Artificial Lift R&D Council

Troubleshooting Gas Lift Wells Using Simultaneous Acoustic Surveys

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ConocoPhillips

(((ECHOMETER)))

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Introduction

- The number of Gas Lift systems has increased significantly along with unconventional wells.
- The need of understanding the performance and troubleshooting Gas Lift systems is now even more relevant for operators.
- Tubing-casing communication is one of the biggest issues and it can be identified from surface using a simple, quick, safe and effective simultaneous acoustic survey to find holes in tubing or leaky gas lift valves above the liquid level.
- The Dual Shot Method is a non-invasive technique.
- Two guns with microphones are connected to the wellhead, one to the tubing and the other to the casing-tubing annulus.
- One of the guns is used to release a pressure wave down the well, while the other gun just listens for possible echoes from tubing-casing pressure communications.
- Both acoustic surveys (tubing and casing) are simultaneously recorded and overlaid for its proper evaluation.

Wireless Fluid Level equipment configuration

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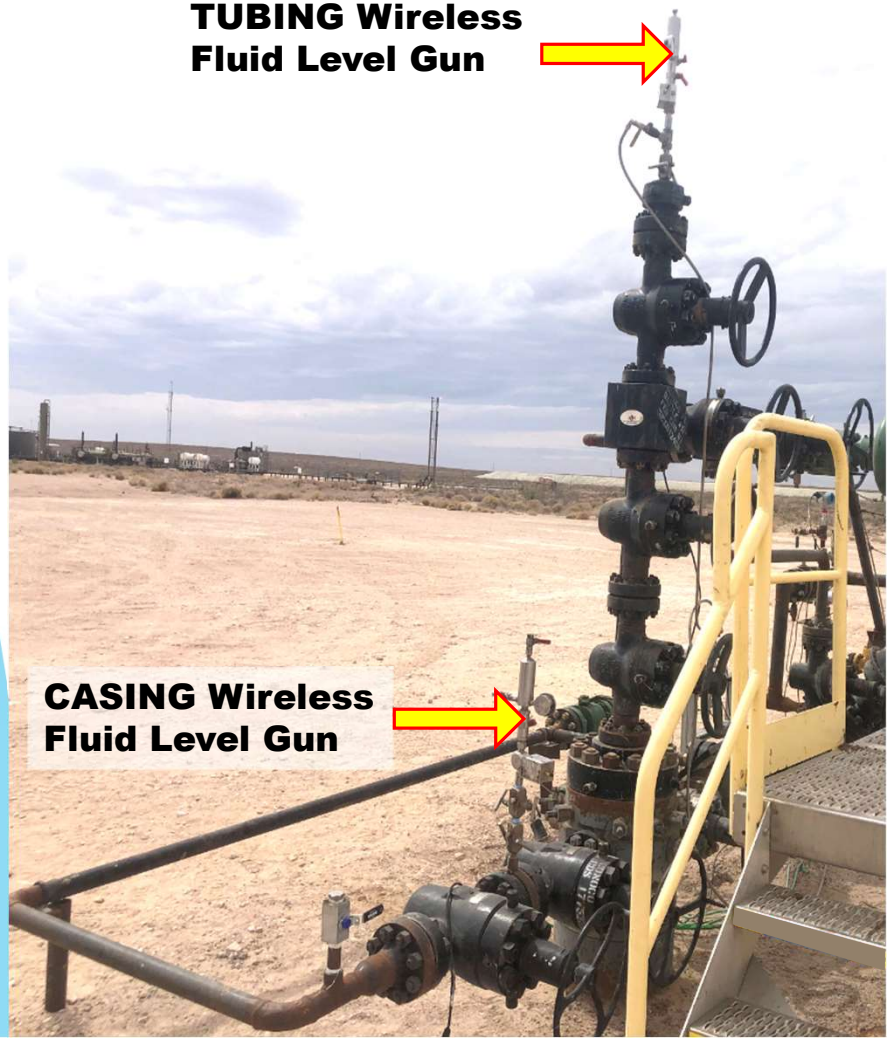
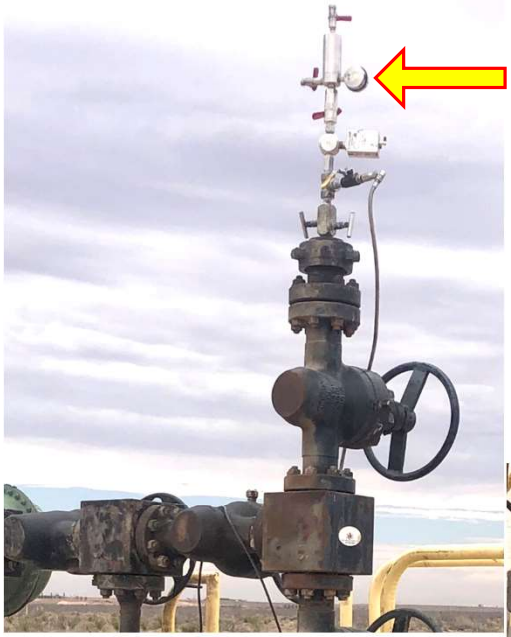
TUBING Wireless Fluid Level Gun

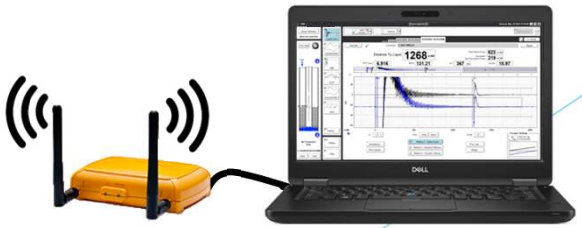


CASING Wireless Fluid Level Gun

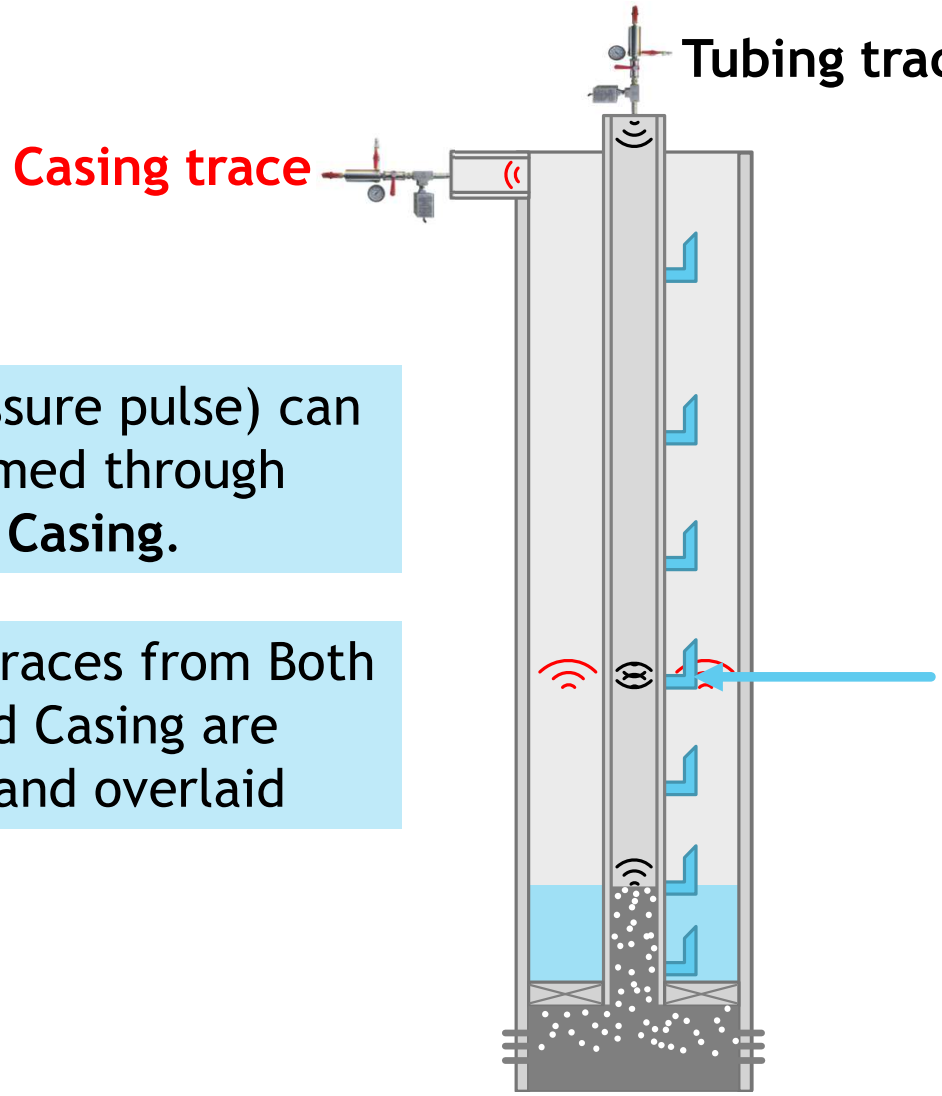


TUBING Wireless Fluid Level Gun

CASING Wireless Fluid Level Gun



Wireless Fluid Level shot recorded in Tubing & Casing



Shot (pressure pulse) can be performed through **Tubing** or **Casing.**

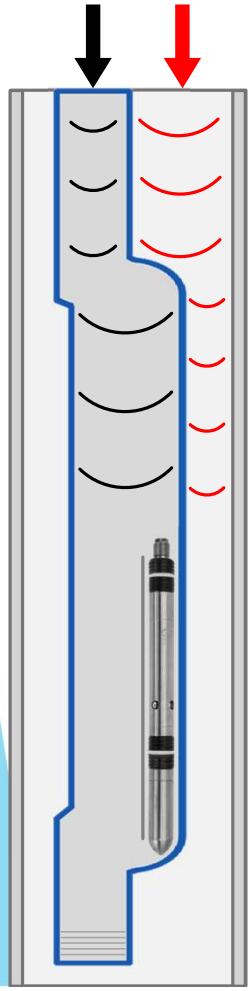
Acoustic traces from Both Tubing and Casing are recorded and overlaid

Tubing-Casing communication point
Pressure wave coming out of tubing

Acoustic traces from Both Tubing and Casing are recorded and overlaid using Plunger Lift Application.

Direction of kicks in fluid level single shots

Tubing vs. Casing from Mandrels and holes.

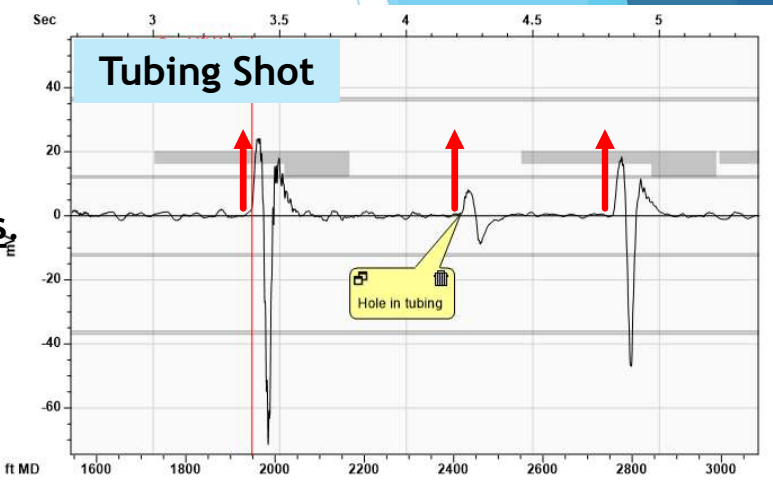


Increases in cross-sectional areas creates **UP-kicks**.

Decreases in cross-sectional areas creates **DOWN-kicks**.

Direction of kicks

Shot Path / Anomaly	Tubing Shot	Casing Shot
Gas Lift Mandrel	↑	↓
Hole in tubing	↑	↑



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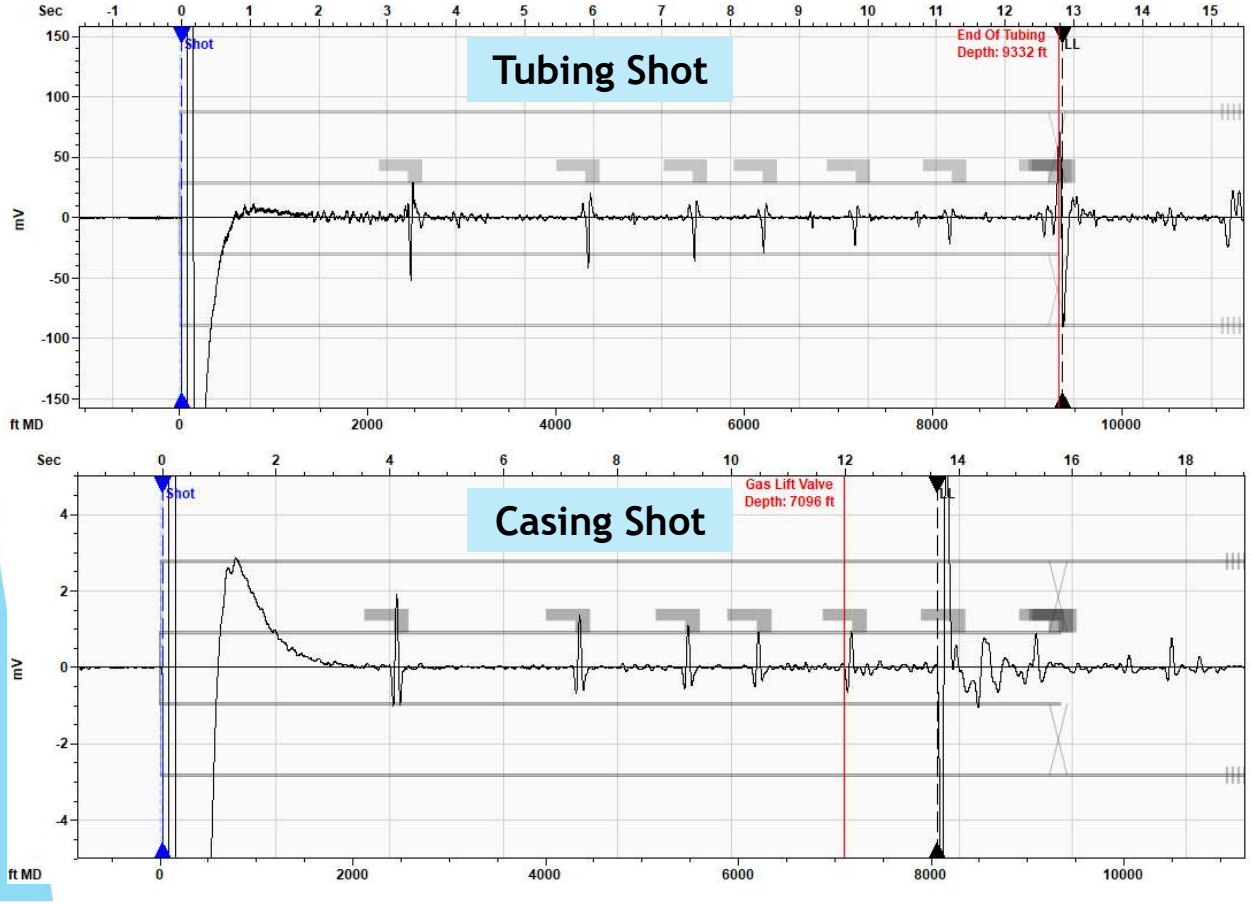
Well Example 1

Wells presented have the following configuration:

- Gas Lift Wells
- Tubing packer installed
- Side pocket Mandrels (Tubing Retrievable Valves)

Well Example 1

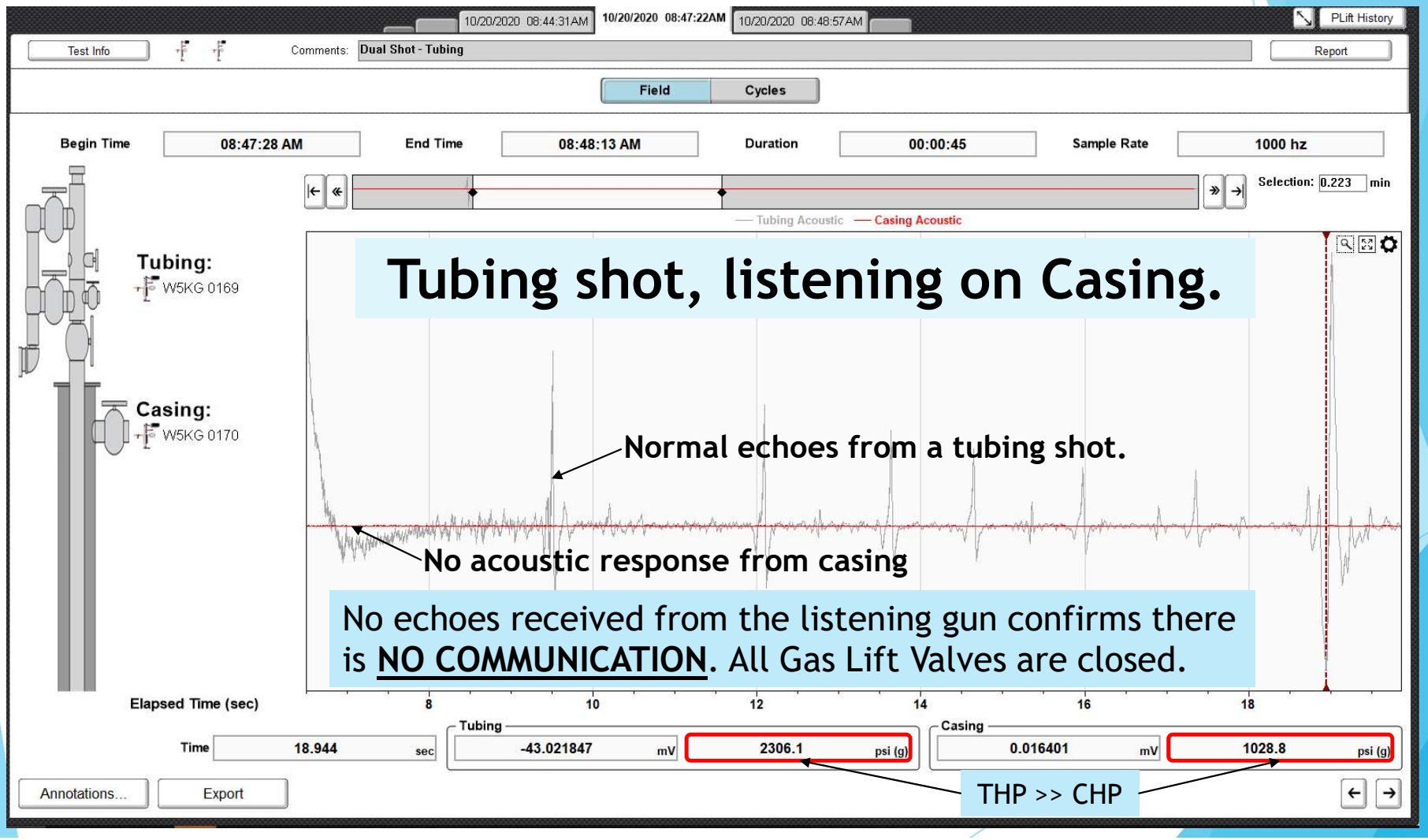
Initial single Tubing and Casing shots, prior simultaneous acoustic acquisition.



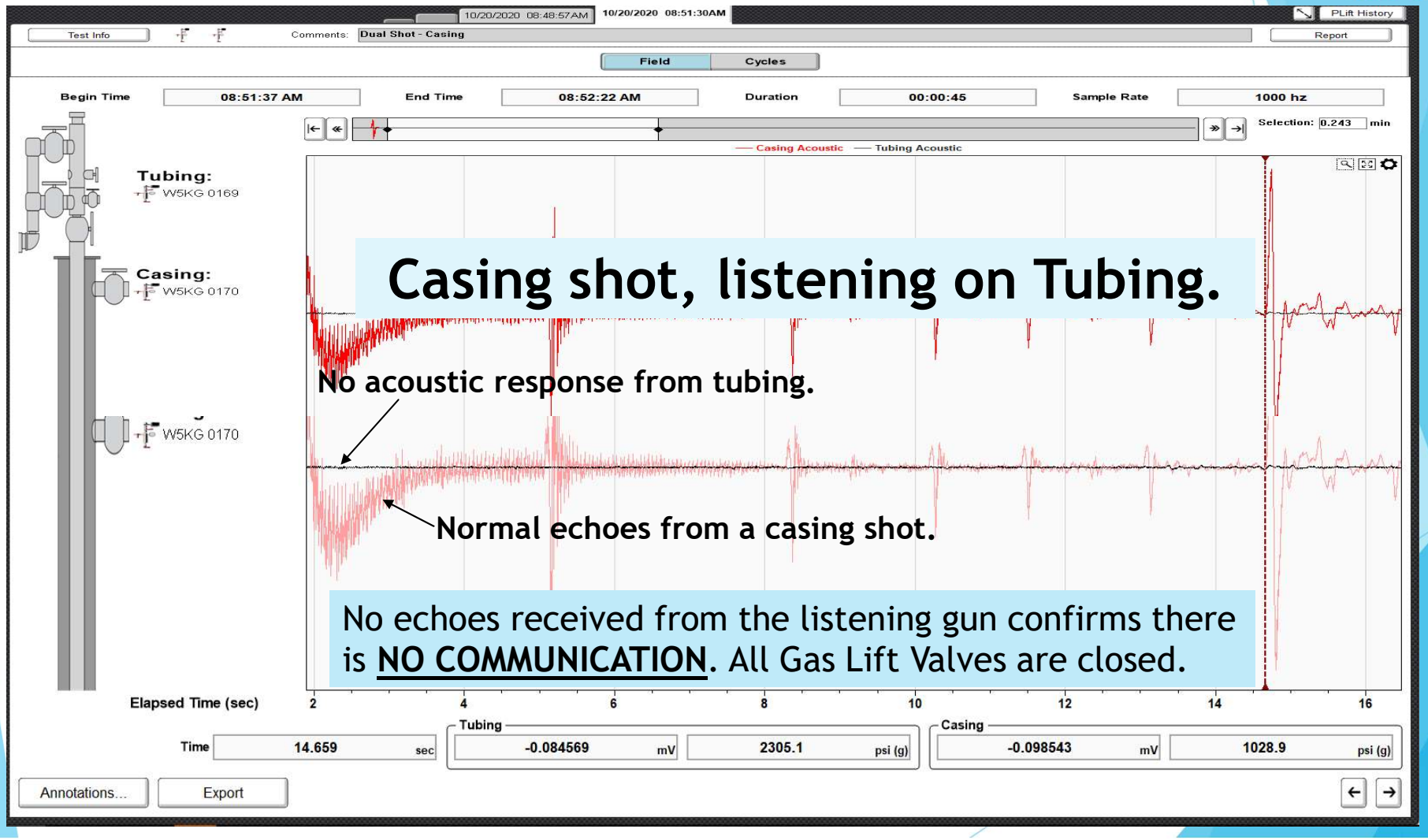
Side pocket Mandrels are visible from tubing and casing shots.

Gas Lift Mandrels can be used as downhole marker to accurately determine depth of anomalies and Fluid Level.

Well Example 1



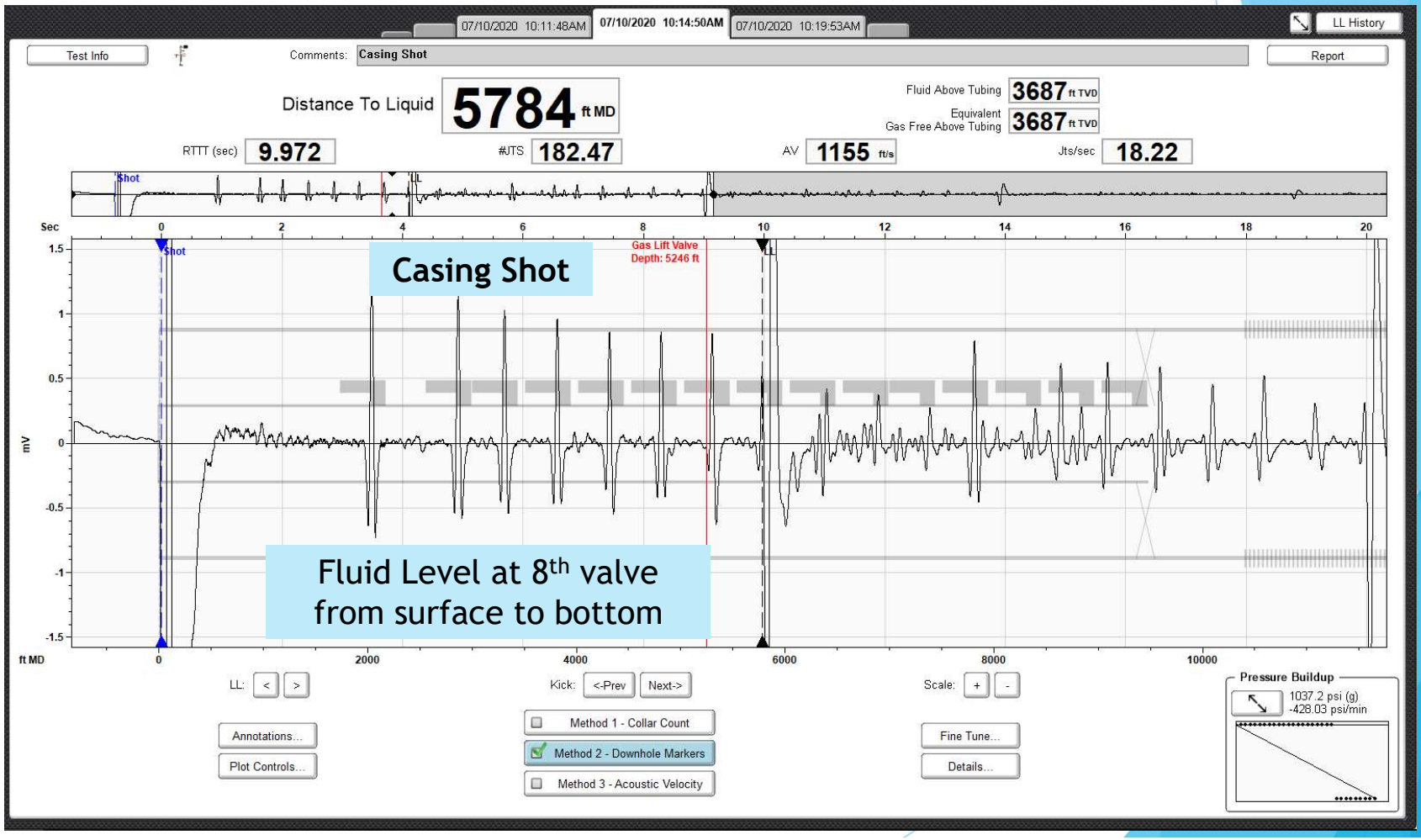
Well Example 1



Well Example 2

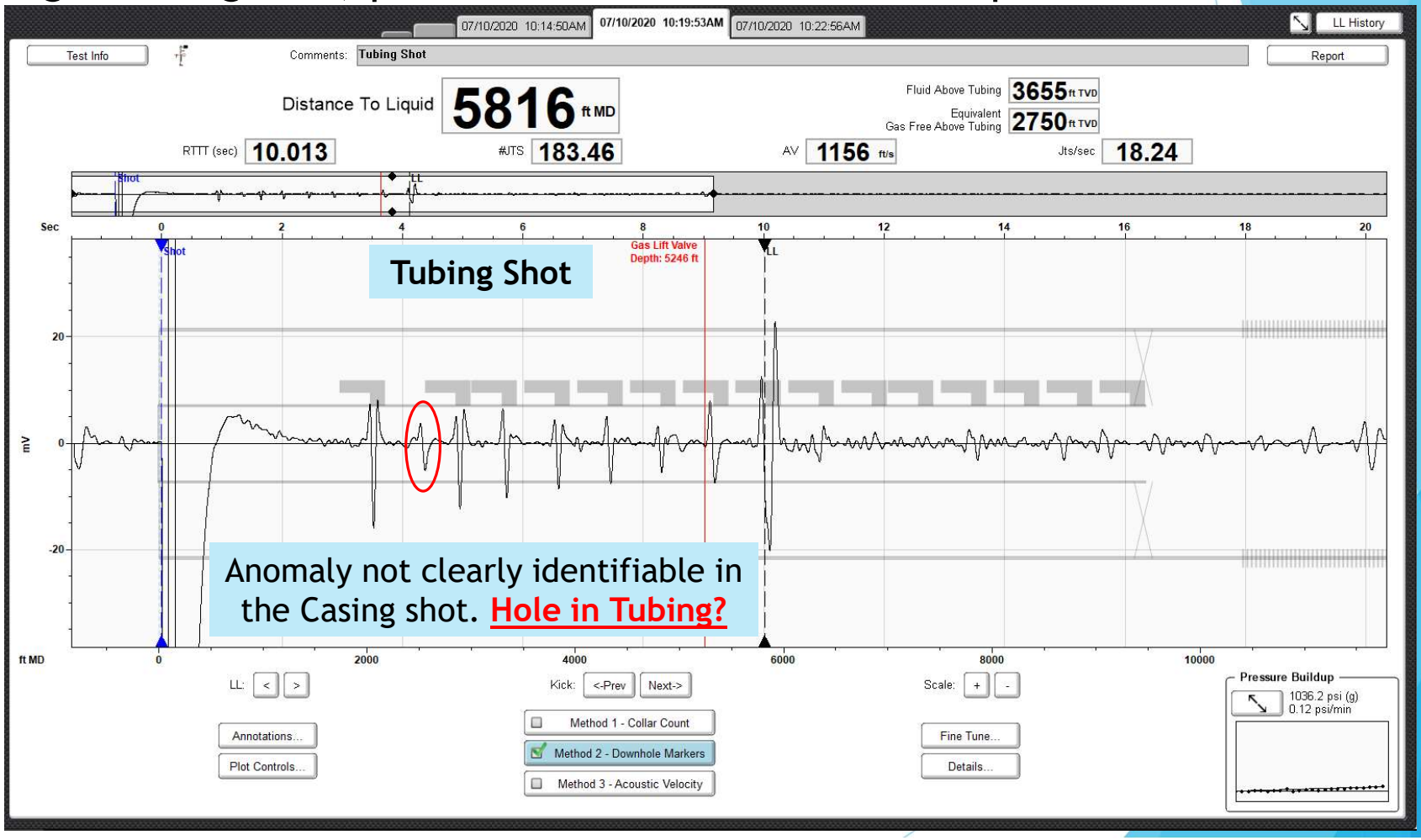
Well Example 2

Initial single Casing shot, prior simultaneous acoustic acquisition.

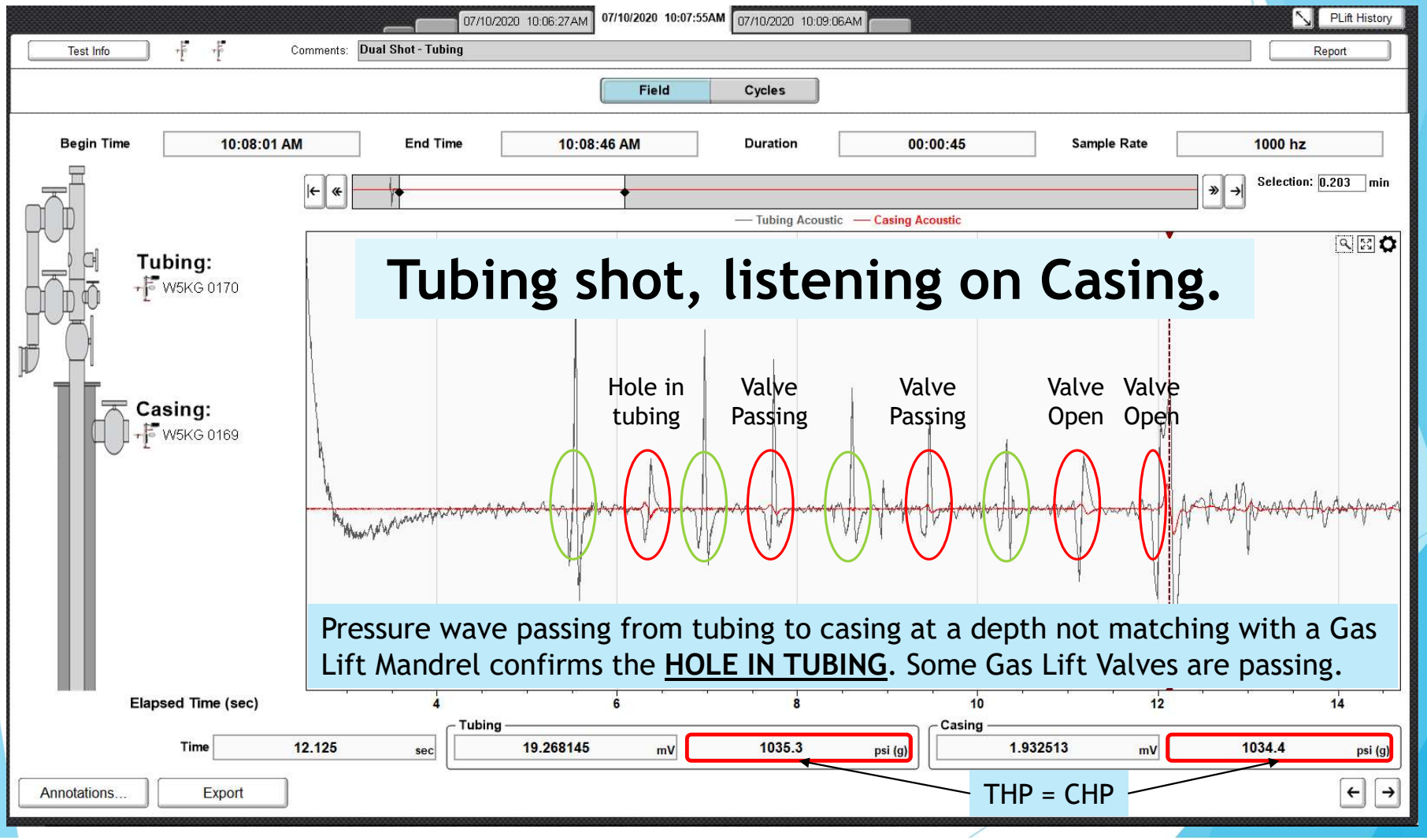


Well Example 2

Initial single Tubing shot, prior simultaneous acoustic acquisition.



Well Example 2



Well Example 2

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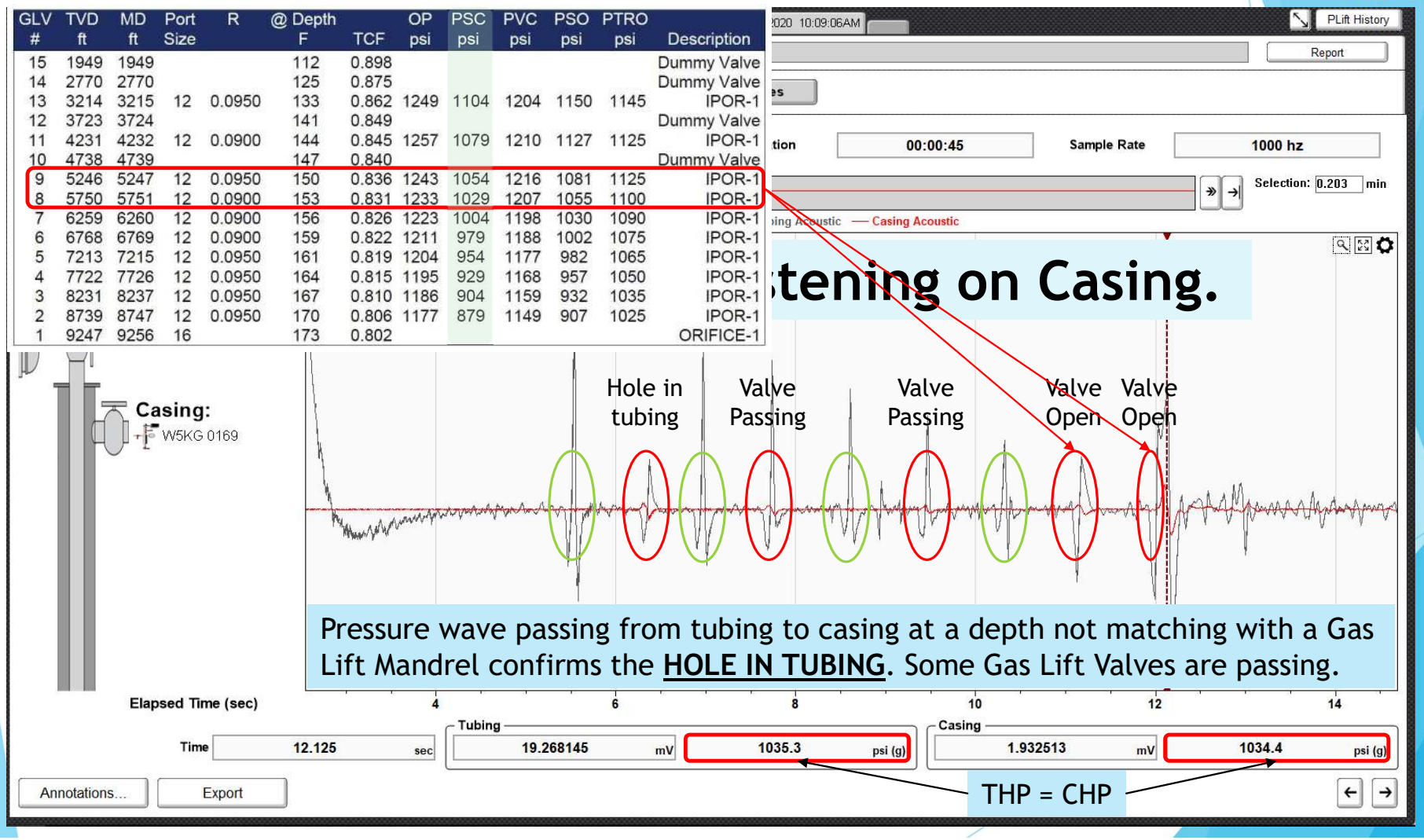
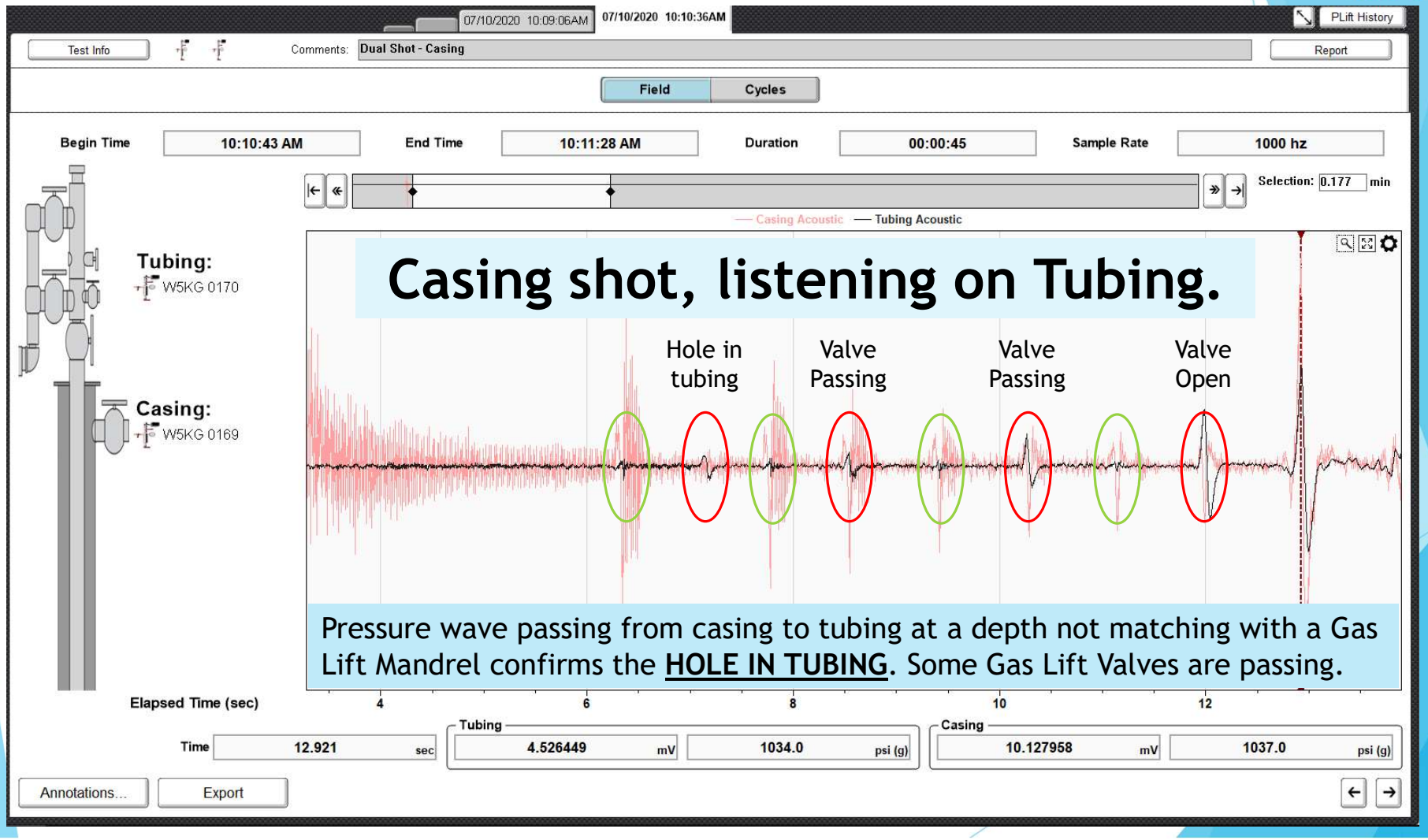
GLV #	TVD ft	MD ft	Port Size	R	@ Depth F	TCF	OP psi	PSC psi	PVC psi	PSO psi	PTRO psi	Description
15	1949	1949			112	0.898						Dummy Valve
14	2770	2770			125	0.875						Dummy Valve
13	3214	3215	12	0.0950	133	0.862	1249	1104	1204	1150	1145	IPOR-1
12	3723	3724			141	0.849						Dummy Valve
11	4231	4232	12	0.0900	144	0.845	1257	1079	1210	1127	1125	IPOR-1
10	4738	4739			147	0.840						Dummy Valve
9	5246	5247	12	0.0950	150	0.836	1243	1054	1216	1081	1125	IPOR-1
8	5750	5751	12	0.0900	153	0.831	1233	1029	1207	1055	1100	IPOR-1
7	6259	6260	12	0.0900	156	0.826	1223	1004	1198	1030	1090	IPOR-1
6	6768	6769	12	0.0900	159	0.822	1211	979	1188	1002	1075	IPOR-1
5	7213	7215	12	0.0950	161	0.819	1204	954	1177	982	1065	IPOR-1
4	7722	7726	12	0.0950	164	0.815	1195	929	1168	957	1050	IPOR-1
3	8231	8237	12	0.0950	167	0.810	1186	904	1159	932	1035	IPOR-1
2	8739	8747	12	0.0950	170	0.806	1177	879	1149	907	1025	IPOR-1
1	9247	9256	16		173	0.802						ORIFICE-1



Pressure wave passing from tubing to casing at a depth not matching with a Gas Lift Mandrel confirms the **HOLE IN TUBING**. Some Gas Lift Valves are passing.

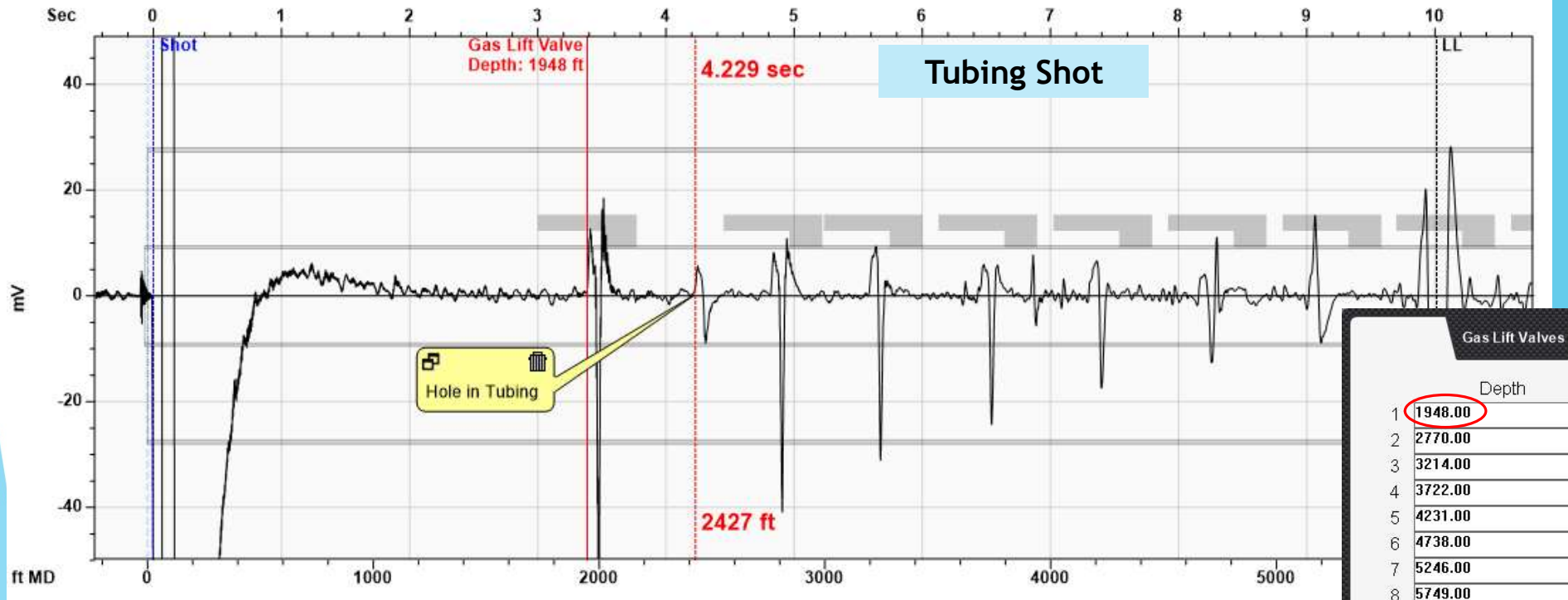
THP = CHP

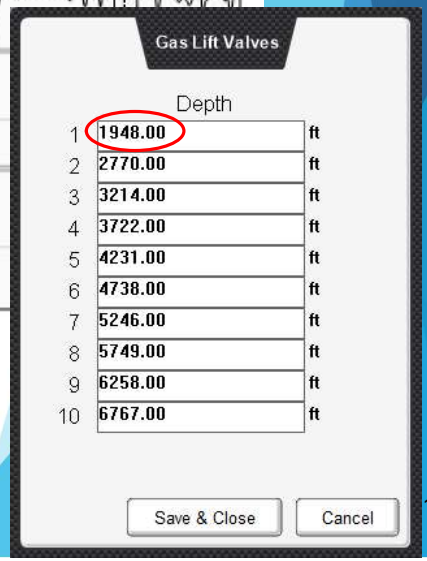
Well Example 2



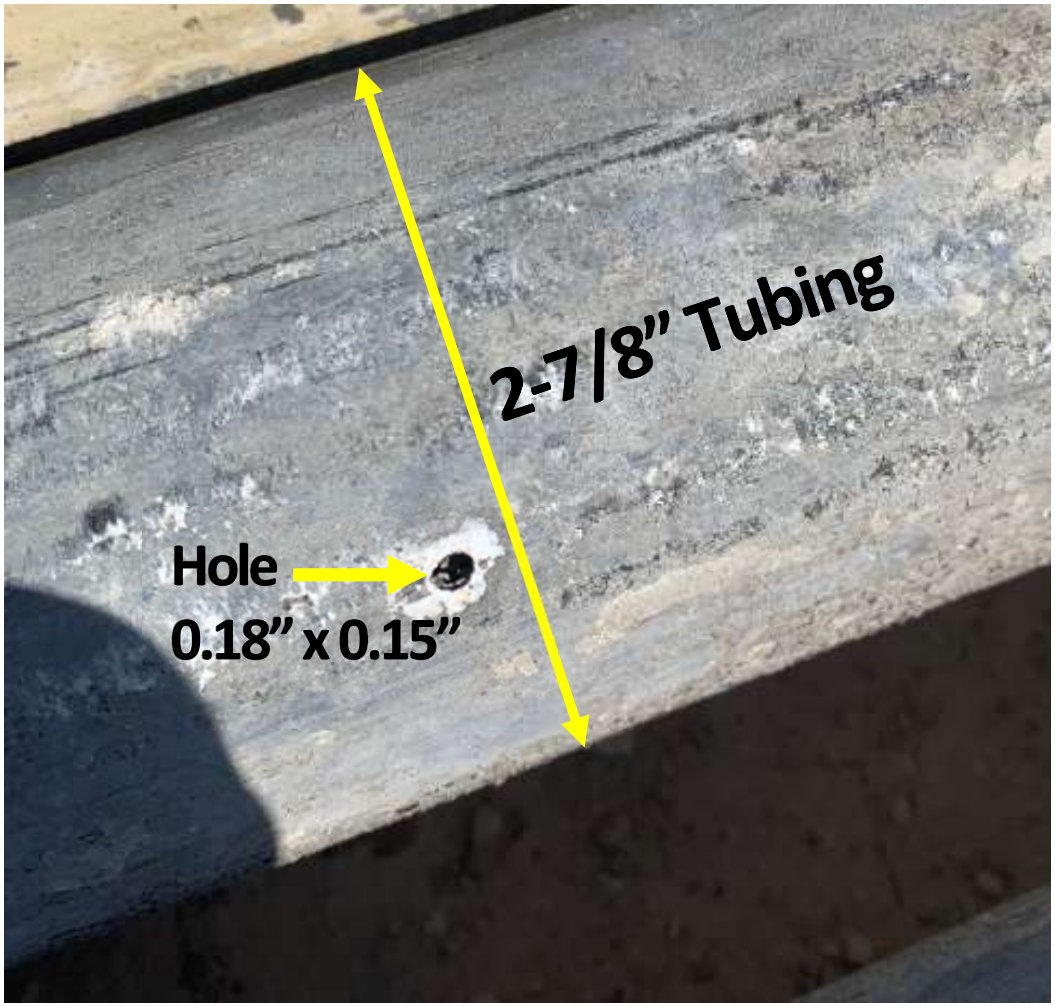
Well Example 2

Using Gas Lift Mandrel depth as downhole marker to accurately calculate the depth to hole in tubing.





Well Example 2



Hole in tubing reported in joint #77 from surface.

Well Example 2

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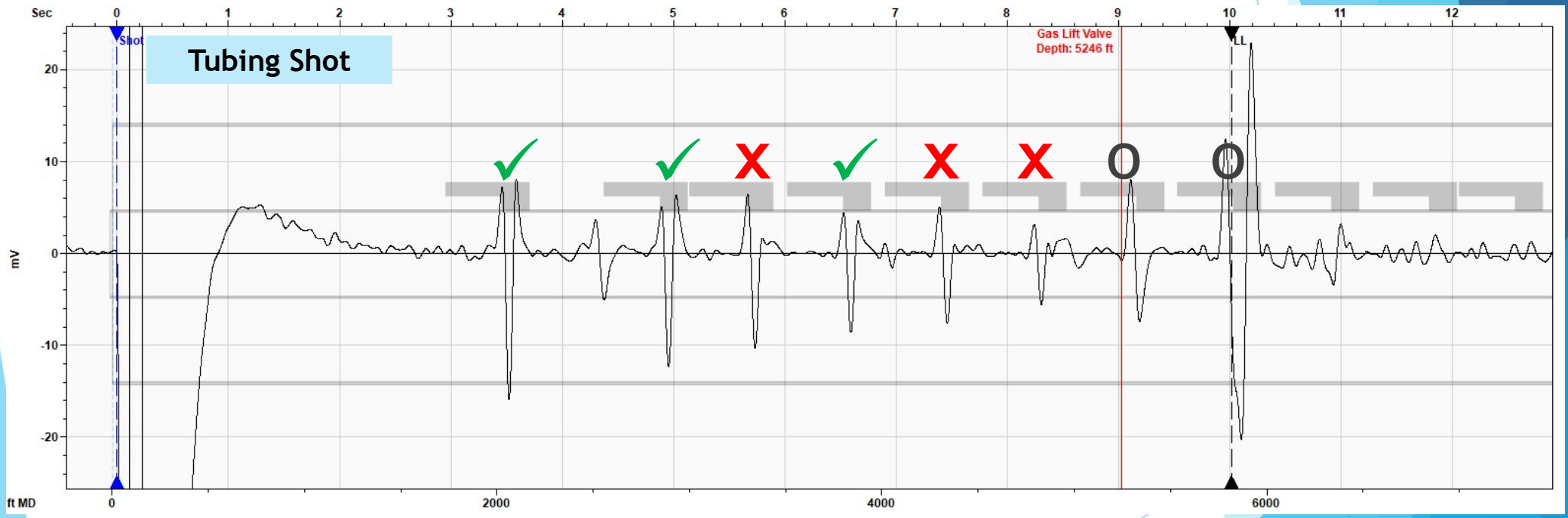
Observation for Tubing shots:
Mandrel kicks “signature” (shape) changes from good to passing to open.



Well Example 3

Well Example 3

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Workover reported there was no valve in shallower mandrel @ 1918 ft.

Last 24hr Summary
DLT CONDUCT JSAAND GO CARD SAFETY MEETING LOTO MIRU SLICK LINE (PRECISION) WELL PSI TBG 721 AND CSG 740 RITH W/ GAGE RING TO 4160 HIT SOMETHING POSS. GAS LIFT VALVE COULD NOT PASS THAT POINT POH RITH W/ IMPRESSION BLOCK TAGGED NOTHING RAN DOWN TO 5000 POH RITH W/ KOT RECOVER #10 VALVE @ 3295 RITH W/ KOT TRIED TO RECOVER # 11 VALVE NO LUCK RITH W/ IMPRESSION BLOCK ON KOT TO MANDREL # 11 @ 1918 POH FOUND THERE IS NO GAS LIFT IN # 11 MANDREL RITH W/ NEW VALVE INSTALL # 11 VALVE @ 1918 RITH W/ FISHING TOOL DOWN TO 9151 #1 MANDREL TRIED TO FISH NO LUCK INSTALLED KNUCKLE W/ FISHING TOOL RITH SOME HOW LATCHED # 7 VALVE INSTALL NEW PIN ON # 7 VALVE RITH PUT # 7 VALVE BACK IN PLACE POH SHUT WELL IN VISIT W/ ENGINEER LEFT NUMBER #11 VALVE DOWN HOLE @ 9151 # 1 MANDREL RIG DOWN SLICK HAND WELL OVER TO PRODUCTION GROUP RETURN HOME SAFE

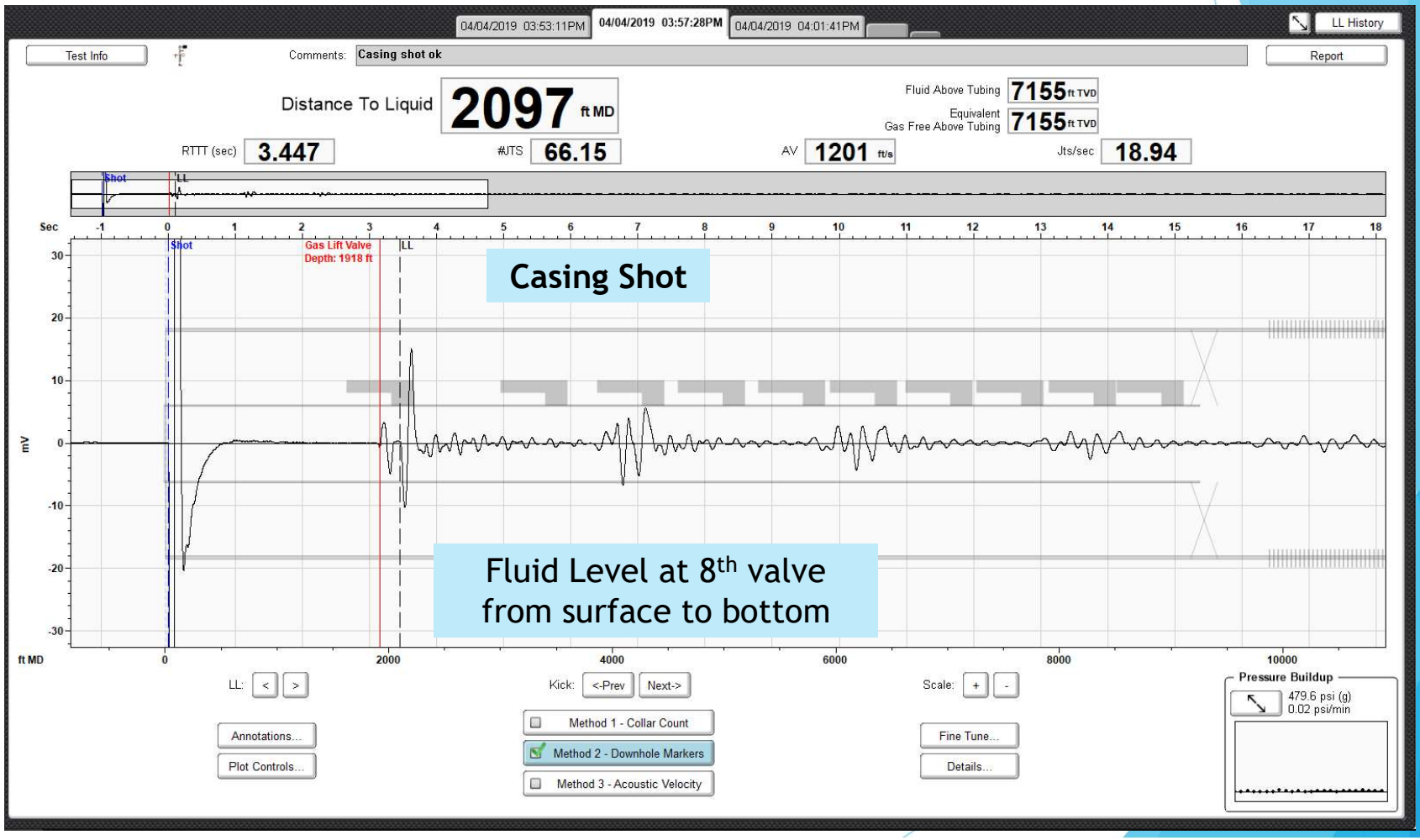
Fluid Level shots and simultaneous acoustic survey were performed to confirm condition reported for workover rig.

Valve at 1918 ft should be **CLOSED** with CHP=480 psi.

GLV #	TVD ft	MD ft	Port Size	R	@ Depth F	TCF	OP psi	PSC psi	PVC psi	PSO psi	PTRO psi	Description
11	1918	1918	12	0.0950	125	0.876	1157	1040	1097	1100	1060	IPOR-1
10	3294	3295	12	0.0950	135	0.860	1160	1020	1118	1063	1060	IPOR-1
9	4154	4160	12	0.0950	141	0.850	1159	1000	1123	1036	1055	IPOR-1
8	4869	4882	12	0.0950	146	0.842	1160	980	1125	1016	1045	IPOR-1
7	5580	5600	12	0.0950	150	0.836	1158	960	1126	993	1040	IPOR-1
6	6218	6243	12	0.0950	153	0.832	1159	940	1125	974	1035	IPOR-1
5	6892	6918	12	0.0950	156	0.827	1157	920	1125	952	1030	IPOR-1
4	7527	7553	12	0.0950	158	0.824	1156	900	1123	933	1025	IPOR-1
3	8168	8194	12	0.0950	160	0.821	1154	880	1122	911	1020	IPOR-1
2	8782	8808	12	0.0950	161	0.820	1139	860	1121	879	1015	IPOR-1
1	9119	9151	12	0.0950	162	0.818	1033	760	1031	763	930	IPOR-1

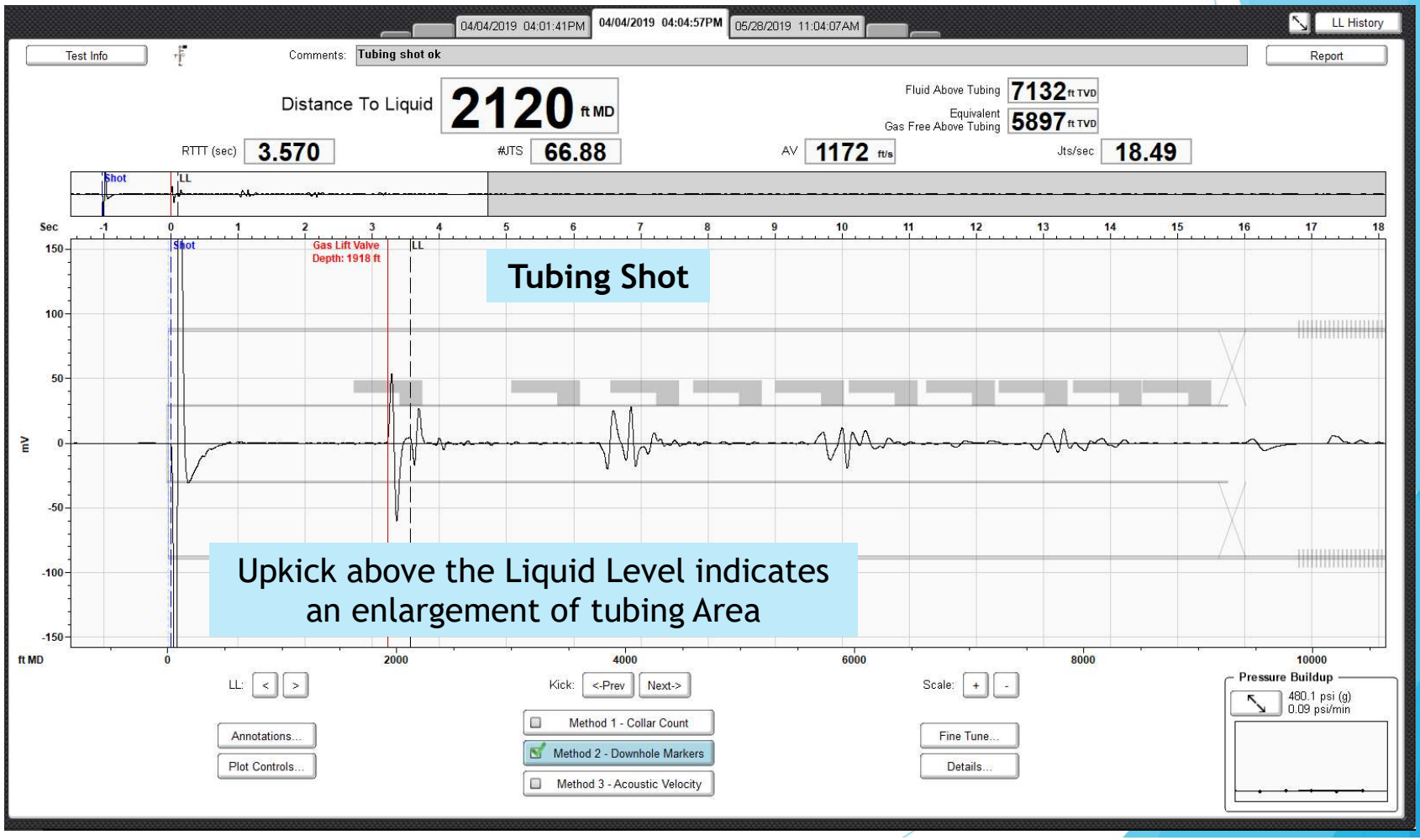
Well Example 3

Initial single Casing shot, prior simultaneous acoustic acquisition.



Well Example 3

Initial single Tubing shot, prior simultaneous acoustic acquisition.



Well Example 3

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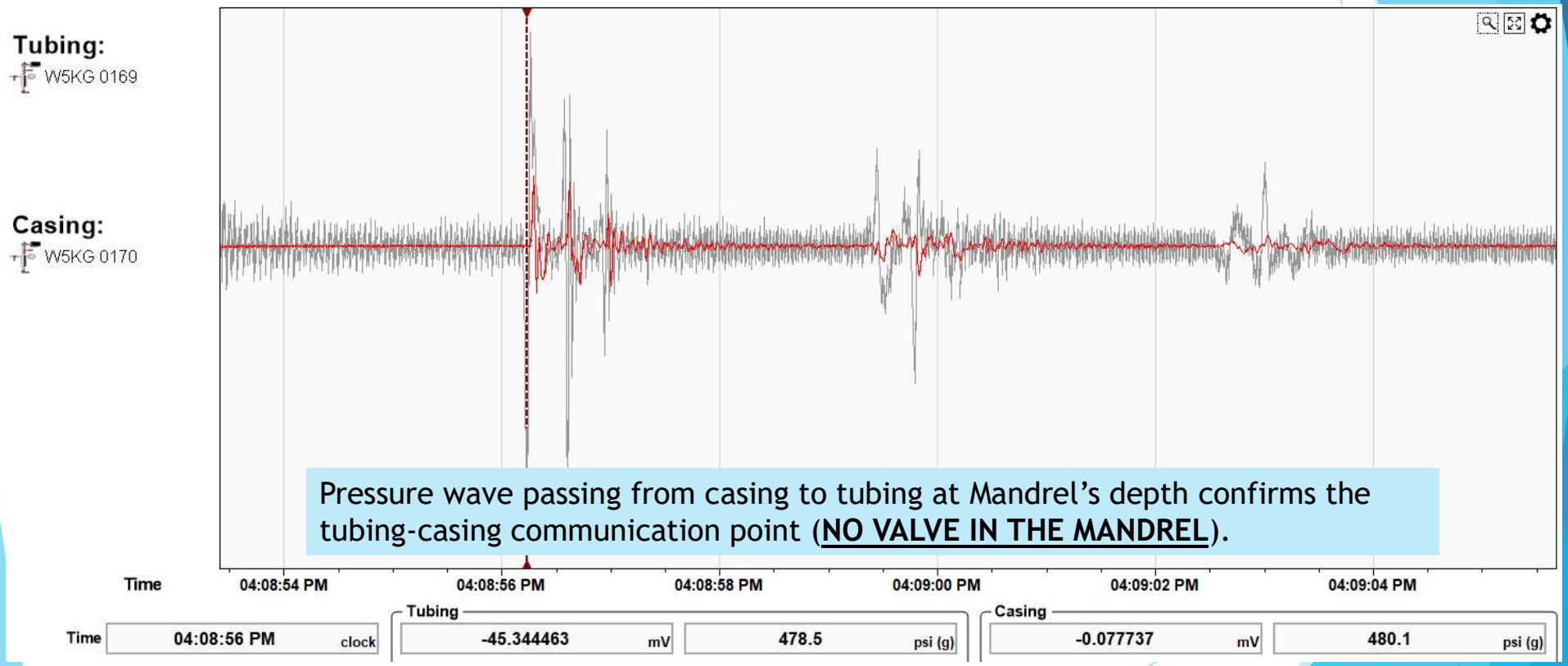
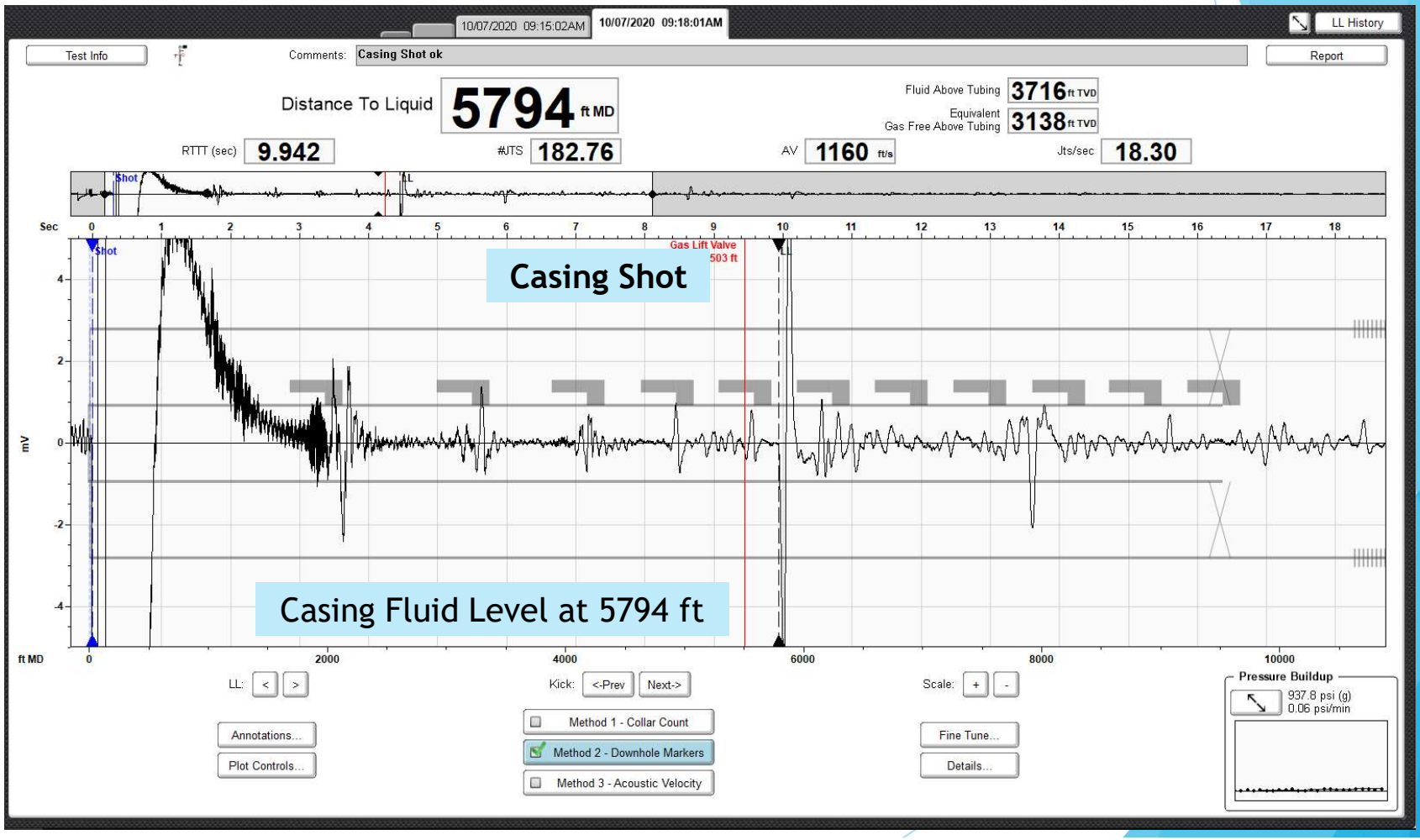
Simultaneous acoustic acquisition



Well Example 4

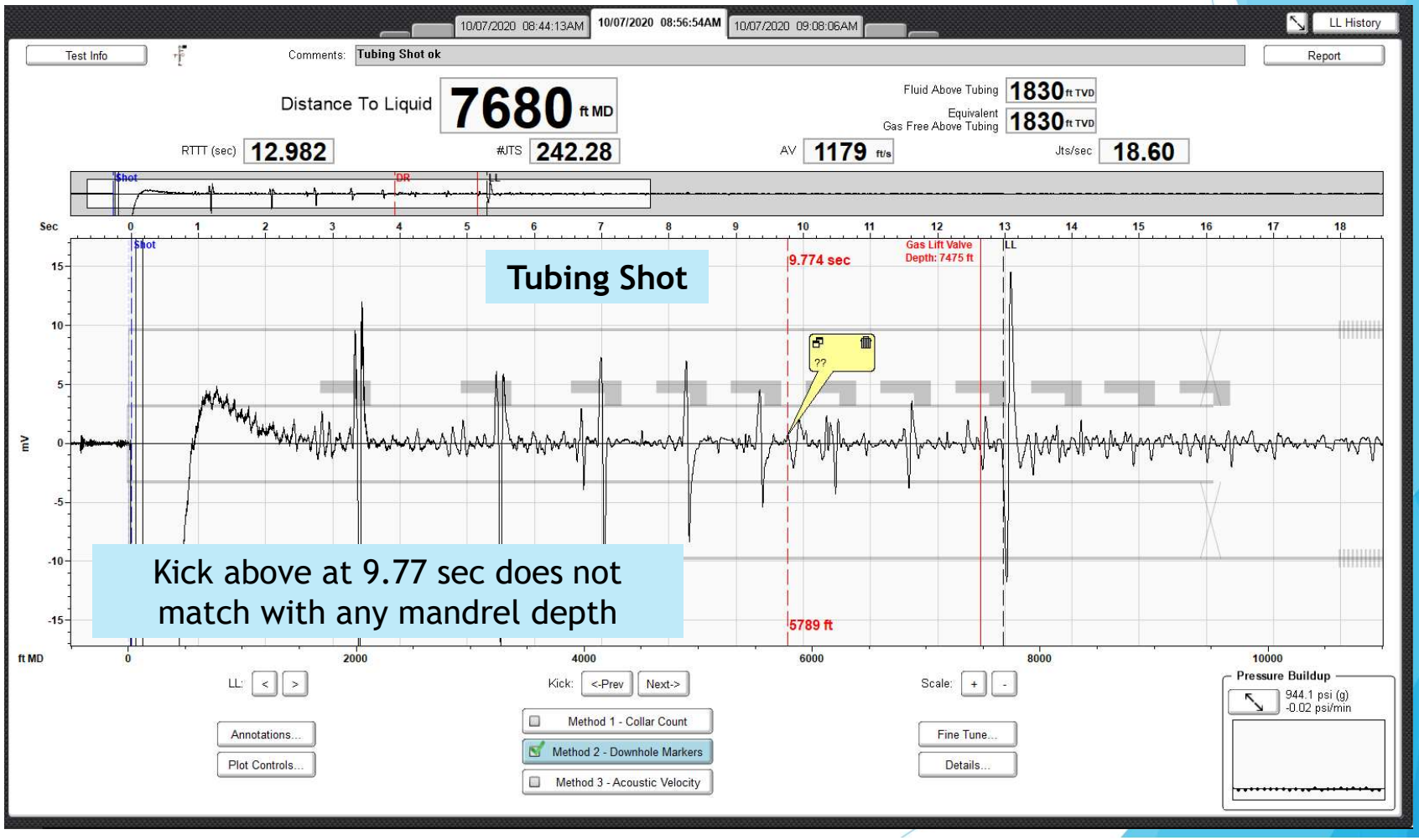
Well Example 4

Initial single Casing shot, prior simultaneous acoustic acquisition.



Well Example 4

Initial single Tubing shot, prior simultaneous acoustic acquisition.



Well Example 4

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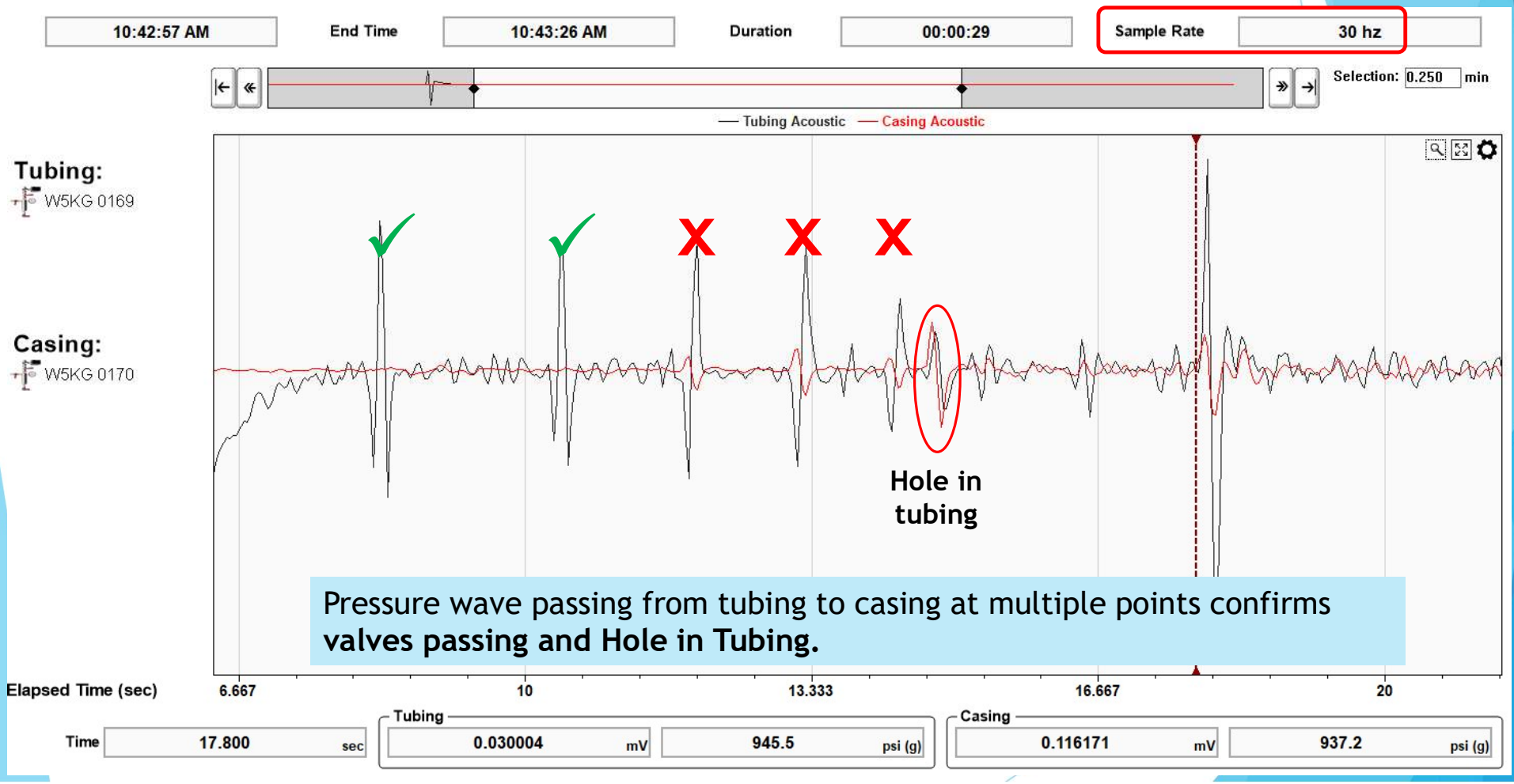
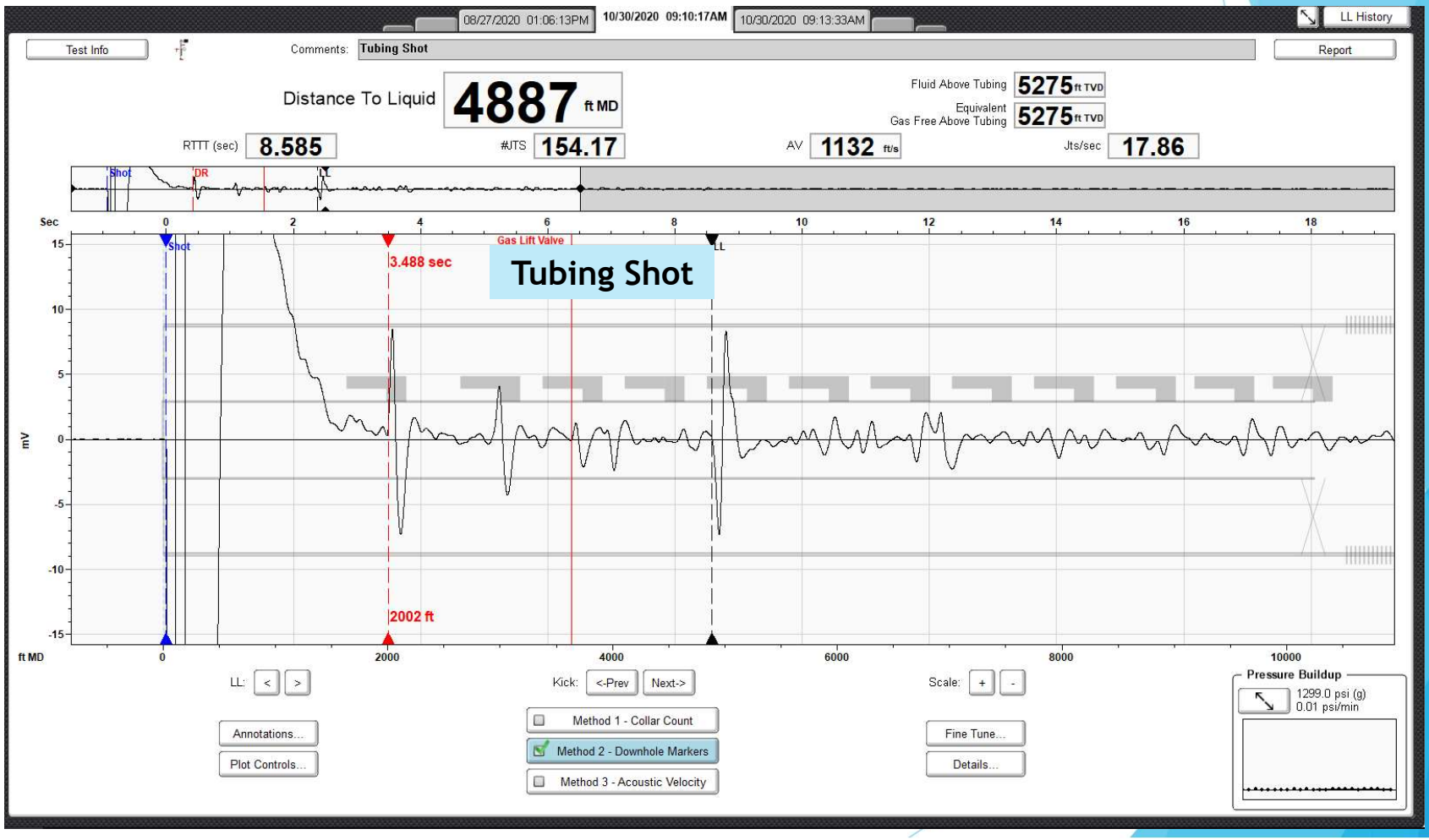
Simultaneous acoustic acquisition



Well Example 5

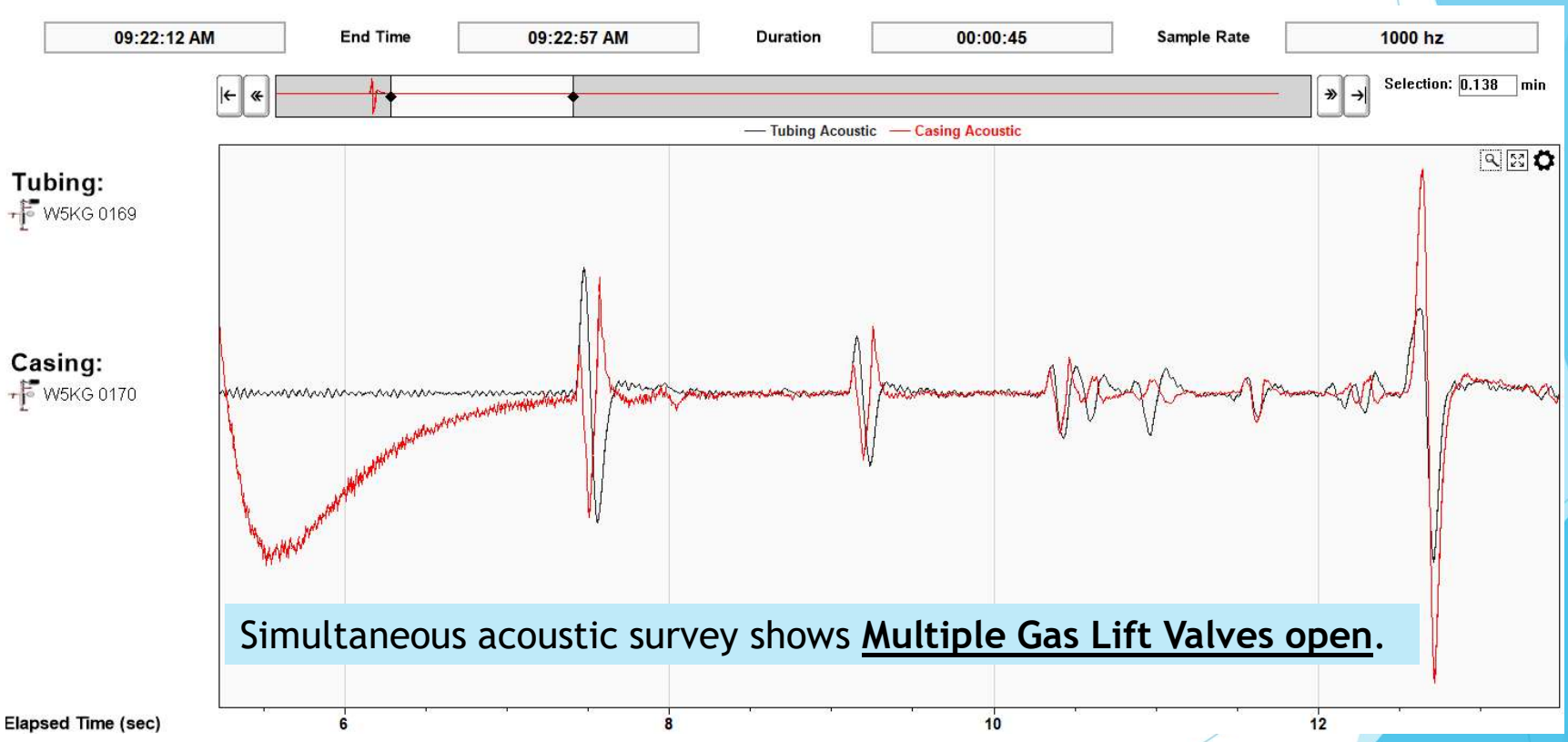
Well Example 5

Initial single Tubing shot, prior simultaneous acoustic acquisition.



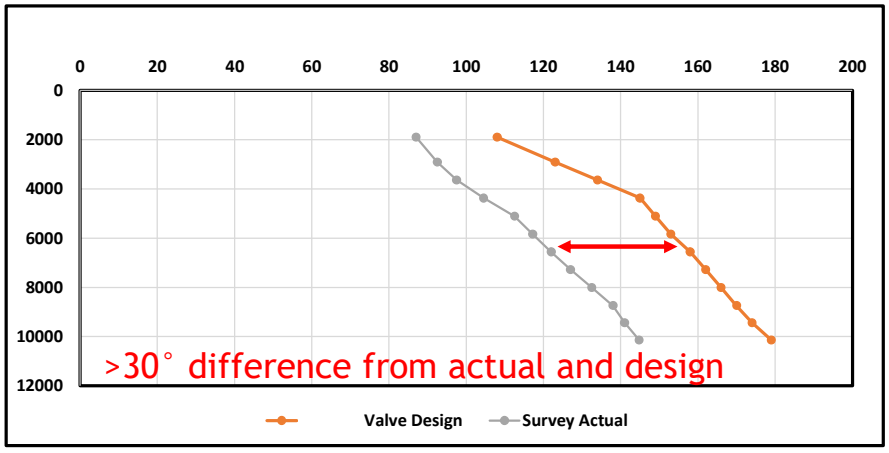
Well Example 5

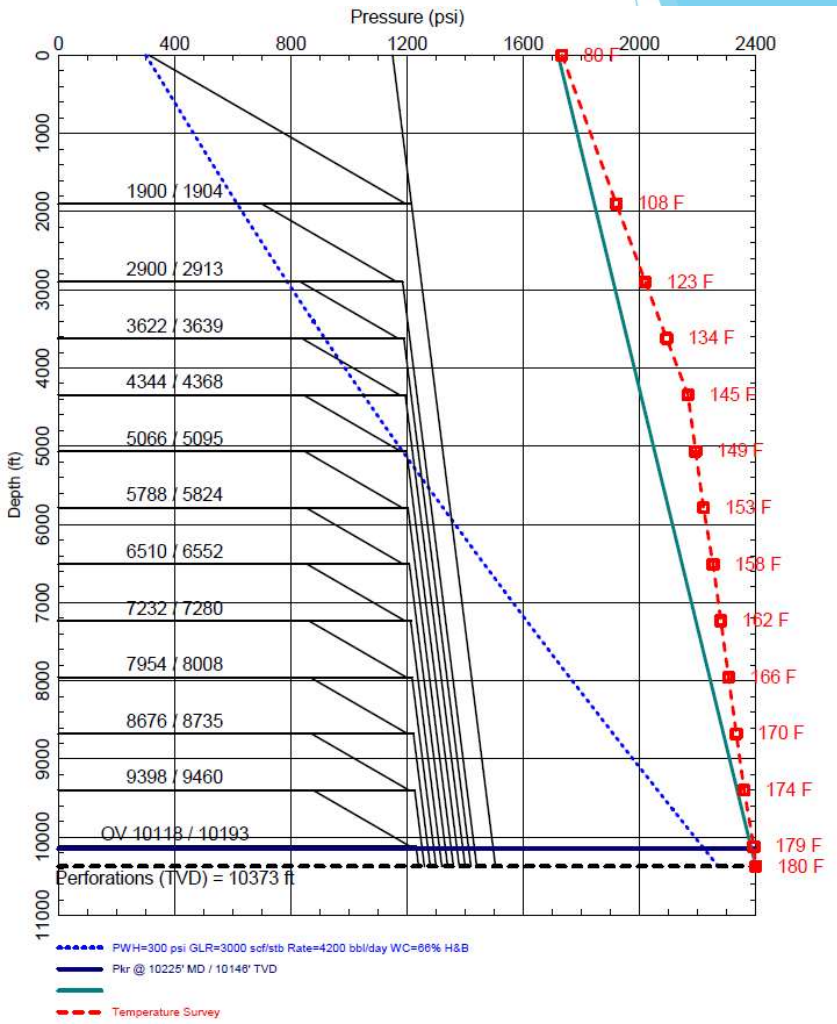
Simultaneous acoustic acquisition



Well Example 5

Wireline Temperature Survey shows >30° difference between design and actual well temperature.





Conclusions

- Confidence & experience will grow by continuously using this technique, which in many cases will eliminate the need of running Wireline Surveys for troubleshooting purposes.
- By using a non-invasive troubleshooting method, it eliminates the risk of running sensors/tools in the well (fish).
- Being able to “see” pressure wave passing from tubing to casing annulus (or vice versa) is used to confirm communication points in the well.
- Simultaneous acoustic surveys technique is used to find communication points such as faulty check valves, leaky gas-lift valves, and holes in tubing.
- Other beneficial information is obtained as which gas lift valves are open (or closed) at a given surface casing pressure.
- Kick shape from Gas Lift valves can give an idea of a malfunctioning valve, but using this troubleshooting method (simultaneous acoustic survey analysis) can confirm the existence of such communication.
- Using Gas Lift Mandrels reflections as downhole marker helps to accurately determine depth of anomalies and Fluid Level.
- This technique using wireless fluid level equipment aids in troubleshooting well problems.
- Commonly used to troubleshoot Gas Lift, Plunger Lift and Gas wells, but it can be used in any type of well with tubing and tubing-casing annulus.

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Lynn Rowlan

CarrieAnne Taylor

Thanks…

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