The Santa Susana fault, Aliso Canyon gas storage field, southern California-possible fault rupture hazard, gas well integrity, and regulatory implications

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The Santa Susana fault (SSF) is a government-recognized, surface-rupture hazard near the San Fernando Valley portion of the City of Los Angeles. Wells at the Aliso Canyon gas storage field, the site of the largest natural gas leak in U.S. history (aka as Porter Ranch), cross the SSF to reach the deeper storage reservoir. Fault movements across gas storage wells are a risk to their integrity but the recent large gas leak at Aliso Canyon is probably the result of casing corrosion, pending on-going investigations, and probably not due to movement on the SSF. However, there remains a well integrity risk at Aliso Canyon worthy of further consideration and evaluation due to several factors: 1) All of the 114 Aliso Canyon gas storage wells intersect the SSF (many at shallow depths of less than 300 m below the surface), and the hanging-wall strata that are highly-fractured and the SSF's thick zone of shear-fractures and smaller faults are likely conduits for gas leakage to the surface if movement on the SSF were to break the casing and tubing of high-pressure gas wells. 2)The California Geologic Survey (CGS) recognizes, via the Alquist-Priolo Act (AP), that the SSF's eastern segment is an earthquake and fault-rupture hazard based on surface offset during the 1971 Sylmar earthquake (M_W=6.4-6.7), but there is no evidence that the SSF moved during the nearby 1994 Northridge earthquake (M_W=6.7). 3) The probability of future fault movement on any segment of the SSF is unclear due to its poor surface exposure, extensive landslide deposits covering much of the fault zone, and a wide and complex shear zone with two major splays-all of which have limited surface-based paleoseimic research. Yeats (1981, 2001-Table 1) lists the fault as active, and using well and surface data concludes the SSF has had 4.9-5.9 km of slip during the last 600,000-700,000 years that yields the exceptionally high slip-rate of 7.0-9.8 mm/yr. Additionally to the west and east the SSF merges with the active Oak Ridge and Sierra Madre faults respectively. For four decades AP zoning has regulated surface construction on and near potentially active surface faults in California, however, similar regulatory constraints do not specifically recognize such faults and their subsurface rupture hazards to gas well integrity. The American Petroleum Institute (API) Recommended Practice 1171, First Edition, 2015 (section 4.4, para 2) that is guiding State of California rule-making states "Depleted hydrocarbon reservoirs are candidates for natural gas storage because the reservoir integrity has been demonstrated over geologic time by hydrocarbon containment at initial pressure conditions." True, but gas wells at storage reservoirs have not existed over geologic time, and if their shallow portions cross potentially active faults, then there is a well integrity risk and potential for leakage to the surface. The oil and gas industry in California, already highly regulated, needs to be involved, cooperate, and support new rule-making dealing with this issue for it cannot politically afford to have another Aliso Canyon-like incident, and everyone now

recognizes how difficult it is to control the subsurface leakage from a single well in a gas storage field.