



A  Sempra Energy utility®

Order Instituting Investigation into the November) Investigation 19-11-010
2019 Submission of Southern California Gas)
Company's Risk Assessment and Mitigation Phase.)

RISK ASSESSMENT MITGATION PHASE

WORKPAPERS TO

CHAPTER SCG-8

STORAGE WELL INTEGRITY

November 27, 2019

Likelihood of “an event”: 1 in 12 years. These events range between small to large events. This was estimated by looking at 6 events over the past 70 years.

Consequence if an event were to occur:

Safety:

2.8 safety units every 40 events (every ~500 years). [Based on study by industry professional.]

Financial: all assumption derived from historical data

Once out of 6 events (once in 70 years): \$1B

Twice out of 6 events (once in 35 years): \$75M

Once out of 6 events (once in 70 years): \$27.5M

Twice out of 6 events (once in 35 years): \$3M

Field	City	Company	Date	Impacts	Reported Cause
Aliso Canyon	Los Angeles	Southern California Gas Company	1/17/1994	Storage well damaged-crushed. Supply of gas from Aliso Canyon interrupted for five days.	Storage well damaged during 1994 Northridge earthquake
Aliso Canyon	Los Angeles	Southern California Gas Company	2008	High-pressure gas could migrate to the surface in an matter of hours, according to SoCalGas testimony.	Corrosion of storage well casing. Surface annulus of well Porter 50 A had a pressure of over 400 PSIG
Aliso Canyon	Los Angeles	Southern California Gas Company	2013	No evidence of leaks at the surface or surface casing	Two wells were found to have leaks in the production casing at depths adjacent to the shallower oil production sands.
HONOR RANCHO	LOS ANGELES	Southern California Gas Company	1992	Storage Well damaged causing shoe leak	Well inadvertently sidetracked during repair of casing shoe leak
MONTEBELLO	LOS ANGELES	Southern California Gas Company	1950-1980	Storage gas loss over extended period. In 1980, found within housing estate above field-led to evacuation of families on many occasions	Storage gas migrated via old, poorly completed wells and possibly faults. Injection pressure higher than original oilfield pressure, causing fracture and damage to old wells. Injection ceased 1980; facility closed 2003.
Aliso Canyon	Los Angeles	Southern California Gas Company	2006	Resident Relocation Required, Extensive and prolonged relief well operations	SS-25 Casing Failure

Incidents for Depleted Field caused by Well Integrity (U.S.A, 1940-2015)

	Severity							
	1	2	3	4	5	6	7	8
Incidents at US natural gas	0	53	3	97	2	3	4	1
Average incident per year	0.000	0.707	0.040	1.293	0.027	0.040	0.053	0.013
Active existing depleted fields	328							
Average incident per year per field	0.0000	0.0022	0.0001	0.0039	0.0001	0.0001	0.0002	0.0000
SCG depleted fields	4							
SCG incident per year (national)	0.0000	0.0086	0.0005	0.0158	0.0003	0.0005	0.0007	0.0002

Severity

Severity	Category	Description
1	<i>Insignificant/nuisance</i>	operational issues that were easily rectified or repaired, not involving leakage of product fire/explosion/blowout, injury, evacuees, fatalities or leading to financial losses
2	<i>Minor/ disruptive</i>	issues including minor/small leakages/surface release, cavern instabilities that were rectified or repaired, vapour flash, but no real financial loss, fire/explosion/blowout, injury, evacuees or fatalities
3	<i>Moderate (1)</i>	issues including substantial losses through subsurface leakages, but not involving surface release, leading to financial losses, but no fire/explosion/blowout, injury, evacuees or fatalities
4	<i>Moderate (2)</i>	issues including substantial operating problems (including shut-down, closure of caverns &/or loss of roof salt) or substantial losses through subsurface leakages, involving surface release, gas in observation or water wells, or pipeline leakages, leading to financial losses, = fire/explosion/blowout, but no injury, evacuees or fatalities
5	<i>Significant</i>	issues including significant leakages/losses and surface release, fire/explosion/blowout leading to financial losses, minor numbers of injured/injuries (1-5), but no evacuees, fatalities or serious property damage
6	<i>Serious</i>	issues mainly involving significant surface release, fire/explosion/blowout, greater number of injured/serious injury (5-10), evacuees (<50) and/or serious property damage/financial losses but no fatalities
7	<i>Major</i>	issues mainly involving large-scale surface release through well or surface pipelines, = fire/explosion/blowout, high numbers of evacuees (50-500), large number of injured/serious injury (10-15) and/or significant property damage/financial losses, but no fatalities
8	<i>Catastrophic</i>	issues mainly involving devastating surface release at facility through well or surface pipelines, fire/explosion/blowout, cratering, fatalities, high number of injured (>15) and/or evacuees (>500) and major property damage/financial losses

	Severity							
	1	2	3	4	5	6	7	8
Number of Fatality	0	0	0	0	0	0	0	[4,6]
Number of Serious Injury	0	0	0	0	[1-5]	(5-10)	(10-15)	(15,25]

Chapter	SCG-8
Risk	Storage Well Integrity Event

Single Point

ID	Activity	Project Life In Years	Cost Forecast (O&M, \$M) 2022	Cost Forecast (Capital, \$M)			Pre-Mitigation Single Point		% risk reduction (use if % risk addressed not available) (%)	% Risk Reduction									RSE Single Point	Post-Mitigation Single Point	
				2020	2021	2022	LORE	CORE		Safety			Reliability			Financial (\$M)				LORE	CORE
				% address ed	% scope	% of effectiveness	% address ed	% scope		% of effectiveness	% address ed	% scope	% of effectiveness	% address ed	% scope	% of effectiveness	LORE	CORE			
SCG-8-C6	Integrity Demonstration, Verification, and Monitoring Practices	2.00	7.88	35.00	35.00	35.00	0.09	4061.67		11%	121%	95%	0%	0%	0%	11%	121%	95%	0.64	0.10	4061.67
SCG-8-A1	Alternative 1: Casing Wall Thickness Inspection Tools (using only MFL)	2.00	5.25	35.00	35.00	35.00	0.09	4061.67		10%	121%	95%	0%	0%	0%	10%	121%	95%	0.59	0.10	4061.67
SCG-8-A2	Alternative 2: Multi string metal loss inspection + MFL + UT	2.00	8.98	33.00	33.00	33.00	0.09	4061.67		11%	114%	95%	0%	0%	0%	11%	114%	95%	0.62	0.10	4061.67

Low Alternative

ID	Activity	Project Life In Years	Cost Forecast (O&M, \$M) 2022	Cost Forecast (Capital, \$M)			Pre-Mitigation Low Alternative		% risk reduction (use if % risk addressed not available) (%)	% Risk Reduction									RSE Low Alternative	Post-Mitigation Low Alternative	
				2020	2021	2022	LORE	CORE		Safety			Reliability			Financial (\$M)				LORE	CORE
				% address ed	% scope	% of effectiveness	% address ed	% scope		% of effectiveness	% address ed	% scope	% of effectiveness	% address ed	% scope	% of effectiveness	LORE	CORE			
SCG-8-C6	Integrity Demonstration, Verification, and Monitoring Practices	2	7.88	35.00	35.00	35.00	0.09	3956.67		11.0%	121.0%	95.0%	0.0%	0.0%	0.0%	11.0%	121.0%	95.0%	0.62	0.10	3956.67
SCG-8-A1	Alternative 1: Casing Wall Thickness Inspection Tools (using only MFL)	2	5.25	35.00	35.00	35.00	0.09	3956.67		9.6%	121.4%	95.0%	0.0%	0.0%	0.0%	9.6%	121.4%	95.0%	0.58	0.10	3956.67
SCG-8-A2	Alternative 2: Multi string metal loss inspection + MFL + UT	2	8.98	33.00	33.00	33.00	0.09	3956.67		11.1%	114.5%	95.0%	0.0%	0.0%	0.0%	11.1%	114.5%	95.0%	0.60	0.10	3956.67

High Alternative

ID	Activity	Project Life In Years	Cost Forecast (O&M, \$M) 2022	Cost Forecast (Capital, \$M)			Pre-Mitigation High Alternative		% risk reduction (use if % risk addressed not available) (%)	% Risk Reduction									RSE High Alternative	Post-Mitigation High Alternative	
				2020	2021	2022	LORE	CORE		Safety			Reliability			Financial (\$M)				LORE	CORE
				% address ed	% scope	% of effectiveness	% address ed	% scope		% of effectiveness	% address ed	% scope	% of effectiveness	% address ed	% scope	% of effectiveness	LORE	CORE			
SCG-8-C6	Integrity Demonstration, Verification, and Monitoring Practices	2	7.88	35.00	35.00	35.00	0.09	4236.67		11.0%	121.0%	95.0%	0.0%	0.0%	0.0%	11.0%	121.0%	95.0%	0.66	0.10	4236.67
SCG-8-A1	Alternative 1: Casing Wall Thickness Inspection Tools (using only MFL)	2	5.25	35.00	35.00	35.00	0.09	4236.67		9.6%	121.4%	95.0%	0.0%	0.0%	0.0%	9.6%	121.4%	95.0%	0.62	0.10	4236.67
SCG-8-A2	Alternative 2: Multi string metal loss inspection + MFL + UT	2	8.98	33.00	33.00	33.00	0.09	4236.67		11.1%	114.5%	95.0%	0.0%	0.0%	0.0%	11.1%	114.5%	95.0%	0.65	0.10	4236.67

SCG-8-C6: Integrity Demonstration, Verification, and Monitoring Practices

Attribute	Risk Reduction			Formula	Basis			Reference	Project Life
			Total		Scope	Effectiveness	Risk Addressed		
Safety	% Scope	121%	12.64%	<i>Wells undergoing assessment on 2 year cycle</i>	SCG designation, some wells might be reassessed	SME Estimate	SME Estimate based on available literature		2
	% Effectiveness	95%		<i>High</i>					
	% Risk Addressed	11%		<i>Risk associated with casing</i>					
Reliability	% Scope	N/A	0.00%						
	% Effectiveness	N/A							
	% Risk Addressed	N/A		<i>Reliability impact is minimal</i>					
Financial	% Scope	121%	12.64%	<i>Wells undergoing assessment on 2 year cycle</i>					
	% Effectiveness	95%		<i>High</i>					
	% Risk Addressed	11%		<i>Risk associated with casing</i>					

SCG-8-A1: Casing Wall Thickness Inspection Tools

Attribute	Risk Reduction			Formula	Basis			Reference	Project Life
			Total		Scope	Effectiveness	Risk Addressed		
Safety	% Scope	121%	11%	<i>Wells undergoing assessment on 2 year cycle</i>	SCG designation, some wells might be reassessed	SME Estimate	SME Estimate based on available literature. This benefit is deflated in proportion to surface defects that will not be caught due to the suspension of a specific test.		2
	% Effectiveness	95%		<i>High</i>					
	% Risk Addressed	10%		<i>Risk associated with casing</i>					
Reliability	% Scope	0%	0.00%						
	% Effectiveness	0%							
	% Risk Addressed	0%		<i>Reliability impact is minimal</i>					
Financial	% Scope	121%	11%	<i>Wells undergoing assessment on 2 year cycle</i>				3rd party information	
	% Effectiveness	95%		<i>High</i>					
	% Risk Addressed	10%		<i>Risk associated with casing</i>					

SCG-8-A2: Multi String Metal Loss Inspection

Attribute	Risk Reduction		Formula	Basis			Reference	Project Life	
		Total		Scope	Effectiveness	Risk Addressed			
Safety	% Scope	114%	12%	Wells undergoing assessment on 2 year cycle	SCG designation, some wells might be reassessed	SME Estimate	SME Estimate based on available literature. The benefit marginally increases with the addition of the additional assessment.	2	
	% Effectiveness	95%							High
	% Risk Addressed	11%							Risk associated with casing
Reliability	% Scope	0%	0.00%						
	% Effectiveness	0%							
	% Risk Addressed	0%							Reliability impact is minimal
Financial	% Scope	114%	12%	Wells undergoing assessment on 2 year cycle				3rd party information	
	% Effectiveness	95%							High
	% Risk Addressed	11%							Risk associated with casing