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# Modeling the behavior of caverns under nitrogen

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**Abstract**

A Hydrostatic Column Model (HCM) was developed at SANDIA to help differentiate between normal "tight" well pressure behavior and small-leak behavior under nitrogen for testing the pressure integrity of crude oil storage wells at the U.S. Strategic Petroleum Reserve. HCM was used to model extended nitrogen monitoring and Mechanical Integrity Tests (MITs) by predicting wellhead pressures along with nitrogen interface movements. A set of field experiments were also conducted where wellhead pressure and high resolution temperature and density logs were used to validate the model assuring that the relevant physical phenomena were adequately captured. This effort was motivated by steady, yet distinct, pressure behavior of a series of Big Hill wells that were placed under nitrogen for extended periods of time following anomalous pressure behavior. The wells exhibited reproducible pressure cycles with a creep-driven nitrogen pressurization rate of about 70% that of brine wells. The analysis shows that the differences in compressibility between nitrogen and the cavern liquids in a manometer configuration drives the nitrogen wellhead pressure to rise at a lower rate than a liquid filled well, even with no leak. The study also concluded that the theoretical relative pressure rate, for no leak conditions, depends on the well configuration, pressure and the location of the nitrogen-oil interface and varies from well to well. This consequently implies that wells under long term nitrogen monitoring do not necessarily pressurize with a relative rate (PN2/Pbrine) of 1.

**Key words:** Cavern Testing, Caverns for Liquid Storage, Computer Modeling, Gulf Coast of the U.S. and Mexico, Mechanical Integrity, MIT (Mechanical Integrity Test), Strategic Petroleum Reserves

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