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Geomechanical Analyses as a Component for an Integrated Management System for Well Integrity for the Strategic Petroleum Reserve

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Abstract

This paper discusses how geomechanical analyses, using high-performance computing methods, can be an important component of an overall well integrity management system for storage facilities in salt domes. This discussion will be an extension of a related presentation included in the technical class for this conference, Well Integrity Management Systems, which presents a recently developed system for the U.S. Strategic Petroleum Preserve.

The U.S. Strategic Petroleum Reserve (SPR) stores crude oil in 62 caverns located at four different sites in Texas (Bryan Mound and Big Hill) and Louisiana (Bayou Choctaw and West Hackberry). The petroleum is stored in solution-mined caverns in salt dome formations. The SPR sites are varied in terms of cavern structure and layout. Most of the caverns at these sites were built as vertical cylinders of reasonably uniform cavern dimensions (radius, height, shape, and depth) and spacing. However, several caverns at these sites, particularly those constructed prior to SPR ownership, are characterized by unusual cavern geometries. Most of the caverns are nearly 40 years old, and have experienced significant cavern closure and creep-induced strain on the well casings during their lifetimes. As a result, efforts have increased in recent years to identify caverns and well casings that need remediation work before integrity issues reach severe levels.

This paper will provide a brief description of the entire well management system developed collaboratively by Sandia National Laboratories, Fluor, and the U.S. Department of Energy. It will then provide detailed description of the dome-scale geomechanical computational models that have been developed for each of the four sites, specifically designed to address geomechanical issues endemic to each site. The knowledge gained by the design and verification of these models, and the resulting predictions of stresses and strains applied to casing materials from salt creep and other mechanical phenomena, are then applied to an evaluation of the current and future conditions for wellbore casings at each site. General conclusions about geomechanical issues related to wellbore integrity can also be derived from these analyses, and a methodology can be developed to introduce less sophisticated geomechanical models to new sites for similar purposes.

Key words: Caverns for Liquid Storage, Well casing, Mechanical Integrity, Geomechanics, Salt Mechanics, Louisiana, Texas