

## LIQUID PRESSURE OBSERVATION TEST AN ALTERNATIVE TO NITROGEN PRESSURE MECHANICAL INTEGRITY TEST

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### Abstract

The Liquid Pressure Observation Test (LPOT) is an alternative to the standard nitrogen Mechanical Integrity Test (MIT) at the U.S. Strategic Petroleum Reserve (SPR). State regulations in Louisiana and Texas require a MIT every five years to test the cavern system (wellhead, wellbore, cavern). Fluor Federal Petroleum Operations (FFPO) Cavern Integrity developed the LPOT method as a comprehensive liquid integrity test.

The LPOT is based on an understanding of Gulf Coast salt dome cavern behavior during static cavern conditions, when there are no fluid movements. SPR cavern pressures increase over time between the minimum and maximum operating pressure range due to cavern creep, typically in cycles lasting 60 to 90 days. Cavern creep rates can change with respect to fluid type stored, cavern hydrostatic pressures, adjacent or offset cavern use, cavern depths, cavern size, salt dome properties, and salt dissolution.

The LPOT uses the measured oil-brine interface level in the cavern and does not require injection and displacement of nitrogen gas or other test media into the system. The test uses pressure monitoring data from the SPR Distributed Control System (DCS). While a cavern is in static condition, pressure versus time plot evaluation provides repeatable trend analyses that demonstrates pressure integrity. Use of the monitoring data from DCS provides a fundamental analytical test approach that is robust, repeatable, and continuous. The LPOT is safer to personnel and equipment, conserves resources, and is less destructive to well components.

The LPOT determines the liquid-tight integrity of the cavern system based on cavern fluid (crude oil and brine) pressures while they are within the normal cavern operating range. Data inputs for a five-year period of cavern use (fluid types and movements), adjacent or offset cavern relationships, and cavern pressures versus time are used to conduct three independent tests within the LPOT. The first test examines the consistency of cavern pressure cycles over time by looking at the buildup with explanations for any deviations. The second test looks at the stability of the current cycle by calculating the R-Square Value (linearity) of the pressure increase over time. And the third test plots the current pressurization rate to establish that it is within the envelope of prior static pressure cycles. The results of the three LPOT tests determine whether the cavern system demonstrates mechanical integrity.

Obtaining regulatory approval for the LPOT was a major milestone for the SPR. Use of beta-testing and submittals of numerous comparison reports with the nitrogen MIT demonstrated comparable and reliable results. In April 2022, the Louisiana Department of Natural Resources (LDNR) approved use of the LPOT as an alternative test method at the SPR Bayou Choctaw and West Hackberry sites, which have 48 wells total. The LPOT can be substituted for a nitrogen MIT with a case-by-case permit approval by LDNR on a five-year rotation with the nitrogen MIT.

**Key words:** Liquid Pressure Observation Test (LPOT), Mechanical Integrity Test (MIT), cavern system (wellhead, wellbore, cavern) testing, Strategic Petroleum Reserve (SPR), Gulf Coast salt dome cavern creep.