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Recommended Minimum and Maximum Reservoir Pressure for the Aliso Canyon Storage Facility

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Introduction:

California Code of Regulations, title 14, section 1724.9, subdivision (b), as amended by the emergency regulations for underground gas storage facilities, requires that the Division of Oil, Gas, and Geothermal Resources (Division) specify a minimum and maximum reservoir pressure in the injection approval for each underground gas storage facility. Senate Bill 380 (Pavley, Chapter 14, Statutes of 2016), adopted as urgency legislation, established a statutory requirement that the minimum and maximum reservoirs pressures approved by the Division for the Aliso Canyon Storage Facility shall be based on 1) a proposal from the operator, 2) consultation between the Division and independent experts, and 3) input from the public on the proposed minimum and maximum reservoir pressure at a public meeting. (Pub. Resources Code, § 3217, subd. (d) and (e).) Following are the recommendations from the Division's Underground Gas Storage Unit (UGS Unit) for proposed minimum and maximum reservoir pressures in the Aliso Canyon Storage Facility gas storage reservoir. These recommendations are based on a proposal from Southern California Gas Company (SoCalGas) and consultation with geotechnical experts at Lawrence Berkley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, and the University of Texas.

Recommendation:

The UGS Unit recommends that the minimum pressure in the Aliso Canyon Storage Facility gas storage reservoir be 1,080 psia. As discussed below, this minimum pressure coincides with what was proposed by SoCalGas.

The UGS Unit recommends that the maximum bottom-hole reservoir pressure at the top of the reservoir structure, as represented by the productive interval in the Porter 69G well, be not greater than 2,926 psia, which is 19% lower than the maximum pressure originally proposed by SoCalGas. The Porter 69G well is completed in the storage reservoir and will function as an observation well. Therefore, a shut-in tubing pressure (SITP) measurement will be used to estimate the reservoir pressure. The difference between the UGS Unit's recommendation and what was proposed by SoCalGas represents the normal hydrostatic gradient, which provides an important margin for well control and safety at this point in the well evaluation regime. As many of the wells in the Aliso Canyon Storage Facility are currently isolated from the reservoir with a mechanical plug and fluid filled tubing and casing, a reservoir pressure exceeding hydrostatic pressure represents a potential risk. Once the isolated wells have been plugged and abandoned or completed all testing and remediation in accordance with Order 1109, the Division would consider a renewed proposal by SoCalGas to inject at a higher operating pressure.

Technical Information and Consultation:

Upon commission from SoCalGas, a third-party geotechnical report titled “Estimated Geomechanical Properties for the Aliso Canyon Gas Storage Field” was competed by GeoMechanics Technologies on July 15, 2016. (Attachment 1) This report was transmitted to the Division of Oil Gas and Geothermal Resources (Division) on July 22, 2016 by a letter (Attachment 2) from Mr. Dan Neville, Storage Engineering Manager for SoCalGas. The report from GeoMechanics recommended a 3,600 psi maximum bottom-hole pressure and a 900 psi minimum bottom-hole pressure, and in its transmittal letter SoCalGas proposed maximum operating pressure of 3,595 psi and minimum operating pressure 1,080 psi.

The UGS Unit reviewed the report and the operator’s proposal and forwarded them for independent review by geotechnical staff at the national laboratories – Barry Freifeld of Lawrence Berkley National Laboratory, Scott Perfect of Lawrence Livermore National Laboratory, and Doug Blankenship of Sandia National Laboratory. The UGS Unit then consulted with the national laboratories’ geotechnical staff and other Division staff in the district office in Cyprus by teleconference on August 10, 2016. The national laboratories’ geotechnical staff concurred with the GeoMechanics Report and the proposal from SoCalGas, finding that the requested maximum operating pressure of 3,595 psi and minimum operating pressure of 1,080 psi are within normal operating parameters (Attachment 3) and should be considered for approval.

Subsequently, Dan Neville, Storage Engineering Manager for SoCalGas, provided additional analysis of the SoCalGas’ proposed minimum bottom-hole pressure in the form of a plot based on zero working gas inventory. (Attachment 4, page 2) The UGS Unit finds that the plot provided by SoCalGas further demonstrates the reasonableness of the proposed minimum operating pressure of 1,080 psi, as do the national laboratories’ geotechnical staff.

In addition, the UGS Unit consulted with Dr. Richard A. Schultz regarding the proposed minimum and maximum reservoir pressures in the Aliso Canyon Storage Facility gas storage reservoir. Dr. Shultz is a professor at the University of Texas at Austin, an instructor for the TopCorp geotechnical training program, and a recognized specialist in overburden and geomechanics. Dr. Shultz also concurred with the GeoMechanics Report and the proposal from SoCalGas, finding that the requested maximum operating pressure of 3,595 psi and minimum operating pressure of 1,080 psi are within normal operating parameters (Attachment 3) and should be considered for approval.

Although the independent experts consulted by the UGS Unit believe that a maximum reservoir pressure of 3,595 psi and a minimum reservoir pressure of 1,080 psi is prudent, the UGS Unit finds that a more conservative maximum pressure should be approved until all wells in Aliso Canyon Storage Facility have either been plugged and abandoned or tested and remediated in accordance with Order 1109. The UGS Unit has estimated the hydrostatic pressure (using a pressure gradient of 0.433 psi/ft) in the reservoir from- wells P-69G & P-68B, both completed in the Sesnon (S4) sand and located between the top and bottom of the reservoir structure as seen in Attachment 5. Maximum reservoir pressure is estimated using a gas gradient of 0.061 psi/ft from the top of the S1 sand in the reservoir to its base. Until the final disposition of all wells, the bottom-hole pressure in the reservoir should not exceed 2,926 psi at

the Porter 69G well, which has a true vertical depth (TVD) of 7,142 feet. All other wells in the reservoir may operate at a bottom-hole pressure of 2,926 psi plus the gas gradient for the difference between the TVD of Porter 69G and the TVD of each individual well.

Proposed Minimum and Maximum Pressure

Recommendation	Minimum Pressure (psi)	Maximum Pressure (psi)
GeoMechanics Technologies	900	3,600
SoCalGas	1,080	3,595
UGS Unit	**1,080**	**2,926**