

Long-Term Viability of Underground Natural Gas Storage in California

An Independent Review of Scientific and
Technical Information

Chapter 1, Section 1.8
References

California Council on Science and Technology

December 2017

Long-Term Viability of Underground Natural Gas Storage in California

An Independent Review of Scientific and Technical Information

*Jane C.S. Long, PhD, Independent Consultant
Steering Committee Co-Chair*

*Jens T. Birkholzer, PhD, Lawrence Berkeley National Laboratory
Steering Committee Co-Chair*

*Amber J. Mace, PhD, California Council on Science and Technology
Project Director*

*Sarah E. Brady, PhD, California Council on Science and Technology
Project Manager*

Steering Committee Members

J. Daniel Arthur, P.E., SPEC, ALL Consulting L.L.C

Riley M. Duren, P.E., NASA Jet Propulsion Laboratory

Karen Edson, retired California Independent System Operator

Robert B. Jackson, PhD, Stanford University

Michael L.B. Jerrett, PhD, University of California, Los Angeles

Najmedin Meshkati, PhD, University of Southern California

Scott A. Perfect, PhD, Lawrence Livermore National Laboratory

Terence Thorn, JKM Energy and Environmental Consulting

Samuel J. Traina, PhD, University of California, Merced

Michael W. Wara, PhD, Stanford Law School

Non-Voting Ex Officio Steering Committee Members

Catherine M. Elder, M.P.P; Aspen Environmental Group (Technical Expert)

Jeffery Greenblatt, PhD; Lawrence Berkeley National Laboratory (Author)

Curtis M. Oldenburg, PhD; Lawrence Berkeley National Laboratory (Author)

Acknowledgments

This report has been prepared by the California Council on Science and Technology (CCST) with funding from the California Public Utilities Commission.

Copyright

Copyright 2017 by the California Council on Science and Technology ISBN Number: 978-1-930117-86-0 Long-Term Viability of Underground Natural Gas Storage in California: An Independent Review of Scientific and Technical Information

About CCST

The California Council on Science and Technology is a nonpartisan, nonprofit organization established via the California State Legislature in 1988. CCST engages leading experts in science and technology to advise state policymakers- ensuring that California policy is strengthened and informed by scientific knowledge, research, and innovation. CCST responds to the Governor, the Legislature, and other State entities who request independent assessment of public policy issues affecting the State of California relating to science and technology.

Note

The California Council on Science and Technology (CCST) has made every reasonable effort to assure the accuracy of the information in this publication. However, the contents of this publication are subject to changes, omissions, and errors, and CCST does not accept responsibility for any inaccuracies that may occur.

For questions or comments on this publication contact: California Council on Science and Technology 1130 K Street, Suite 280 Sacramento, CA 95814

916-492-0996

ccst@ccst.us www.ccst.us

Layout by a Graphic Advantage! 3901 Carter Street #2, Riverside, CA 92501

www.agraphicadvantage.com

1.8 REFERENCES

- Abediniso, F., 2014. Societal risk criteria: History, current risks, risk aversion and scale effect, Ph.D. dissertation, University of Maryland, College Park. <http://drum.lib.umd.edu/handle/1903/15963>
- ACGIH (American Conference of Government Industrial Hygienists). 2017. *2017 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. Signature Publications.
- ACS (American Chemical Society), 2017. Common Chemistry Substance Search. <http://www.commonchemistry.org/>.
- AGA (American Gas Association), 2011. "Safety Culture Statement," Washington DC.
- AIHA (American Industrial Hygiene Association) (2017). Occupational exposure limits. <https://www.aiha.org/publications-and-resources/TopicsofInterest/Topics/Pages/Occupational-Exposure-Limits.aspx>
- ALL Consulting, LLC, 2015. Unpublished research and spreadsheet on California gas storage fields.
- ALL Consulting, LLC, 2016. Unpublished figure of work-over underway.
- ALL Consulting, LLC, 2017. Unpublished well diagram showing internal and external integrity considerations.
- Alvarez, R.A., S.W. Pacala, J.J. Winebrake, W.L. Chameides, and S.P. Hamburg, 2012. Greater focus needed on methane leakage from natural gas infrastructure. *Proceedings of the National Academy of Sciences*, 109 (17), 6435–6440.
- American Nuclear Society, 2014. Standard ANSI/ANS-3.1-2014, "Selection, Qualification, and Training of Personnel for Nuclear Power Plants."
- Anyadiogwu, C.I.C., and C.M. Muonagor, 2013. Effects of formation damage on productivity of underground gas storage reservoirs. *Asia Pacific Journal of Multidisciplinary Research*, 1 (1), December 2013, 10pp.
- API (American Petroleum Institute), 2014. Recommended Practice 1173, Pipeline Safety Management System Requirements (First Edition, June 2014, Draft Version 11.2).
- API (American Petroleum Institute), 2015. API Recommended Practice 1171 Functional Integrity of Natural Gas Storage in Depleted Hydrocarbon Reservoirs and Aquifer Reservoirs (First Edition, September 2015).
- Araktingi, R.E., Benefield, M.E., Bessenyei, Z., Coats, K.H., Tek, M.R. (1984). Leroy storage facility, Uinta County, Wyoming: A case history of attempted gas-migration control. *Journal of Petroleum Technology*, 36(01), pp.132-140.
- ASME/ANS (American Society of Mechanical Engineers/American Nuclear Society), 2013. ASME/ANS RA-Sb-2013, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," (so-called Addendum B).
- ASME (American Society of Mechanical Engineers), 2016. Managing System Integrity of Gas Pipelines, B31.8S, American Society of Mechanical Engineers, 76 pp.
- ATSDR (Agency for Toxic Substances and Disease Registry), 2004. Public Health Statement: Ammonia. <https://www.atsdr.cdc.gov/phs/phs.asp?id=9&tid=2> (September 2004).
- ATSDR (Agency for Toxic Substances and Disease Registry), 2007. Public Health Statement: Benzene. <https://www.atsdr.cdc.gov/phs/phs.asp?id=37&tid=14> (August 2007).
- ATSDR (Agency for Toxic Substances and Disease Registry), 2008a. Public Health Statement-1,1,2,2,-Tetrachloroethane. <https://www.atsdr.cdc.gov/ToxProfiles/tp93-c1-b.pdf>
- ATSDR (Agency for Toxic Substances and Disease Registry), 2008b. Public Health Statement: Formaldehyde. <https://www.atsdr.cdc.gov/phs/phs.asp?id=218&tid=39> (September 2008)
- ATSDR (Agency for Toxic Substances and Disease Registry), 2014. Medical Management Guidelines for Ethylene Dibromide. <https://www.atsdr.cdc.gov/MMG/MMG.asp?id=1143&tid=251>

- ATSDR (Agency for Toxic Substances and Disease Registry, 2016. Public Health Statement – Trichloroethylene. <https://www.atsdr.cdc.gov/ToxProfiles/tp19-c1-b.pdf>
- ATSDR (Agency for Toxic Substances and Disease Registry), 2017a. Minimal Risk Levels (MRLs). https://www.atsdr.cdc.gov/mrls/pdfs/atsdr_mrls.pdf
- ATSDR (Agency for Toxic Substances and Disease Registry). 2017b. Health Consultation, Exposure Investigation – Ambient Airborne Exposure to Hydrogen Sulfide and Particulate Matter. https://www.atsdr.cdc.gov/HAC/pha/IndustrialPipeInc/Industrial_Pipe_Inc_EI-HC_08-21-2017_508.pdf
- Bair, E.S., D.C. Freeman, and J.M. Senko, 2010. Subsurface gas invasion Bainbridge Township, Geauga County, Ohio, Expert Panel Technical Report, submitted to Ohio Department of Natural resources, Division of Mineral Resources Management, June 2010.
- Bajpai, S., and J.P. Gupta, 2007. Securing oil and gas infrastructure. *Journal of Petroleum Science and Engineering*, 55(1), 174-186.
- Barriere, M., D. Bley, S. Cooper, J. Forester, A. Kolaczowski, W. Luckas, G. Parry, A. Ramey-Smith, C. Thompson, D. Whitehead, and J. Wreathall, 2000. Technical Basis and Implementation Guidelines for A Technique for Human Event Analysis (ATHEANA). Report NUREG-1624, Rev. 1, U.S. Nuclear Regulatory Commission.
- Baum, R.L., D.L. Galloway, and E.L. Harp, 2008. *Landslide and Land Subsidence Hazards to Pipelines* (No. 2008-1164). Geological Survey (U.S.).
- Beckerman, B., and M. Jerrett, 2016. Cluster Analysis of Metals and Organics in Dust Samples: Porter Ranch Area. Available at: http://www.publichealth.lacounty.gov/media/docs/Attachment%203%20-%20PCA_FactorAnalysisDustOnly.pdf.
- Behbod, B., E.M. Parker, E.A. Jones, T. Bayleyegn, J. Guarisco, M. Morrison, M.G. McIntyre, M. Knight, B. Eichold, and F. Yip, 2014. Community Health Assessment Following Mercaptan Spill: Eight Mile, Mobile County, Alabama, September 2012. *J Public Health Management Practice*, 20(6), 632-639.
- Benarie, M.M., 1980. *Urban Air Pollution Modeling*. The MIT Press.
- Benion, D.B., and W. Jones, 1994. Procedures for minimizing drilling and completion damage in horizontal wells, laboratory and field case studies in the Virginia Hills Belloy Sands, presented at SPE/CIM 4th Annual One Day Conference on Horizontal Wells, Calgary, Canada, November 22, 1994.
- Benjamin, S.G., S.S. Weygandt, J.M. Brown, M. Hu, C.R. Alexander, T.G. Smirnova, J.B. Olson, E.P. James, D.C. Dowell, G.A. Grell, H. Lin, S.E. Peckham, T.L. Smith, W.R. Moninger, J.S. Kenyon, and G.S. Manikin, 2016. A North American Hourly Assimilation and Model Forecast Cycle: The rapid refresh. *Mon. Wea. Rev.*, 144, 1669–1694, DOI:10.1175/MWR-D-15-0242.1
- Berkstresser, C.F., Jr., 1973. Base of fresh ground water approximately 3,000 micromhos in the Sacramento Valley and Sacramento-San Joaquin Delta, California. United States Geological Survey Water-Resources Investigation Report 73-40. 1:500,000.
- Bley, D., S. Cooper, J. Forester, A. Kolaczowski, E. Lois, and J. Wreathall, 2005. Untangling the causes of human error: Predicting the likelihood of human error in high-risk industries, Report JCN-Y6497, U.S. Nuclear Regulatory Commission.
- Branum, D., R. Chen, M. Petersen, and C. Wills, 2016. Earthquake shaking potential for California. Map Sheet 48 (revised 2016), Sacramento, CA. Department of Conservation, California Geological Survey. GIS file for 2% probability of exceeding 1.0-second spectral acceleration in 50 years available at ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/MS48/ms48r_1hz_2pc50.zip.
- Broughton, E., 2005. The Bhopal disaster and its aftermath: A review, *J. Environmental Health*, 4, 6.
- Browder, J., R. Gutterud, and J. Schade, 2010. Performance Data Analysis Reporting System (PDARS)—A valuable addition to FAA managers’ toolkit. *Managing the Skies, the Journal of the FAA Managers Association*, 8 (6).

- Bruno, M.S., 2001. Geomechanical Analysis and Decision Analysis for Mitigating Compaction Related Casing Damage. Paper SPE 71695 presented at the SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA, 30 September 30-3 October.
- Bruno, M., 2014. Development of improved caprock integrity and risk assessment techniques, DOE Grant No. DE-FE0009168 Final Report, December 15, 143 pp.
- Burgess, W.A., 1995. *Recognition of Health Hazards in Industry: A Review of Materials and Processes*. Second Edition, John Wiley & Sons, Inc. New York.
- California Code of Regulations, 2017. Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change, Article 4, Subarticle 13: Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities
- California Governor's Office of Emergency Services, 2012. "California Emergency Management Mutual Aid Plan," November 2012.
- California Legislative Information, 2017. Health and Safety Code (HSC) 39655. http://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=HSC§ionNum=39655 (accessed September 1, 2017)
- California Natural Resources Agency, Department of Conservation, Division of Oil, Gas, and Geothermal Resources, 2016. "Text of Emergency Regulations, California Code of Regulations, Title 14, Chapter 4, Development, Regulation, and Conservation of Oil and Gas Resources, Article 4, Requirements for Underground Gas Storage Projects, Section 1724.9, Gas Storage Projects," adopted February 5, 2016
- California Natural Resources Agency, Department of Conservation, Division of Oil, Gas, and Geothermal Resources, 2017. "Text of Proposed Regulations, California Code Of Regulations, Title 14, Chapter 4. Development, Regulation, And Conservation Of Oil And Gas Resources, Article 4. Requirements for Underground Gas Storage Projects," released for public comment May 19, 2017.
- Cal Fire (California Department of Forestry and Fire Protection), 2007a. Fire hazard severity zones in state responsibility areas. Adopted November 7, 2007. GIS file available at <http://frap.fire.ca.gov/webdata/data/statewide/fhszs.sn.zip>.
- Cal Fire (California Department of Forestry and Fire Protection), 2007b. Draft Fire hazard severity zones in LRA – Fresno County. Adopted November 7, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/fresno/fhszl06_1.10sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007c. Draft Fire hazard severity zones in LRA – Madera County. Adopted September 20, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/madera/fhszl06_1.20sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007d. Draft Fire hazard severity zones in LRA – Solano County. Adopted October 3, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/solano/fhszl06_1.48sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007e. Draft Fire hazard severity zones in LRA – San Joaquin County. Adopted October 2, 2007. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownLoadServlet?DFIRMID=06077C&state=CALIFORNIA&county=SAN%20JOAQUIN%20COUNTY&fileName=06077C_20171023.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007f. Draft Fire hazard severity zones in LRA – Sacramento County. Adopted September 19, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/sacramento/fhszl06_1.34sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007g. Draft Fire hazard severity zones in LRA – Colusa County. Adopted October 2, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/colusa/fhszl06_1.6sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007h. Draft Fire hazard severity zones in LRA – Butte County. Adopted September 19, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/butte/fhszl06_1.4sn.zip.

- Cal Fire (California Department of Forestry and Fire Protection), 2007i. Draft fire hazard severity zones in LRA – Contra Costa County. Adopted September 19, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/contra_costa/fhszl06_1.7sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007j. Draft fire hazard severity zones in LRA – Yolo County. Adopted October 5, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/yolo/fhszl06_1.57sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2007k. Draft fire hazard severity zones in LRA – Santa Barbara County. Adopted September 25, 2007. GIS file available at http://frap.fire.ca.gov/webdata/data/santa_barbara/fhszl06_1.42sn.zip.
- Cal Fire (California Department of Forestry and Fire Protection), 2011. Very high fire hazard severity zones in LRA – Los Angeles County. September, 2011. GIS file available at http://frap.fire.ca.gov/webdata/data/los_angeles/c19fhszl06_5.zip.
- CalOSHA (California Occupational Safety and Health Administration), 2017a. SoCalGas Just Says No to CalOSHA Pipeline Jurisdiction. *CalOSHA Reporter*. <https://www.mpa-nc.com/ArchiveCenter/ViewFile/Item/146>
- CalOSHA (California Occupational Safety and Health Administration), 2017b. Process Safety Management Unit, adding section 5189.1 to Title 8 of the California Code of Regulations (Title 8, Div. 1, Chapter 4; Subchapter 7. General Industry Safety Orders; Group 16. Control of Hazardous Substances; Article 109. Hazardous Substances and Processes §5189.1. Process Safety Management for Petroleum Refineries, p. 3), June 2017.
- CARB (California Air Resources Board), 2007. “Hot Spots” Inventory Guidelines – Emissions Inventory Criteria and Guidelines Report – Appendix 1.A (List of Substances). <https://www.arb.ca.gov/ab2588/2588guid.htm>
- CARB (California Air Resources Board), 2016a. Determination of Total Methane Emissions from The Aliso Canyon Natural Gas Leak Incident. 28 p. Available at: https://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_methane_emissions-arb_final.pdf.
- CARB (California Air Resources Board), 2016b. Aliso Canyon Natural Gas Leak: Preliminary Estimate of Greenhouse Gas Emissions (As of April 5, 2016). Accessed on July 12, 2017. Available at: https://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_natural_gas_leak_updates-sa_flights_thru_April_5_2016.pdf.
- CARB (California Air Resources Board), 2016c. AB 2588 Air Toxics “Hot Spots” Program. <https://www.arb.ca.gov/ab2588/ab2588.htm>, April 25, 2016.
- CARB (California Air Resource Board), 2017a. Emissions Inventory Facility Search Engine. <https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php>, accessed 2017.
- CARB (California Air Resource Board), 2017b. Mandatory Reporting of Greenhouse Emissions (MRR), GHG Facility and Entity Emissions Data, from CARB Pollution Mapping Tool. Web accessed, June 2017. https://www.arb.ca.gov/ei/tools/pollution_map/pollution_map.htm
- CARB (California Air Resource Board), 2017c. Regulation of Oil and Gas Operations. Web accessed, July 2017. <https://www.arb.ca.gov/regact/2016/oilandgas2016/oil%20gasfro.pdf>.
- CARB (California Air Resource Board) (2017d). California Greenhouse Gas Emission Inventory Program. <https://www.arb.ca.gov/cc/inventory/inventory.htm>.
- CCPS (Center for Chemical Process Safety), 2005. *Building Process Safety Culture: Tools to Enhance Process Safety Performance*. Center for Chemical Process Safety, American Institute of Chemical Engineers, New York, 2005.
- CCST (California Council on Science and Technology), 2015a. An Independent Scientific Assessment of Well Stimulation in California, Volume II: Potential Environmental Impacts of Hydraulic Fracturing and Acid Stimulations, Chapter 6 Appendices, pages 679 – 683. <http://ccst.us/publications/2015/160708-sb4-vol-II-6A.pdf>
- CCST (California Council on Science and Technology), 2015b. An Independent Scientific Assessment of Well Stimulation in California, Volume I, Chapter 3: Historical and Current Application of Well Stimulation Technology in California, pages 115 – 116. <http://ccst.us/publications/2015/vol-I-chapter-3.pdf>

- CEMA (California Emergency Management Agency), California Geological Survey, and USC (University of Southern California), 2009a. Tsunami inundation map for emergency planning, State of California, County of Santa Barbara, Goleta quadrangle, January 31, 2009, 1:24,000.
- CEMA (California Emergency Management Agency), California Geological Survey, and USC (University of Southern California), 2009b. Tsunami inundation map for emergency planning, State of California, County of Los Angeles, Venice quadrangle, March 1, 2009, 1:24,000.
- CGS (California Geological Survey), 1976. Official maps of Earthquake Fault Zones: GIS files of official maps of Alquist-Priolo earthquake fault zones - Oat Mountain, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>
- CGS (California Geological Survey), 1993. Official maps of Earthquake Fault Zones: GIS files of official maps of Alquist-Priolo Earthquake Fault Zones – Vine Hill, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>
- CGS (California Geological Survey), 1995a. Official maps of Earthquake Fault Zones: GIS files of official maps of Alquist-Priolo Earthquake Fault Zones - Newhall, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>.
- CGS (California Geological Survey), 1995b. Official maps of Seismic Hazard Zones: GIS files of official maps of Seismic Hazard Zones - Venice, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>.
- CGS (California Geological Survey), 1998a. Official maps of Seismic Hazard Zones: GIS files of official maps of Seismic Hazard Zones - Newhall, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>.
- CGS (California Geological Survey), 1998b. Official maps of Seismic Hazard Zones: GIS files of official maps of Seismic Hazard Zones – Oat Mountain, Sacramento, CA. Department of Conservation, California Geological Survey. <http://maps.conservation.ca.gov/cgs/informationwarehouse/>.
- Chilingar, G.V., and B. Endres, 2005. Environmental hazards posed by the Los Angeles Basin urban oilfields: A historical perspective of lessons learned. *Environmental Geology*, 47, 302-3017.
- Cicerone R.J., and R.S. Oremland, 1988. Biogeochemical aspects of atmospheric methane. *Global Biogeochemical Cycles*, 2 (4). Available at: <http://escholarship.org/uc/item/3xq3t703>.
- Clark, C.E., and J.A. Veil, 2009. Produced Water Volumes and Management Practices in the United States (No. ANL/EVS/R-09-1). Argonne National Laboratory (ANL).
- Conley, S., G. Franco, I. Faloon, D.R. Blake, J. Peischl, and T.B. Ryerson, 2016. Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA. *Science*, 351 (6279), pp.1317-1320.
- Conley, S., I. Faloon, S. Mehrotra, M. Suard, D.H. Lenschow, C. Sweeney, S. Herndon, S. Schwietzke, G. Pétron, J. Pifer, E.A. Kort, and R. Schnell, 2017. Application of Gauss's Theorem to quantify localized surface emissions from airborne measurements of wind and trace gases, *Atmos. Meas. Tech. Discuss.*, <https://doi.org/10.5194/amt-2017-55>.
- CPUC (California Public Utilities Commission), 2010. Central Valley Gas Storage Project – Appendix 1.D: System Safety and Risk of Upset. http://www.cpuc.ca.gov/environment/info/dudek/cvgs/archive/CVGS_IS-MND.htm
- CPUC (California Public Utilities Commission), 2016. Administrative Law Judge's Ruling Entering Summary of Best Practices Working Group Activities and Staff Recommendations into the Record and Seeking Comments, R.15-01-008, CARB report in March 24, 2016. <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=10695>.
- CSB (U.S. Chemical Safety and Hazard investigation Board), 2007. "Investigation Report: Refinery Explosion and Fire (15 Killed, 180 Injured) BP Texas City, Texas, March 23, 2005," CSB Report No. 2005-04-I-TX, 2007.
- CSB (U.S. Chemical Safety and Hazard Investigation Board), 2016. Investigation Report, "Drilling Rig Explosion and Fire at the Macondo Well (11 Fatalities, 17 Injured, and Serious Environmental Damage), Deepwater Horizon Rig, Mississippi Canyon 252, Gulf of Mexico, April 20, 2010," Report No. 2010-10-I-OS.

- Davis Namson Consulting Geologists, 2005. Geologic report of development and exploration opportunities La Goleta gas storage field area, Santa Barbara County, California, in Appendix R of Santa Barbara County Planning and Development Department (2013). Final environmental impact report: Southern California Gas Company, La Goleta storage field enhancement project. State Clearinghouse No. 2010021069. <http://www.sbcountyplanning.org/energy/documents/projects/SoCalGas/FEIR Appendices.pdf>
- Davis, T.L., J.S. Namson, and S. Gordon, 2015. Ventura basin oil fields: Structural setting and petroleum system, field trip #5, May 7, 2015. Joint annual meeting of PSAAPG and Coast Geological Society, May 2-8, 2015. 58 pp.
- Den Braven, W., and J. Schade, 2003. Concept and operation of the performance data analysis and reporting system (PDARS) (No. 2003-01-2976). SAE Technical Paper.
- DOG (California Division of Oil and Gas), 1942. Annual report of the State Oil and Gas Supervisor, 1942. Vol. 28, No. 2.
- DOG (California Division of Oil and Gas), 1943. Annual report of the State Oil and Gas Supervisor, 1943. Vol. 29, No. 1.
- DOG (California Division of Oil and Gas), 1982. California oil and gas fields, volume III: northern California. California Division of Oil and Gas, Sacramento, CA, 327 p.
- DOG (California Division of Oil and Gas), 1992. California oil and gas fields, volume II: southern, central coastal, and offshore California. California Division of Oil and Gas, Sacramento, CA, 689 p.
- DOGGR (California Division of Oil, Gas and Geothermal Resources), 1998. California oil and gas fields, volume I: central California. California Division of Oil, Gas, and Geothermal Resources, Sacramento, CA, 507 p.
- DOGGR (California Division of Oil, Gas and Geothermal Resources), 2015. GIS mapping. <http://www.conservation.ca.gov/dog/maps/Pages/GISMapping2.aspx>. Accessed 7 Jul 2017
- DOGGR (California Division of Oil, Gas and Geothermal Resources), 2016. Termination of Underground Injection Control Gas Storage Project for Montebello Field (Project No. 478-06-001). Letter from Scott Walker, DOGGR Area Supervising Engineer, to Bob Dentici, Southern California Gas Company, on 9 December 2016. 1 pp.
- Dooher, B., 2016. "Landslide Sources: Santa Lucia Escarpment," presentation at the Diablo Canyon Independent Safety Committee Public Meeting, Avila Lighthouse Suites, February 3-4, 2016.
- Dryer, F.L., M. Chaos, Z. Zhao, J.N. Stein, J.Y. Alpert, and C.J. Homer, 2007. Spontaneous ignition of pressurized releases of hydrogen and natural gas into air. *Combustion Science and Technology*, 179 (4), 663-694.
- Duren, R., et al., 2017. Methane emissions from underground natural gas storage in California. *Atmospheric Chemistry and Physics Discussion, Env. Res. Let.*, (to be submitted).
- DWR (California Department of Water Resources), 2016. California's groundwater: working toward sustainability, Bulletin 118, Interim update 2016. Available at http://www.water.ca.gov/groundwater/bulletin118/docs/Bulletin_118_Interim_Update_2016.pdf
- DWR (California Department of Resources), 2017. Records from the California Department of Water Resources' Online System of Well Completion Reports as of 7/1/2017. File "OSWCR_201707.csv" provided by Ben Brezing.
- DWR (California Department of Water Resources), Southern District, 1961. Planned utilization of the ground water basins of the Coastal Plain of Los Angeles County – Appendix 1.A: groundwater geology. Bulletin 104. Available at http://www.water.ca.gov/waterdatalibrary/docs/historic/Bulletins/Bulletin_104/Bulletin_104-A_1961.pdf
- Evans, D.J., 2008. An appraisal of underground gas storage technologies and incidents, for the development of risk assessment methodology, Prepared by the British Geological Survey for the Health and Safety Executive 2008, British Geological Survey Research Report RR 605, 264pp.

- Evans, D.J., 2009. A review of underground fuel storage events and putting risk into perspective with other areas of the energy supply chain, in *Underground Gas Storage, Worldwide Experiences and Future Development in the UK and Europe*, The Geological Society, London, Special Publications, 313, pp.173–216.
- Evans, D.J., and R.A. Schultz, 2017. Analysis of occurrences at underground fuel storage facilities and assessment of the main mechanisms leading to loss of storage integrity, *American Rock Mechanics Association, ARMA*, 17-265, 27 pp.
- Faroon, O., N. Roney, J. Taylor, A. Ashizawa, M.H. Lumpkin, and D.J. Plewak, D.J., 2008. Acrolein health effects. *Toxicology and Industrial Health*. 24, 447-490. Accessed at: <https://www.ncbi.nlm.nih.gov/pubmed/19028774>
- FEMA (Federal Emergency Management Agency), 2010). “Developing and Maintaining Emergency Operations Plans, Comprehensive Preparedness Guide 101,” Version 2.0.
- FEMA (Federal Emergency Management Agency), 2011). National Flood Hazard Layer– Butte County. Published January 6, 2011. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06007C&state=CALIFORNIA&county=BUTTE%20COUNTY&fileName=06007C_20110106.zip.
- FEMA (Federal Emergency Management Agency), 2014. “Every Business Should have a Plan”
- FEMA (Federal Emergency Management Agency), 2015. National Flood Hazard Layer– Colusa County. Published August 4, 2015. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06011C&state=CALIFORNIA&county=COLUSA%20COUNTY&fileName=06011C_20150804.zip.
- FEMA (Federal Emergency Management Agency), 2016a. National Flood Hazard Layer– Fresno County. Published January 19, 2016. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06019C&state=CALIFORNIA&county=FRESNO%20COUNTY&fileName=06019C_20160119.zip.
- FEMA (Federal Emergency Management Agency), 2016b. National Flood Hazard Layer– Solano County. Published August 2, 2016. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06095C&state=CALIFORNIA&county=SOLANO%20COUNTY&fileName=06095C_20160802.zip.
- FEMA (Federal Emergency Management Agency), 2016c. National Flood Hazard Layer– Sacramento County. Published November 10, 2016. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06067C&state=CALIFORNIA&county=SACRAMENTO%20COUNTY&fileName=06067C_20161110.zip.
- FEMA (Federal Emergency Management Agency), 2016d. Very high fire hazard severity zones in LRA – Los Angeles County. November 1, 2016. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06037C&state=CALIFORNIA&county=LOS%20ANGELES%20COUNTY&fileName=06037C_20161101.zip.
- FEMA (Federal Emergency Management Agency), 2016e. National Flood Hazard Layer– Santa Barbara County. Published June 12, 2016. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06083C&state=CALIFORNIA&county=SANTA%20BARBARA%20COUNTY&fileName=06083C_20160612.zip.
- FEMA (Federal Emergency Management Agency), 2017a. National Flood Hazard Layer– Madera County. Published June 15, 2017. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06039C&state=CALIFORNIA&county=MADERA%20COUNTY&fileName=06039C_20170615.zip.
- FEMA (Federal Emergency Management Agency), 2017b. National Flood Hazard Layer– San Joaquin County. Published June 22, 2017. GIS file available at http://frap.fire.ca.gov/webdata/data/san_joaquin/fhszl06_1.39sn.zip.

- FEMA (Federal Emergency Management Agency), 2017c. National Flood Hazard Layer– Contra Costa County. Published July 6, 2017. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06013C&state=CALIFORNIA&county=CONTRA%20COSTA%20COUNTY&fileName=06013C_20170706.zip.
- FEMA (Federal Emergency Management Agency), 2017d. National Flood Hazard Layer– Yolo County. Published February 12, 2017. GIS file available at https://hazards.fema.gov/femaportal/NFHL/Download/ProductsDownloadServlet?DFIRMID=06113C&state=CALIFORNIA&county=YOLO%20COUNTY&fileName=06113C_20170212.zip.
- Field, E.H., et al., 2014. Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) – the time-independent model. *Bulletin of the Seismological Society of America*, 104, 1122-1180.
- Filippini, T., J.E. Heck, C. Malagoli, C. Del Giovane, and M. Vinceti, 2015. A Review and meta-analysis of outdoor air pollution and risk of childhood leukemia. *Journal of Environmental Science and Health. Part C, Environmental Carcinogenesis & Ecotoxicology Reviews*, 33(1), 36–66. <http://doi.org/10.1080/10590501.2015.1002999>.
- Fischer, M.L., S. Jeong, I. Faloon, and S. Mehrotra, 2017. Survey of Methane Emissions from the California Natural Gas System. California Energy Commission. Report # 500-2017-033. <http://www.energy.ca.gov/2017publications/CEC-500-2017-033/CEC-500-2017-033.pdf>
- Folga, S., E. Portante, S. Shamsuddin, A. Tompkins, L. Talaber, M. McLamore, J. Kavicky, G. Conzelmann, and T. Levin, 2016. “U.S. Natural Gas Storage Risk-Based Ranking Methodology and Results,” Report ANL-16/19, Argonne National Laboratory, 122pp.
- Forester, J., A. Kolaczowski, S. Cooper, D. Bley, and E. Lois, 2007. “ATHEANA User’s Guide,” Report NUREG-1880, U.S. Nuclear Regulatory Commission.
- Foxall, W., C. Doughty, K.J. Lee, S. Nakagawa, T. Daley, E. Burton, C. Layland-Bachmann, S. Borglin, K. Freeman, J. Ajo-Franklin, P. Jordan, T. Kneafsey, C. Oldenburg, and C. Ulrich, 2017. Investigation of Potential Induced Seismicity Related to Geologic Carbon Dioxide Sequestration in California, California Energy Commission Report CEC-500-2017-028, <http://www.energy.ca.gov/2017publications/CEC-500-2017-028/CEC-500-2017-028.pdf> (accessed 20 October 2017).
- Frank, M.V., 2008. *Choosing Safety: A Guide to Using Probabilistic Risk Assessment and Decision Analysis in Complex High-Consequence Systems*, RFF Press, Resources For the Future, Washington DC.
- Frankenberg, C., A.K. Thorpe, D.R. Thompson, G. Hulley, E.A. Kort, N. Vance, J. Borchardt, T. Krings, K. Gerilowski, C. Sweeney, and S. Conley, 2016. Airborne methane remote measurements reveal heavy-tail flux distribution in Four Corners region. *Proceedings of the National Academy of Sciences*, p.201605617.
- Garrick, J.B., 2009. *Quantifying and Controlling Catastrophic Risks*, Elsevier Publishers.
- Gasda, S.E., S. Bachu, and M.A. Celia, 2004. Spatial characterization of the location of potentially leaky wells penetrating a deep saline aquifer in a mature sedimentary basin. *Environmental Geology*, 46 (6-7), 707-720.
- Geosyntec, 2017. Wet Weather Surface Water Sampling Updated Report. Investigative Order R4-2016-0035. Regional Board Case No. 03700776 Geotracker Id T1000008175. Geosyntec Consultants, LLC. February 2017. Available at: https://geotracker.waterboards.ca.gov/view_documents_all?global_id=T1000008175&doc_id=5912143.
- Geotracker, 2017. California State Water Quality Control Board. Available at: https://geotracker.waterboards.ca.gov/profile_report?global_id=T1000008175. Accessed 10/30/2017
- Gertman, D., H. Blackman, J. Marble, J. Byers, and C. Smith, 2005. “SPAR-H Human Reliability Analysis Method.” U.S. Nuclear Regulatory Commission, Report NUREG/CR-6883.
- Griggs, G., J. Árvai, D. Cayan, R. DeConto, J. Fox, H.A. Fricker, R.E. Kopp, C. Tebaldi, and E.A. Whiteman, (California Ocean Protection Council Science Advisory Team Working Group), 2017. Rising Seas in California: An Update on Sea-Level Rise Science. California Ocean Science Trust, April 2017. (<http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>, accessed 12 October 2017).

- GWPC and IOGCC (Ground Water Protection Council and Interstate Oil and Gas Compact Commission), 2017. Underground gas storage regulatory considerations: A guide for state and federal regulatory agencies, States First Gas Storage Workgroup, 122pp.
- Hanna, S.R., M.J. Brown, F.E. Camelli, S.T. Chan, W.J. Coirier, S. Kim, O.R. Hansen, A.H. Huber, and R.M. Reynolds, 2006. Detailed simulations of atmospheric flow and dispersion in downtown Manhattan: An application of five computational fluid dynamics models. *Bulletin of the American Meteorological Society*, 87(12), 1713-1726.
- Harris, J., S. Ramamoorthy, R. Schultz, J. Shaw, R. Shlemon, and P. Somerville, 2017. Aliso Canyon Gas Storage Field Geologic, Seismologic, and Geomechanical Studies: Scope of Work. <http://www.conservation.ca.gov/dog/Documents/Aliso/Seismic%20Risk%20SOW%20%288-9-17%29.pdf> (accessed 12 October 2017).
- Harrison, S.S., 1985. Contamination of aquifers by overpressuring the annulus of oil and gas wells. *Groundwater*, 23 (3), 317-324.
- Hauser, R.L., and W.F. Guerard Jr., 1993. A history of oil-and gas-well blowouts in California, 1950–1990. Publication No. TR43. California Division of Oil, Gas, and Geothermal Resources.
- Hickman J., et al., 1983. “PRA Procedures Guide: A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants,” Report NUREG/CR-2300, American Nuclear Society, Institute of Electrical and Electronic Engineers, and U.S. Nuclear Regulatory Commission.
- Highfield, W.E., Norman, S.A., Brody, S.D. (2013). Examining the 100-year floodplain as a metric of risk, loss, and household adjustment. *risk analysis*, 33: 186-191.
- Hoffman, R.D., 1992. Structural geology of the Concord area, in Cherven, V.B., and W.F. Edmondson, eds., *The Structural Geology of the Sacramento Basin*. Annual Meeting, Pacific Section, American Association of Petroleum Geologists, Volume MP-41, pp. 79-90. <http://archives.datapages.com/data/pacific/data/088/088001/pdfs/79.pdf>
- Hong, Y.-C., 2013. Aging society and environmental health challenges. *Environ Health Perspect.*, 121, a68–a69. DOI: 10.1289/ehp.1206334
- Huftile, G.J., and R.S. Yeats, 1996. Deformation rates across the Placerita (Northridge Mw = 6.7 aftershock zone) and Hopper Canyon segments of the Western Transverse Ranges deformation belt. *Bulletin of the Seismological Society of America*, 86, S3-S18.
- Hurst, W., J.D. Clark, and E.B. Brauer, 1969. The skin effect in producing wells. *Journal of Petroleum Technology*, 21 (11), November 1969, 7pp.
- IAEA (International Atomic Energy Agency), 1992. *The Chernobyl Accident: Updating of INSAG-1*. Safety Series No. 75-INSAG-7. Vienna, Austria.
- IARC (International Agency for Research on Cancer), 2000. Diethanolamine. <https://monographs.iarc.fr/ENG/Monographs/vol101/mono101-004.pdf>
- ICRP (International Commission on Radiological Protection), 2007. The 2007 Recommendations of the ICRP. ICRP Publication 103, *Ann. ICRP* 37(2–4).
- IEAGHG (International Energy Agency Greenhouse Gas), 2006. R&D Programme. “Safe Storage of CO₂: Experiences Form the Natural Gas Storage Industry,” 2006/2, January 2006.
- INPO (Institute for Nuclear Power Operations), 2013. Traits of a Healthy Nuclear Safety Culture, Report INPO 12–012, Atlanta GA.
- Interagency Task Force on Natural Gas Storage Safety, 2016. Final Report of the Interagency Task Force on Natural Gas Storage Safety 83pp. Available at: <https://www.alisoupdates.com/1443739975368/ReliableUndergroundNaturalGasStorage.pdf>.
- IPCC (Intergovernmental Panel on Climate Change), 2005. Special Report on CO₂ Capture and Storage, Chap. 5, S.M. Benson and P.J. Cook (Eds.), (Bert Metz, Ogunlade Davidson, Heleen de Coninck, Manuela Loos and Leo Meyer (Eds.)), Cambridge University Press, UK. pp. 431.

- Jennings, C.W., and W.A. Bryant, 2010. Fault activity map of California: California Geological Survey Geologic Data Map No. 6, map scale 1:750,000. <http://maps.conservation.ca.gov/cgs/fam/>
- Jo, Y.D., and B.J. Ahn, 2002. Analysis of hazard areas associated with high-pressure natural-gas pipelines. *Journal of Loss Prevention in the Process Industries*, 15, 179-188.
- Jordan, P.D., and S.M. Benson, 2009. Well blowout rates and consequences in California Oil and Gas District 4 from 1991 to 2005: Implications for geological storage of carbon dioxide. *Environmental Geology*, 57: 1103-1123
- Jordan, P.D., and J.W. Carey, 2016. Steam blowouts in California Oil and Gas District 4: Comparison of the roles of initial defects versus well aging and implications for well blowouts in geologic carbon storage projects. *International Journal of Greenhouse Gas Control*, 51, 36-47.
- Kaplan, S., and B.J. Garrick, 1981. On the Quantitative Definition of Risk. *Journal of Risk Analysis*, 1, 11.
- Katz, D.L., and M.R. Tek, 1981. Overview of underground storage of natural gas, *Journal of Petroleum Technology*, 33, 943-951.
- Keller, E.A., and L.D. Gurrola, 2000. Earthquake Hazard of the Santa Barbara Fold Belt, California. Final Report, NEHRP Award #99HQGR0081, SCEC Award #572726, 78 pp.
- Khilyuk, L.F. et al., 2000. Gas migration events preceding earthquakes. Gulf Publishing, Houston, Texas.
- King, G.E., and D.E. King, 2013. Environmental risk arising from well-construction failure--differences between barrier and well failure, and estimates of failure frequency across common well types, locations, and well age. *SPE Production & Operations*, 28 (04), 323-344.
- Krautwurst, S., K. Gerilowski, H.H. Jonsson, D.R. Thompson, R.W. Kolyer, A.K. Thorpe, M. Horstjann, M. Eastwood, I. Leifer, S. Vigil, and T. Krings, 2017. Methane emissions from a Californian landfill, determined from airborne remote sensing and in-situ measurements. *Atmospheric Measurement Techniques Discussions*.
- LACDPH (Los Angeles County Department of Public Health), 2016a. Aliso Canyon Gas Leak: CASPER Initial Findings. April 8, 2016. Available at: <http://publichealth.lacounty.gov/media/docs/assessment.pdf/>
- LACDPH (Los Angeles County Department of Public Health), 2016b. Aliso Canyon Gas Leak: Public Health Assessment. Available at: <http://www.publichealth.lacounty.gov/media/docs/PublicHealthAssessment.pdf/>
- LACDPH (Los Angeles County Department of Public Health), 2016c. Aliso Canyon Gas Leak: Results of Air Monitoring and Assessments of Health. February 5, 2016. Available at: <http://www.publichealth.lacounty.gov/media/docs/AlisoAir.pdf>.
- LACDPH (Los Angeles County Department of Public Health), 2016d. Environmental Conditions and Health Concerns in Proximity to Aliso Canyon Following Permanent Closure of Well SS 25. May 13, 2016. Available at: <https://www.alisoupdates.com/1443739457814/PublicHealthAssessment.pdf>
- LACDPH (Los Angeles County Department of Public Health), 2016e. Aliso Canyon Gas Leak Community Assessment for Public Health Emergency Response (CASPER). May 13, 2016. Available at: <http://publichealth.lacounty.gov/media/docs/CASPERFinalReport.pdf>.
- Landrigan, P.J., C.A. Kimmel, A. Correa, and B. Eskenazi, 2004. Children's health and the environment: Public health issues and challenges for risk assessment. *Environ Health Perspect.*, 112, 257-265.
- Lisbona, D., A. McGillivray, J.L. Saw, S. Gant, M. Bilio, and M. Wardman, 2014. Risk assessment methodology for high-pressure pipelines incorporating topography. *Process Safety and Environmental Protection*, 92 (1), 27-35.
- Lung, R., and R.J. Weick, 1987. Exploratory trenching of the Santa Susana fault in Los Angeles and Ventura counties. In: *Recent Reverse Faulting in the Transverse Ranges, California*, USGS Professional Paper 1339, 65-70. <https://pubs.er.usgs.gov/publication/pp1339>
- Mahgerefteh, H., A. Oke, and O. Atti, 2006. Modelling outflow following rupture in pipeline networks. *Chemical Engineering Science*, 61 (6), 1811-1818

- McGillivray, A., J.L. Saw, D. Lisbona, M. Wardman, and M. Bilio, 2014. A risk assessment methodology for high pressure CO₂ pipelines using integral consequence modeling. *Process Safety and Environmental Protection*, 92 (1), 17-26.
- Mehrotra, S., I.C. Faloona, M. Suard, S. Conley, and M.L. Fischer, 2017. Airborne methane emission measurements for selected oil and gas facilities across California. *Environmental Science and Technology*. DOI: 10.1021/acs.est.7b03254.
- Meshkati, N., 1999. Cultural context of nuclear safety culture: A conceptual model and field study. In: *Nuclear Safety: A Human Factors Perspective* (J. Misumi, B. Wilpert, and R. Miller, eds.), Taylor and Francis, London, pp. 61-75.
- Meshkati, N., and Y. Khashe, 2015. Operators' improvisation in complex technological systems: Successfully tackling ambiguity, enhancing resiliency and the last resort to averting disaster. *Journal of Contingencies and Crisis Management (JCCM)*, 23 (2), 90-96.
- Michanowicz, D.R., J.J. Buonocore, S.T. Rowland, K.E. Konschnik, S.A. Goho, and A.S. Bernstein, 2017. A national assessment of underground natural gas storage: identifying wells with designs likely vulnerable to a single-point-of-failure. *Environmental Research Letters*.
- Miyazaki, B., 2009. Well integrity: An overlooked source of risk and liability for underground natural gas storage. Lessons learned from incidents in the USA. *Geological Society, London, Special Publications*, 313 (1), 163-172.
- Montiel, H., J.A. Vilchez, J. Arnaldos, and J. Casal, 1996. Historical analysis of accidents in the transportation of natural gas. *Journal of Hazardous Materials*, 51, 77-92.
- Mousa, H.L., 2015. Short-term effects of subchronic low-level hydrogen sulfide exposure on oil field workers. *Environ Health Prev Med.*, 20, 12-17. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4284242/pdf/12199_2014_Article_415.pdf.
- Myhre, et al., 2013. Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf
- NAS/TRB (National Academy of Sciences Transportation Research Board) (2017), "Designing Safety Regulations for High Hazard Industries," National Academies Press, Washington DC.
- National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011. "Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling, Report to the President."
- National Fuel Gas, 2016. National Fuel's gas storage operations celebrates 100th anniversary, <https://www.nationalfuelgas.com/EmployeeRetireePortal/docs/GasStorage100thAnniversary.pdf>, accessed July 10, 2017.
- National Institutes of Health, 2017. Toxicology Data Network Hazardous Substances Database – 1,3-Butadiene. <https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/r?dbs+hsdb:@term+@DOCNO+181>
- National Research Council, 1983. *Risk Assessment in the Federal Government: Managing the Process*. National Academy Press, Washington, DC.
- National Research Council, 1994. *Science and Judgement in Risk Assessment*. National Academy Press, Washington, DC.
- National Research Council, 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. National Academy Press, Washington, DC.
- National Research Council, 2009. *Science and Decisions: Advancing Risk Assessment*. National Academies Press, Washington, DC.
- National Research Council, 2011. *Macondo Well-Deepwater Horizon Blowout: Lessons for Offshore Drilling Safety*. National Academies Press, Washington DC.

- National Toxicology Program, 2016. Report on Carcinogens, Fourteenth Edition <https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>
- NCRP (National Council on Radiation Protection, 1999. "The Application of ALARA for Occupational Exposures," NCRP Position Statement No. 8, NCRP, Bethesda MD.
- New York Times, 2011. "Mismanagement Blamed for Bay Area Gas Disaster," by Matthew L. Wald, August 30, 2011.
- Nordella, Jeffrey, 2017. Presentation on October 14th, 2017. Accessed November 8th, 2017 at: http://docs.wixstatic.com/ugd/3d1481_e78b110e4a49487a9f1b100fd77503c6.pdf
- NTSB (National Transportation Safety Board), 2010. "Collision of Two Washington Metropolitan Area Transit Authority Metrorail Trains near Fort Totten Station, Washington, D.C. June 22, 2009," Railroad Accident Report NTSB/RAR-10/02.
- NTSB (National Transportation Safety Board), 2011. "Pipeline Accident Report, Pacific Gas and Electric Company Natural Gas Transmission Pipeline Rupture and Fire, San Bruno, California, Sept. 9, 2010," Report NTSB/PAR-11/01, PB2011-916501, Notation 8275C, August 30, 2011.
- Nuclear Energy Institute, 2009. Fostering a Strong Nuclear Safety Culture, Report NEI 09-07, Washington DC.
- Nuclear Energy Institute, 2014. "Lessons from the 1979 Accident at Three Mile Island," Washington DC.
- Nygaard, R., 2012. Geomechanical stimulation of CO₂ leakage and cap rock remediation. DE-F0001132, U.S. Dept. Energy, NETL, presented at Carbon Storage R&D Project Review Meeting, Developing the Technologies and Building the Infrastructure for CO₂ Storage, August 21-23, 2012.
- Oedewald, P., E. Pietikäinen, and T. Reiman, 2011. "A Guidebook for Evaluating Organizations in the Nuclear Industry: An Example of Safety Culture Evaluation." Report No. 2011:20, Swedish Radiation Safety Authority.
- OEHHA (Office of Environmental Health Hazard Assessment), 2014. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. Accessed on July 12, 2017. Available at: <https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary>.
- OEHHA (Office of Environmental Health Hazard Assessment), 2016. Aliso Canyon Underground Storage Field, Los Angeles County. May 11, 2016. Available at: <https://oehha.ca.gov/air/general-info/aliso-canyon-underground-storage-field-los-angeles-county>
- Oldenburg, C.M., and R.J. Budnitz, 2016. Low-Probability High-Consequence (LPHC) Failure Events in Geologic Carbon Sequestration Pipelines and Wells: Framework for LPHC Risk Assessment. Lawrence Berkeley National Laboratory Report LBNL-1006123.
- Oldenburg, C.M., S.L. Bryant, and J.-P. Nicot, 2009. Certification framework based on effective trapping for geologic carbon sequestration. *Int. J. Greenhouse Gas Control*, 3, 444–457. LBNL-1549E.
- Olson, D.J., 1982. Surface and subsurface geology of the Santa Barbara-Goleta metropolitan area, Santa Barbara County, California. Master's thesis, Oregon State University. 71 pp. <http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/41853/OlsonDanielJ1983.pdf?sequence=1>
- OSHA (Occupational Safety and Health Administration), 1992. *Process Safety Management of Highly Hazardous Chemicals standard* (29 CFR 1910.119). https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9760
- OSHA (Occupational Safety and Health Administration), 2016. Chemical Sampling Information: Butyl mercaptan. Available at: https://www.osha.gov/dts/chemicalsampling/data/CH_223600.html.
- Occupational Safety and Health Administration (OSHA), 2017a. Accessed September 26, 2017. General Safety and Health - Hydrogen Sulfide Gas. https://www.osha.gov/SLTC/etools/oilandgas/general_safety/h2s_monitoring.html
- OSHA, 2017b. Accessed September 26, 2017. Hydrogen Sulfide – Evaluating and Controlling Exposure. <https://www.osha.gov/SLTC/hydrogensulfide/exposure.html>

- OSHA, 2017c. Accessed October 22, 2017. Process Safety Management. <https://www.osha.gov/SLTC/processsafetymanagement/>
- OSHA, 2017d. Accessed October 22, 2017. California State Plan. <https://www.osha.gov/dcsp/osp/stateprogs/california.html>
- OSHA NIOSH Recommended Practices, Protecting Temporary Workers, 2014. DHHS (NIOSH) Publication Number 2014-139 OSHA - 3735-2014. <https://www.cdc.gov/niosh/docs/2014-139/pdfs/2014-139.pdf> accessed October 15, 2017
- Page, R.W., 1973. Base of fresh ground water (approximately 3,000 micromhos) in the San Joaquin Valley, California. United States Geological Survey Hydrologic Atlas 489. 1:500,000. Available at <https://pubs.er.usgs.gov/publication/ha489>.
- Pan, L., C.M. Oldenburg, B.M. Freifeld, and P.D. Jordan, 2018. Modeling the Aliso Canyon underground gas storage well blowout and kill operations using the coupled well-reservoir simulator T2Well. *J. Petrol. Sci. and Eng. Vol. 161*, 158-174.
- Parsons, T., J. McCarthy, P.E. Hart, J.A. Hole, J. Childs, D.H. Oppenheimer, and M.L. Zoback, 2002. A review of faults and crustal structure in the San Francisco Bay Area as revealed by seismic studies: 1991-97. In Parsons, T., ed., *Crustal Structure of the Coastal and Marine San Francisco Bay Region*. USGS Professional Paper 1658. <http://geopubs.wr.usgs.gov/prof-paper/pp1658/ch8.pdf>
- PEHSU (Pediatric Environmental Health Specialty Units), 2016. The Aliso Canyon Gas Leak Public Health Roles and Responses. PowerPoint Presentation. Available at: [http://www.pehsu.net/Library/PEHSU Webinars/Rangun Case Conference 032316 - FINAL.pdf](http://www.pehsu.net/Library/PEHSU%20Webinars/Rangun%20Case%20Conference%20032316%20FINAL.pdf).
- Perrow, C., 1984. *Normal Accidents: Living with High Risk Technologies*, Princeton University Press.
- Petrowiki, 2017. Definition of formation damage and skin, <http://petrowiki.org/Formationdamage> (accessed October 9, 2017).
- PHMSA (Pipeline and Hazardous Materials Safety Administration), 2016. Administrator Marie Therese Dominguez, written statement before the U.S. House of Representatives, February 25, 2016.
- Rasmussen, J., 1997. Risk management in a dynamic society: A modelling problem. *Safety Science*, 27 (2), 183-213.
- Reason, J., 1990. *Human Error*, Cambridge University Press.
- Reason, J., 1998. *Managing the Risks of Organizational Accidents*, Ashgate Publishing.
- Reason, J., 2016. *Organizational Accidents Revisited*. Ashgate Publishing.
- Risher, J.F., G.D. Todd, D. Meyer, and C.L. Zunker, 2010. The elderly as a sensitive population in environmental exposures: Making the case. In: Whitacre, D.M. (ed), *Reviews of Environmental Contamination and Toxicology*, 207. Springer New York, pp. 95–157.
- Rojstaczer, S.A., R.E. Hamon, S.J. Deverel, and C.A. Massey, 1991. *Evaluation of Selected Data to Assess the Causes of Subsidence in the Sacramento-San Joaquin Delta, California*. U.S. Geological Survey, no. 91-193; For sale by the Books and Open-File Reports Section [distributor].
- Rausand, M. and A. Hoylan, 2004. *System Reliability Theory: Models, Statistical Methods, and Applications*. Wiley Publishing, second edition
- Santa Barbara County Planning and Development Department, 2013. Final environmental impact report: Southern California Gas Company, La Goleta storage field enhancement project. State Clearinghouse No. 2010021069. [http://www.sbcountyplanning.org/energy/documents/projects/SoCalGas/SoCal Gas 2013 FEIR with Cover.pdf](http://www.sbcountyplanning.org/energy/documents/projects/SoCalGas/SoCal%20Gas%202013%20FEIR%20with%20Cover.pdf)
- SCAQMD (South Coast Air Quality Management District), 2013. Oil and Gas Well Electronic Notification and Reporting – Rule 1148.2. Available at: <http://www.aqmd.gov/home/regulations/compliance/1148-2>

- SCAQMD (South Coast Air Quality Management District), 2014. Supplemental Instructions: Reporting Procedures for AB2588 Facilities Reporting their Quadrennial Air Toxics Emissions Inventory – Annual Emissions Reporting Program. http://www.aqmd.gov/docs/default-source/planning/risk-assessment/quadrennial_atir_procedure.pdf?sfvrsn=2
- SCAQMD (South Coast Air Quality Management District), 2015. Multiple Air Toxics Exposure Study in the South Coast Air Basin Available at: <http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/mates-iv-final-draft-report-4-1-15.pdf?sfvrsn=7>
- SCAQMD (South Coast Air Quality Management District), 2017a. Triggered Sample Data. Accessed on July 11, 2017. Available at: <http://srvwww.aqmd.gov/home/regulations/compliance/aliso-canyon-update/air-sampling/air-monitoring-activities/grab-sample-data>
- SCAQMD (South Coast Air Quality Management District), 2017b. Emission Inventory Facility Search Tool. <http://www3.aqmd.gov/webappl/aersearch/search.aspx>, accessed 2017.
- Schultz, R.A., C. Chabannes, and D. Vereide, 2017. An Asset Integrity Management System for Underground Natural Gas Storage in Solution-Mined Salt Caverns. SMRI Spring 2017 Technical Conference, 23-26 April, 2017, Albuquerque, New Mexico.
- SFPE (Society of Fire Protection Engineers), 2008. Handbook of Fire Protection Engineering, chapter Fire Hazard Calculations for Large, Open Hydrocarbon Fires, National Fire Protection Association, Quincy, Massachusetts, fourth edition.
- Sklavounos, S., and F. Rigas, 2006. Estimation of safety distances in the vicinity of fuel gas pipelines. *J. of Loss Prevention in the Process Industries*, 19, 24-31.
- Sly, J.L., and D.O. Carpenter, 2012. Special vulnerability of children to environmental exposures. *Reviews on Environmental Health*, 27, 151–157. DOI: 10.1515/reveh-2012-0024
- Smit, B., J.A. Reimer, C.M. Oldenburg, and I.C. Bourg, 2014. *Introduction to Carbon Capture and Sequestration* (Vol. 1). World Scientific.
- SoCalGas (Southern California Gas Company), 2015. Aliso Canyon Emergency Action and Fire Prevention Plan, V 3.2. http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/News_Room/News_and_Updates/AlisoCanyonEmergencyActionandFire%20PreventionPlan_2.pdf
- SoCalGas (Southern California Gas Company), 2016a. Aliso Canyon Air Sample Results. Available at: <https://www.socalgas.com/newsroom/aliso-canyon-updates/aliso-canyon-air-sample-results>.
- SoCalGas (Southern California Gas Company), 2016b. Supplement to SoCalGas' Storage Risk Management Plan #2, August 2016.
- SoCalGas (Southern California Gas Company), 2017a. History of SoCalGas, <https://www.socalgas.com/company-history>.
- SoCalGas (Southern California Gas Company), 2017b. Appeal- Complaint for Declaratory and Injunctive Relief – United States District Court Central District of California, Case 2:17-cv-05140. <https://www.courthousenews.com/wp-content/uploads/2017/07/Pipeline-Complaint.pdf>
- Sperber, W.H., 2001. Hazard identification: From a quantitative to a qualitative approach. *Food Control*, 12, 223-228.
- Stringfellow, W.T., M.K. Camarillo, J.K. Domen, and S.B.C. Shonkoff, 2017. Comparison of chemical-use between hydraulic fracturing, acidizing, and routine oil and gas development. *PLoS ONE*, 12 (4): e0175344. Available at: <https://doi.org/10.1371/journal.pone.0175344>
- Sugiyama, G., and J. Nasstrom, 2015. Lawrence Livermore National Laboratory, National Atmospheric Release Advisory Center, NARAC Fact Sheet, Report LLNL-BR-650024 Revision 1.
- Sutton, G.D., and L.D. Roberts, 1974. Paraffin precipitation during fracture stimulation. *Journal of Petroleum Technology*, 26 (9). 997-1004.

- Tabibzadeh, M., and N. Meshkati, 2014. A risk analysis study to systematically address the critical role of human and organizational factors in negative pressure test for the offshore drilling industry: policy recommendations for HSE specialists. In SPE International Conference on Health, Safety, and Environment. Society of Petroleum Engineers.
- Tabibzadeh, M., S. Stavros, M.S. Ashtekar, and M. Meshkati, (in press). A Systematic framework for root-cause analysis of the Aliso Canyon Gas Leak Using the AcciMap Methodology: Implication for Underground Gas Storage Facilities. *Journal of Sustainable Energy Engineering*.
- Thio, H.K., P.G. Somerville, and J. Polet, 2010. Probabilistic Tsunami Hazard in California. University of California, Berkeley, Pacific Earthquake Engineering Research Center, PEER Report 2010/108.
- Thompson, D.R., I. Leifer, H. Bovensmann, M. Eastwood, M. Fladeland, C. Frankenberg, K. Gerilowski, R.O. Green, S. Kratwurst, T. Krings, and B. Luna, 2015. Real-time remote detection and measurement for airborne imaging spectroscopy: a case study with methane. *Atmospheric Measurement Techniques*, 8 (10), 4383-4397.
- Thompson, D.R., A.K. Thorpe, C. Frankenberg, R.O. Green, R. Duren, L. Guanter, A. Hollstein, E. Middleton, L. Ong, and S. Ungar, 2016. Space-based remote imaging spectroscopy of the Aliso Canyon CH₄ superemitter. *Geophysical Research Letters*, 43 (12), 6571-6578.
- Thorpe, A.K., C. Frankenberg, A.D. Aubrey, D.A. Roberts, A.A. Nottrott, T.A. Rahn, J.A. Sauer, M.K. Dubey, K.R. Costigan, C. Arata, and A.M. Steffke, 2016. Mapping methane concentrations from a controlled release experiment using the next generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG). *Remote Sensing of Environment*, 179, 104-115.
- Tomastik, T.E., and J.D. Arthur, 2016. An evaluation of well construction/drilling/conversion methodologies associated with gas storage depleted field operations in the United States, Presented at the Ground Water Protection Council 2016 Annual Meeting, September 11-14, 2016, Orlando, Florida.
- Tureyen, O.I., H. Karaalioglu, and A. Satman, 2000. Effects of the wellbore conditions on the performance of underground gas storage reservoirs. *SPE*, 59737, April 2000, pp.1-12.
- UK HSE (United Kingdom Health and Safety Executive), 1974. Health and Safety at Work Act.
- UK HSE (United Kingdom Health and Safety Executive), 2009. A Guide to Safety and Health Regulation in Great Britain, 4th edition.
- Unruh, J., and S. Sundermann, 2006. Digital Compilation of Thrust and Reverse Fault Data for the Northern California Map Database. Collaborative Research with William Lettis & Associates, Inc., and the U.S. Geological Survey. Final technical report for USGS National Earthquake Hazards Reduction Program Award 05HQGR0054. 20 pp.
- U.S. BSEE (United States Bureau of Safety and Environmental Enforcement), 2013. Department of Interior, Final Safety Culture Policy Statement, *Federal Register*, Vol. 78, No. 91, May 10, 2013, pp. 27419-27421.
- U.S. Census Bureau, 2011. 2010 Census summary file 1. Demographic data files. http://www2.census.gov/census_2010/04-Summary_File_1/. Accessed 23 Apr 2015
- U.S. EIA (United States Energy Information Administration), 2016. Natural gas annual respondent query system, 191 field level storage data (annual). Release date September 2016. Available from https://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP7&f_sortby=ACI&f_items=&f_year_start=2005&f_year_end=2015&f_show_compil=Name&f_fullscreen=
- U.S. EIA (United States Energy Information Administration), 2017. California Natural Gas Storage. Web. 02 June, 2017. <https://www.eia.gov/dnav/ng/hist/n3060ca2m.htm>.
- U.S. EPA (United States Environmental Protection Agency), 2000. Acetaldehyde Hazard Summary. <https://www.epa.gov/sites/production/files/2016-09/documents/acetaldehyde.pdf>
- U.S. EPA (United States Environmental Protection Agency), 1986. Guidelines for the Health Risk Assessment of Chemical Mixtures. Washington, DC. 38 pp. Available at: https://www.epa.gov/sites/production/files/2014-11/documents/chem_mix_1986.pdf.

- U.S. EPA (United States Environmental Protection Agency), 2012. Geologic Sequestration of Carbon Dioxide Underground Injection Control (UIC) Program Class VI Well Project Plan Development Guidance, Office of Water (4606M), EPA 816-R-11-017, August 2012 (see <https://www.epa.gov/uic/final-class-vi-guidance-documents>)
- U.S. EPA (United States Environmental Protection Agency), 2015. Glossary of Health, Exposure, and Risk Assessment Terms and Definitions of Acronyms. Available at <https://www.epa.gov/haps/health-effects-notebook-glossary>
- U.S. EPA (United States Environmental Protection Agency), 2016a. Carbon Monoxide (CO) Pollution in Outdoor Air. <https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#Effects>
- U.S. EPA (Environmental Protection Agency), 2016b. Ethylene dibromide Hazard Summary. <https://www.epa.gov/sites/production/files/2016-09/documents/ethylene-dibromide.pdf>
- U.S. EPA (Environmental Protection Agency), 2016c. 1,1,2,2-Tetrachloroethane Hazard Summary. <https://www.epa.gov/sites/production/files/2016-09/documents/1-1-2-2-tetrachloroethane.pdf>
- U.S. EPA (Environmental Protection Agency), 2016d. Trichloroethylene Hazard Summary. <https://www.epa.gov/sites/production/files/2016-09/documents/trichloroethylene.pdf>
- U.S. EPA (Environmental Protection Agency), 2016e. 1,3-Butadiene Hazard Summary. <https://www.epa.gov/sites/production/files/2016-08/documents/13-butadiene.pdf>
- U.S. EPA (United States Environmental Protection Agency), 2017a. Criteria Air Pollutants. <https://www.epa.gov/criteria-air-pollutants>
- U.S. EPA (Environmental Protection Agency), 2017b. Risk-Screening Environmental Indicators (RSEI) Model – RSEI Toxicity Data and Calculations. <https://www.epa.gov/rsei/rsei-toxicity-data-and-calculations>.
- USGS (United States Geological Survey), 2014. Landslide types and processes, Fact Sheet, <https://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf> (accessed 7/17/17).
- USGS and CGS (United States Geological Survey and California Geological Survey), 2006. Quaternary fault and fold database for the United States. <http://earthquake.usgs.gov/hazards/qfaults/>
- U.S. NRC (United States Nuclear Regulatory Commission), 1979. TMI-2 Lessons Learned Task Force Final Report,” Report NUREG-0585.
- U.S. NRC (United States Nuclear Regulatory Commission), 1980. Special TMI Inquiry Group, Three Mile Island: A Report to the NRC and to the Public, in four volumes, M. Rogovin, Director (R.J. Budnitz, Technical Coordinator), U.S. Nuclear Regulatory Commission.
- U.S. NRC (United States Nuclear Regulatory Commission), 2009. Internal Safety Culture Task Force: Final Report, April 2009.
- U.S. NRC (United States Nuclear Regulatory Commission), 2011. Safety Culture Policy Statement. Report NUREG/BR-0500.
- U.S. NRC (United States Nuclear Regulatory Commission), 2017a. Title 10 Code of Federal Regulations, Section 20.1003, “Standards for Protection Against Radiation: Definitions.”
- U.S. NRC (United States Nuclear Regulatory Commission), 2017b. Licensee event report system, Code of Federal Regulations 10 CFR 50.73.
- van Vliet, A.A.C., L. Gooijer, and G.M.H. Laheij, 2011. On-site natural gas piping Scenarios and failure frequency, National Institute for Health and the Environment, RIVM Report 620550004.
- Varnes, D.J. 1978. Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides— Analysis and control: National Research Council, Washington, D.C., Transportation Research Board, Special Report 176, p. 11–33.

- Vendrig, M., J. Spouge, A. Bird, J. Daycock, and O. Johnsen, 2003. Risk analysis of the geological sequestration of carbon dioxide, in Crown, ed., Volume R246 DTI/Pub URN 03/1320 Department of Trade and Industry's Cleaner Coal Technology Transfer Programme.
- Vesely, W.E., F.F. Goldberg, N.H. Roberts, and D.F. Haasl, 1981. Fault tree handbook (No. NUREG-0492). Washington DC: U.S. Nuclear Regulatory Commission.
- Watson, T.L., and S. Bachu, 2007. Evaluation of the potential for gas and CO₂ leakage along wellbores. In: SPE Paper 106817, E&P Environmental and Safety Conference, Galveston, Texas, 5–7 March 2007.
- Webb, E., J. Hays, L. Dyrszka, et al., 2016. Potential hazards of air pollutant emissions from unconventional oil and natural gas operations on the respiratory health of children and infants. *Reviews on Environmental Health*. doi: 10.1515/reveh-2014-0070
- Wills, C.J., F.G. Perez, and C.I. Gutierrez, 2011. Susceptibility to deep-seated landslides in California, Sacramento, CA. Department of Conservation, California Geological Survey. GIS file available at <ftp://ftp.consrv.ca.gov/pub/dmg/rgmp/MS58/MS58Geology.gdb.zip>.
- Yeats, R.S., 2001. Neogene tectonics of the east Ventura and San Fernando basins, California: An overview. In T.L. Wright and R.S. Yeats eds., *Geology and Tectonics of the San Fernando Valley and East Ventura Basin, California*. Pacific Section American Association of Petroleum Geologists, Guidebook 77, 9-36.
- Zhou, Y., S. Zhang, Z. Li, J. Zhu, Y. Bi, Y. Bai, et al., 2014. Maternal benzene exposure during pregnancy and risk of childhood acute lymphoblastic leukemia: A meta-analysis of epidemiologic studies. *PLoS ONE*, 9 (10): e110466. <https://doi.org/10.1371/journal.pone.0110466>