



Weatherford®

REAL RESULTS

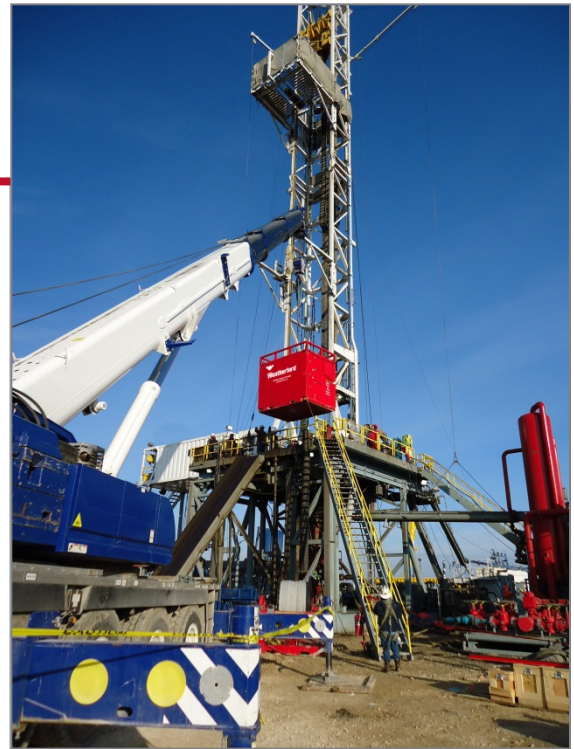
High-Pressure/High-Temperature Oriented Perforating with OmniWell™ Optical Downhole Gauges and Cable in Place

Objectives

- Multizone permanent downhole pressure and temperature (P/T) monitoring with gauges installed externally on casing strings and cemented in place.
- Well 1: five-zone monitoring of internal casing pressure before, during, and after oriented casing perforation.
- Well 2: five-zone monitoring of formation pressure following oriented external casing-mounted gun detonation.
- Orientation of gun assemblies (for both well scenarios) away from the optical cable to prevent cable or gauge damage.

Results

- With Weatherford's *OmniWell* reservoir monitoring solution, five optical high-pressure/high-temperature (HP/HT) gauge assemblies were successfully installed in each of the two wells on the casing string and cemented in place.
- A combination of single-ended and pass-through model gauges were used on a single optical cable in each well.
- Both wells were perforated without damaging the optical cable by using alternative gun systems and orientation methodology (see detailed perforating description below).
- Continuous internal casing pressure was measured in Well 1 throughout well operations, including cementing and perforating.
- Formation pressure was measured at each externally mounted gun in Well 2 following the perforating operations.



Weatherford's optical permanent downhole monitoring systems were installed in two wells to successfully measure and monitor downhole conditions.

Location
USA

Well Type
Land well—fracture and zonal monitoring of five zones with P/T gauge in each zone

Casing Size / Open Hole
9 5/8-in., 40ppf, L80 and 8 3/4-in. open hole

Tubing Size
5 1/2-in., 20lb/ft, P110, run to well depth and cemented

Well Depths
Approx. 13,300 ft (4054 m) and approx. 13,500 ft (4115 m)

Maximum Gauge Depths
Approx. 13,130 ft (4002 m) and approx. 13,120 ft (3999 m)

Products/Services

- *OmniWell* optical permanent downhole monitoring system
- Optical P/T gauges and cable rated to 347°F (175°C) and 20,000 psi (1379 bar) continuous operation



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Value to Client

- Downhole temperature was measured throughout the cementation process.
- Individual gun-perforating operations were monitored downhole.
- Continuous real-time pressure and temperature data were recorded from the multiple reservoir levels in the zone of interest with conditions in excess of 320°F (160°C) and 15,000 psi (1034 bar).
- Monitoring of dynamic pressure interaction with nearby horizontal wells undergoing multizone hydraulic fracturing was enabled.

Oriented Perforating Process

Well 1:

The multiple gauge assemblies were installed externally on the casing string, connected together by a single optical cable and configured to measure pressure internally in the casing.

The optical cable was protected using special cable protectors that provided a substantial magnetic mass (with welded inserts) as well as cable protection.

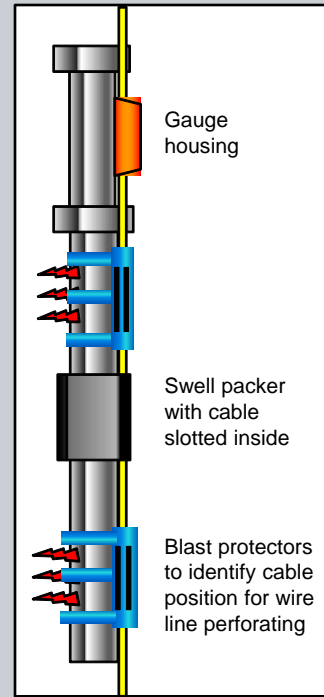
Following the cementation process, a Weatherford wireline-deployed orienting tool with perforating gun assemblies attached was lowered into the well. The tool identified the magnetic mass (around the optical cable) in the zone of interest and then oriented the perforating guns away from the mass before detonation, avoiding damaging the cable or gauges. This operation was performed multiple times, one for each zone being perforated.

Well 2:

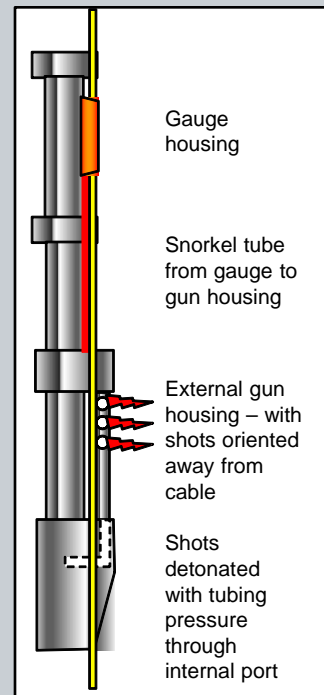
The multiple gauge assemblies were installed externally on the casing string, near externally mounted perforating guns, and connected together by a single optical cable.

The gauge pressure ports were plumbed, using sections of bare control line, into the externally mounted gun housings to measure pressure on the outside of the casing. The gun assemblies were oriented so that their perforation ports were pointing away from the optical cable.

When installed, the entire system was cemented in place. Following cement hardening, the guns were detonated by applying pressure from surface, inside the casing, which overcame burst disk barriers to initiate the firing in all guns simultaneously. Once the guns fired, pressure from the reservoir was routed through the additional control line to the gauges.



Well 1



Well 2

Fiber cable to surface and lower gauges.

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