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**Research
Report
2017-2**



**SMRI Research Report RR2017-2:
Past Salt Caverns Incidents Database
Part 1: Leakage, Overfilling and Blow-out**

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2. SUMMARIES AND GENERAL INFORMATION ON THE INCIDENTS

The following table presents the general information on each incident, as well as a brief summary of the event and its consequences. The events are then described in the next section, which should be considered as the reference description:

General information					Incident information			
Country (,State)	Location	Facility	Operator at the time of the incident	Product	Date (1 st noticed)	Case	Brief summary of the event (cf. report for details)	Description of consequences when available (fatalities / injuries, cost, environment)
USA, Louisiana	West Hackberry	SPR	SPR	Oil	Sept. 21, 1978	Blow-out	Packer upwards slip during a workover operation. Oil blow out and fire.	Fire, 1 dead. c. 72,000 bbls (11 500 m ³) crude oil released. 14 – 20 M\$ total cost estimate.
Germany	Teutschenthal / Bad Lauchstädt			Town gas	Nov. 1984	Blow-out	Leakage during an operation to recover a logging tool stuck in a wellhead.	18 M Nm ³ (0.6 bcf) city gas release to the atmosphere.
Canada, Alberta	Fort-Saskatchewan		BP	Ethane	August 26, 2001	Blow-out	Ethane leak developed in a surface pipe linking the two wellheads of a double well cavern.	14,500 m ³ of ethane was lost over 8 days. No injury was reported.
USA, Texas	Moss Bluff	Moss Bluff Hub Partners	Spectra Energy	Natural gas	August 2004	Blow-out	Fracture of a corroded above-ground brine outlet pipe upon gas arrival during debrining. Gas escaped and led to a fire and explosion. The wellhead was then further damaged as a result of intense heat.	~360 evacuated, ~170 Mcm (6 Bcf) of natural gas released and burned. Fire allowed to self-extinguish by burning off the remaining gas.
Canada, Saskatchewan	Prud'homme		SaskEnergy /TransGas	Natural gas	October 11, 2014	Blow-out	A failure in the steel casing, located about 2 m (6 ft) below ground, allowed natural gas to leak into an external concrete casing protecting the pipe, where it moved up and released through a valve on the side of the cavern wellhead. The force of the high pressure natural gas release damaged the wellhead building, causing a spark and the resulting fire. The gas blow-out and fire lasted 9 days.	No one was hurt in the incident, and no service was lost to any residential, business or industrial customer.
USA, Oklahoma	Elk city	Yelton LPG	Shell Oil Company	LPG (mostly propane)	February 23, 1973	Leakage	Likely to be an LPG leakage through the well casing, migration through a porous formation and blow-out (without ignition)	LPG release to the atmosphere without igniting. No dead or injured. 30 ton boulders lifted,

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)			2300 ft (700 m) away.	trees tilted 45°.
USA, Kansas	Conway, McPherson County	Indeterminate		LPG	1980 (1 st major report), 1966 - 2000 in total	Leakage	LPG or NGLs were found in private wells and groundwater, which implies leakage(s) out of one or several underground storage(s) and subsurface migration. The precise origin is unclear in a region experiencing a dense cavern storage activity.	30 homes bought out and c. 120 people relocated 1980-81.
USA, Kansas	Yoder, Reno County	Indeterminate		Propane	June 30 1980	Leakage and blowout	Similar to the Conway case. Origin unclear. Propane release to the atmosphere suggesting propane leakage(s) from one or several underground storage(s) and subsurface migration.	Leakage to the atmosphere, including propane, groundwater and sand blowout.
USA, Texas	Mont Belvieu / Barber's Hill	Warren Petroleum Company Terminal		LPG	Sept 17 th , 1980	Leakage	LPG Leakage from a well and migration through pervious layers. It notably accumulated in the foundation of a house and ignited as a result of a spark from an electrical appliance.	Approx. 50 families evacuated. Holes drilled into the water tables above salt to find and vent the gas.
Germany	Teutschenthal / Bad Lauchstädt			Ethylene	March 29, 1988	Leakage	Leakage from a failed threaded connection of the last cemented casing, accumulation led to a complete rupture of casing, lateral migration in permeable layers and vertical migration along a fault zone up to the surface.	60 % to 80 % of the cavern inventory was released. A rural area of approx. 8 km ² (3 square miles) was evacuated.
USA, Texas	Clute	Clute LPG	South Texas Pipeline Company	Ethylene	1989	Leakage	Casing failures attributed to movements in the salt formation led to ethylene leakage at 1300 ft (396 m) depth and accumulation under the caprock of the salt dome.	\$6 million of ethylene (7 million gallons - 27 000 m ³) lost between December 1988 & March 1989. Collected beneath caprock of the salt dome.
Canada, Saskatchewan	Regina South		TransGas Ltd.	Natural gas	1989	Leakage	Gas leakage from two caverns to the overlying non-salt layers following large roof collapses.	Inventory loss. No environmental impact was reported. Cavern was operated at lower pressure after the

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USA, Louisiana	Clovelly Dome - LOOP	Clovelly storage facility	LOOP	brine	1992	Leakage	The analysis of a long duration pressure test concluded that a brine leakage was occurring through a sandstone layer, from the storage cavern to the exterior of the salt dome.	No environmental impact was reported.
USA, Texas	Mineola	Mineola Storage Terminal	Suburban Propane	Propane	1995	Leakage	Casing breach and propane leakage to the soil, groundwater and atmosphere as far as 30 m (100 ft) around the well.	Product release to the groundwater and atmosphere.
USA, Kansas	Hutchinson	"Yaggy"		Natural gas	January 17, 2001	Leakage	A natural gas leakage pathway progressively developed from a breach in the cemented casing, damaged during the re-drilling operation of this formerly plugged and abandoned cavern converted to gas storage. Up to 8 miles (12 km) gas lateral migration through a thin permeable layer lead to geyser gas releases, some of them ignited. A vertical migration along an abandoned well notably led to an explosion under a mobile home.	2 dead, 1 injured and 250 people evacuated.
USA, Texas	Spindletop	Gladys city	Centana Intrastate Pipeline LLC (Duke)/ Texas Brine	Natural gas	December 19, 2001	Leakage	Leakage from a gas cavern to an adjacent brine cavern. It is unknown whether the gas migrated through an induced fracture, a fault plane or a seam of porous and permeable salt intersecting both caverns at an unknown altitude.	~40 MMscf (1 million Nm ³), 1 % of the gas cavern inventory, were recovered in the brine cavern, and then flared.
USA, Louisiana	Grand Bayou, Napoleonville	Magnolia	Gulf South Pipeline Co.	Natural gas	December 24 th , 2003	Leakage	Gas leakage from the casing of one (and possibly two) cavern wells. Leaks identified through cracks near the couplings, potentially attributed to	Gas found boiling at surface above 2 storage caverns. Evacuation of 30 people for 50 days. No fire or explosion.

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							improper back welding.	
USA, Texas	Boling salt dome, Wharton County		Enterprise Products Operating LLC (Enterprise)	Natural Gas	2005	Leakage	Pressure monitoring and temperature logs indicated a probable leak in the vicinity of the cavern roof. Openings due to tensile failures (fracture of the pipe body, of the threaded coupling and thread jump out) were found in the lowest portion of the cased well, due to salt dragging the casing to the cavern.	No environmental impact was reported.
USA, Mississippi	Eminence salt dome, Covington County (Hattiesburg)		Transcontinental Gas Pipe Line Corporation	Natural gas	December 26, 2010	Leakage	A 357 psi (25 bar) pressure drop in one minute was observed on a cavern due to a shallow failure of the well completion, leading to water / gas geysers releases to the atmosphere, and affecting the integrity of the neighboring caverns. Some of the damages were attributed to operational practices that contributed to excessive salt movements causing stress and failure of well completions.	Two dozen families evacuated for 12 days. Monitoring and gas extraction wells were drilled. ~34 mcm (1.20 bcf) of gas had been vented, 54.9 mcm (1.94 bcf) flared, and 36 mcm (1.27 bcf) produced from the caprock and surrounding water zones. 4 caverns were taken out of service, and the 3 remaining ones of the field had their operation range restricted.
Germany	Epe		SGW	Crude oil	2014	Leakage	Crude oil leakage through a partly failed screwed connection of the well casing at 217 m (712 ft) depth. The oil then migrated controlled by the structural geology and reached the surface.	Oil spill at the surface. A family was displaced for a few days.
USA, Texas	Brenham			LPG	April 7, 1992	Overfilling and blow-out	An overfilling occurred during LPG injection, resulting in LPG release in the brine pond and the development of a gas cloud that ignited when an auto entered it.	Severe magnitude 3.5 to 4 explosion. 3 dead, 23 injured, 50 evacuated, 26 homes destroyed within 1.5 miles (2 km) of the explosion, damage to further 33 homes.

3. TECHNICAL SUMMARIES OF HISTORICAL INCIDENTS

The technical summaries of the incident cases are presented in the following, sorted per type of event and in chronological order.

BLOWOUT

- 1. West-Hackberry, Louisiana, USA, 1978, Oil**
- 2. Teutschenthal/Bad Lauchstädt, Germany, 1984, Town gas**
- 3. Fort-Saskatchewan, Alberta, Canada, 2001, Ethane**
- 4. Moss Bluff, Texas, USA, 2004, Natural Gas**
- 5. Prud'homme, Saskatchewan, Canada, 2014, Natural Gas**

LEAKAGE

- 6. Elk City, Oklahoma, USA, 1973, Natural gas**
- 7. Conway, Kansas, USA, 1956-2000, Natural gas**
- 8. Yoder, Reno County, Kansas, USA, 1980, Propane**
- 9. Mont Belvieu, Texas, USA, 1980, Ethane and propane**
- 10. Teutschenthal, Germany, 1988, Ethylene**
- 11. Clute, Texas, USA, 1988, Ethylene**
- 12. Regina South, Canada, 1989 and 1993, Natural gas**
- 13. Clovelly Salt Dome, Louisiana, USA, 1992, Brine leakage (from an oil storage)**
- 14. Mineola, Texas, USA, 1995, Propane**
- 15. Hutchinson, Kansas, USA, 2001, Natural gas**
- 16. Spindletop, Texas, USA, 2001, Natural gas**
- 17. Grand Bayou / Napoleonville, Louisiana, USA, 2003, Natural gas**
- 18. Boling Salt Dome, USA, 2005, Natural gas**
- 19. Eminence, Mississippi, USA, 2010, Natural gas**
- 20. Epe, Germany, 2014, Oil**

OVERFILLING

- 21. Brenham, Texas, USA, 1992, Propane**