shot Detection Chart – (Fired)



Improved use of Shot Detection Systems

The Beginning of the End!

- Over 100 wells from shot detection analyzed.
- HSE issues with drop bar FH been solved.
- New model for the use of shot detection system beside HSE exposure was carried out.

Improved use of Shot Detection Systems

Case study to enhance the use of shot detection acoustic device to:

1. Avoid POOH Live Guns.
2. Failure investigations.
3. Redesign TCP jobs.

Improved use of Shot Detection Systems

1. **Avoid POOH Live Guns:**

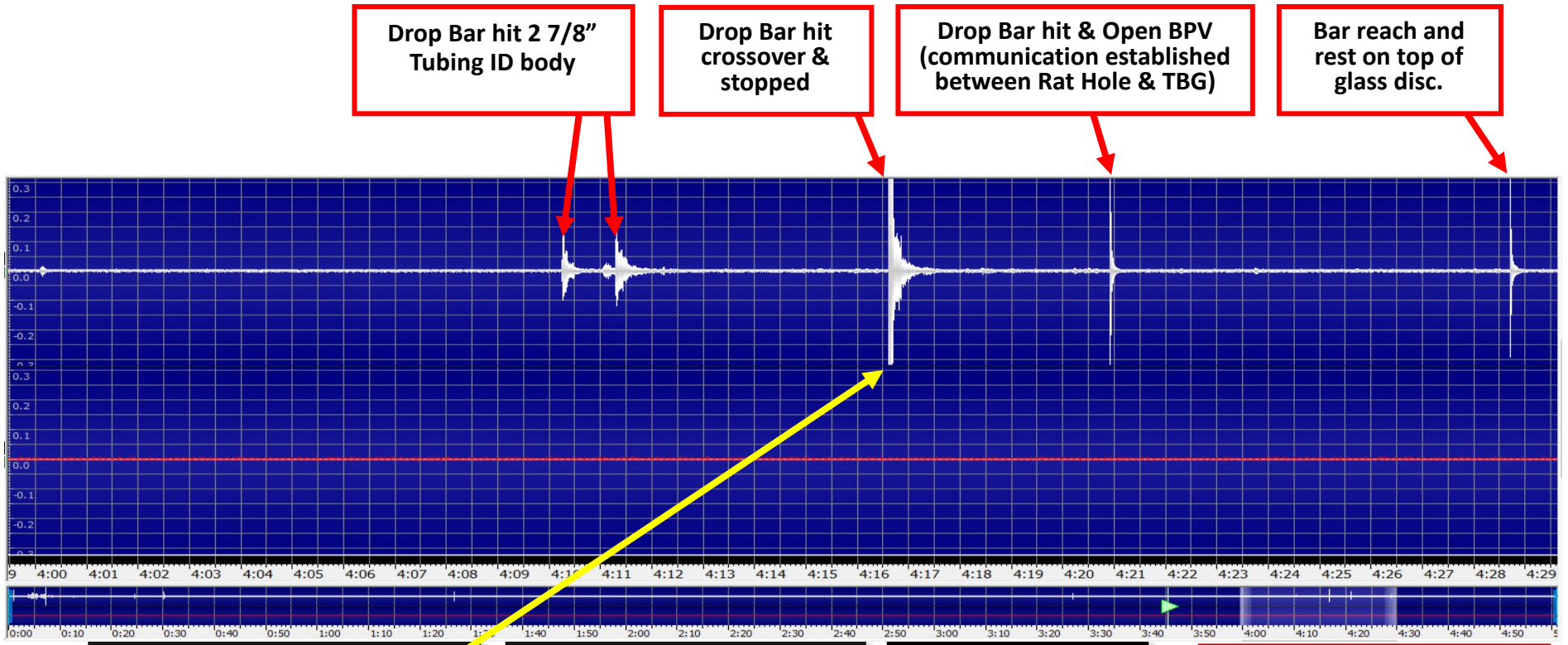
- Analyze different indication to identify detonation.
- Calculate drop bar traveling time in dry and wet strings.
- Analyze indication with Mechanical and Hydraulic Firing Heads.

Improved use of Shot Detection Systems

2. Failure investigation:

- Understand drop-bar reaction downhole.
- Compare theoretical and practical facts in investigation findings.
- Link distance, time and sound to support decision making.
- Improve contingency procedure to avoid any HSE issues.

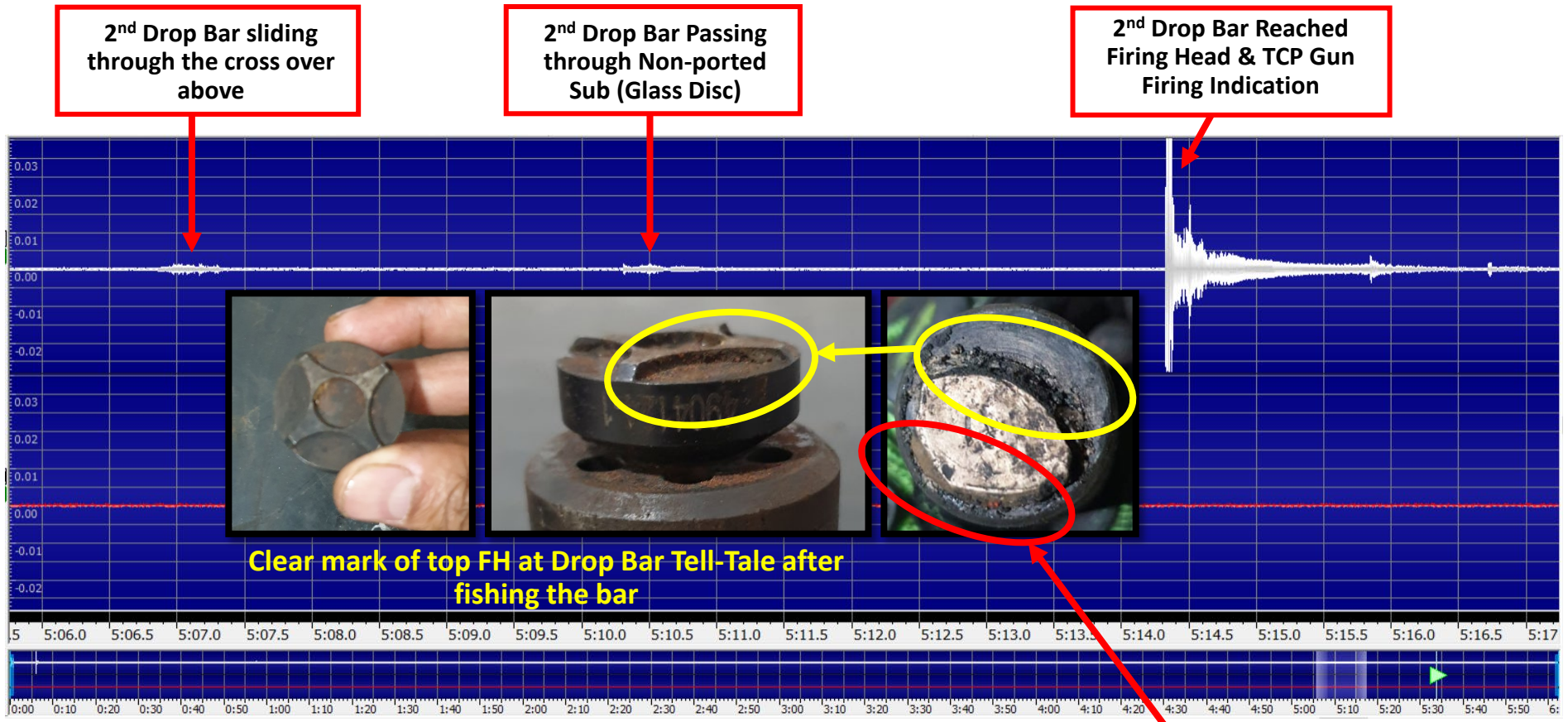
Drop bar failure investigation



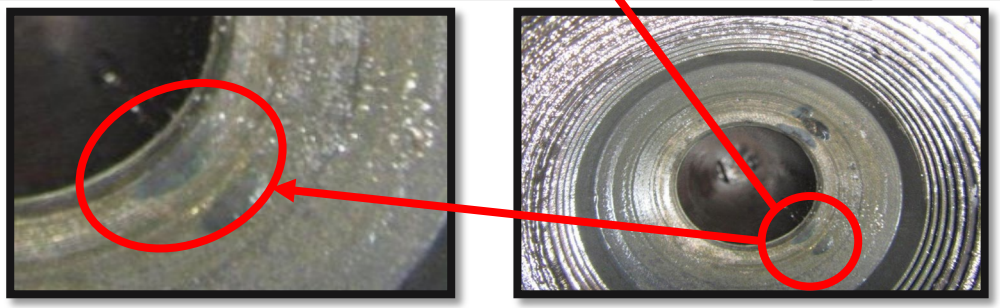
Deep Mark of Drop Bar at the 1.5" ID Crossover. X/O was at depth 3327m (which was above BPV)

Solids/Sand found above FH after POOH

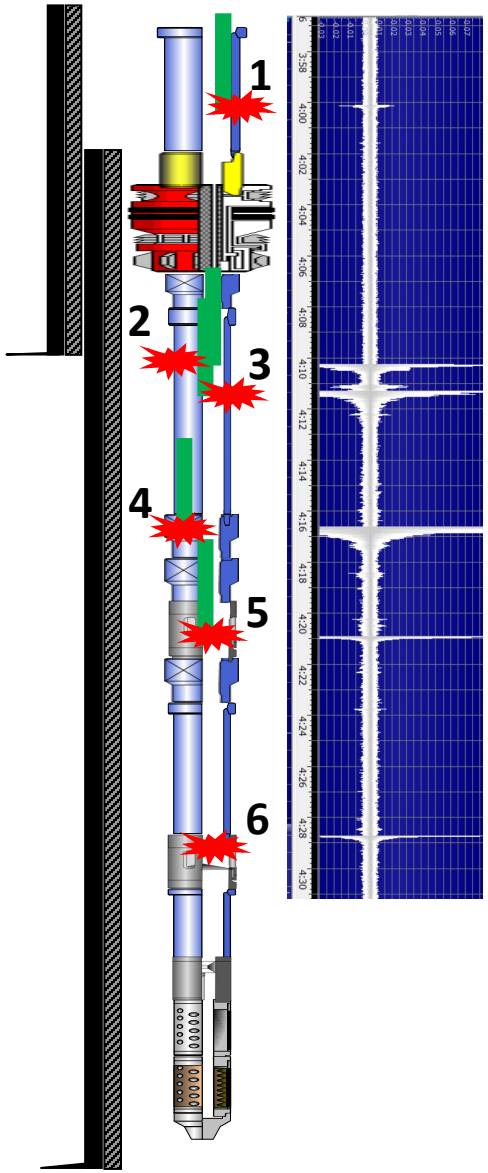
Drop bar failure investigation



Mark of 2nd drop bar touching the tip of 1.5” ID cross over while travelling down



Drop bar failure investigation



Description of Event

Bar hitting wall ID of 3 1/2" EUE tubing

Bar hitting wall ID of 2 7/8" EUE tubing

Bar hitting and stopping at crossover 2.7/8" PAC (P) by 2.7/8" EUE (B)

Bar breaking BPV pin to open the circulation ports

Bar hitting and stopping on top of Non-ported sub glass disc.

Depth

3104.0 m → Impact 1

3241.3 m → Impact 2

3255.0 m → Impact 3

3327.7 m → Impact 4

3357.8 m → Impact 6

Impact Time vs. Distance

10 Sec - 137 m

1 Sec – 13.7 m

5.3 Sec - 72.7 m

4.5 Sec - 1 m

7 Sec - 29 m

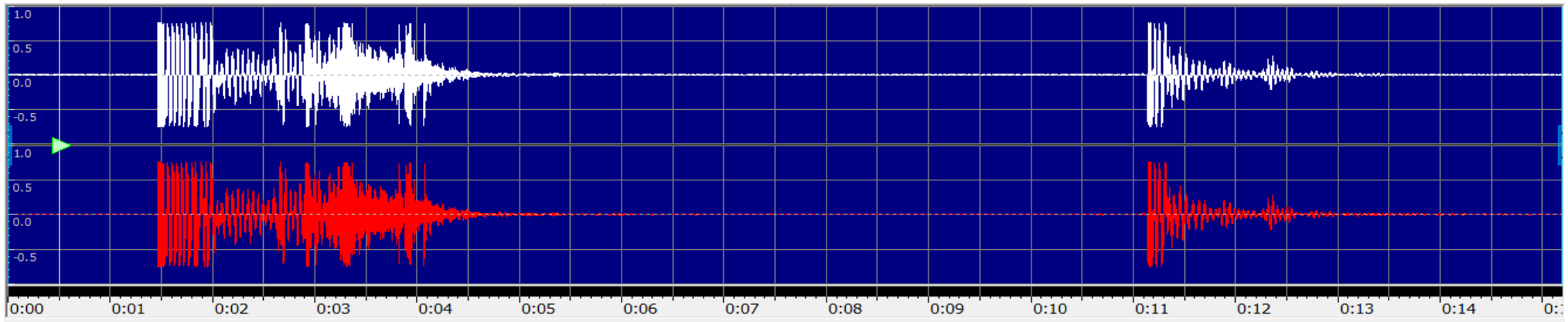
2nd Drop bar travelled the same distance in 3.5 seconds.

Drop bar normally travels 30m in 3 seconds. However, due to drop bar impact in X/O it lost its complete speed & took 11.5 seconds instead. Acceleration and velocity was not enough to pass through solids/sand settling on top of the glass disc.

Improved use of Shot Detection Systems

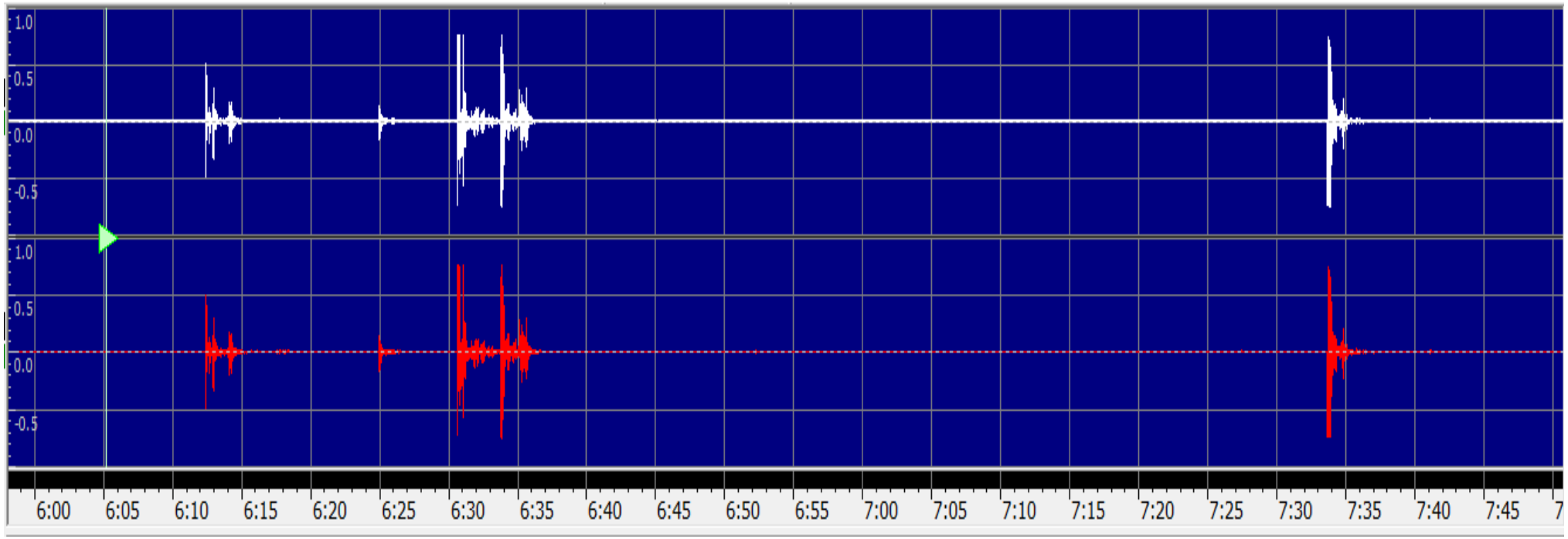
3. Use shot detection data to support on TCP job design:

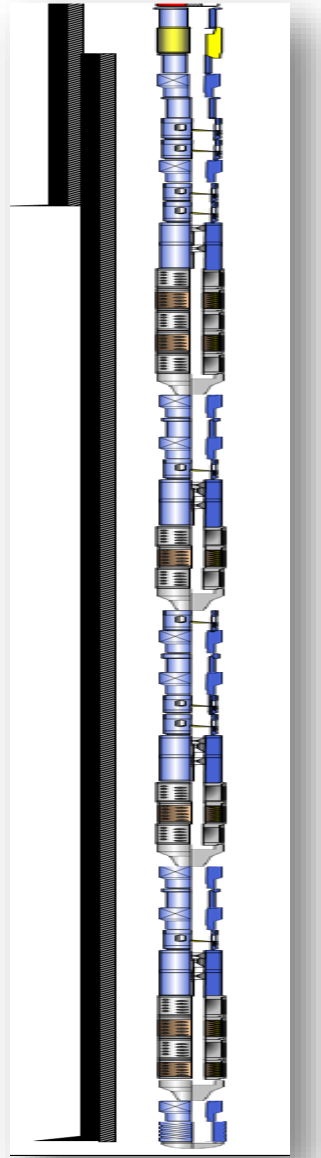
- Enhance TCP design for multiple firing heads.
- Ensure positive firing of all zones.
- Reduce risk of not activating any of the Firing Heads.
- Trial run to confirm firing of both zones.



Detecting Multiple Firing Heads Detonation

- Using same activation pressure and delay time.
- All zones detonation indications was easily identified by Shot Detection System.





Conclusion

- **Wrong interpretation of shot detection data leads to POOH live guns.**
- **Shot Detection System have allowed us to:**
  - ✓ Avoid HSE exposure.
  - ✓ Save time on decision making.
  - ✓ Help on detecting indications with multi firing heads.

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Q&A

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