Lessons Learned Database
Individual Incident Summary Report

IChemE
Safety & Loss Prevention
Special Interest Group

Incident Title	**Gasoline Storage Tank Overfilled**	
Incident Type	Explosion and Fire	
Date	23rd October 2009	
Country	Puerto Rico	
Location	Bayamón	
Fatalities	**Injuries**	**Cost**
0	3 (offsite)	Unknown

Incident Description

Credit: US Chemical Safety Board

An above-ground storage tank overfilled with gasoline (petrol) during a night-time unloading operation from a ship berthed 3 km (2 miles) away. Nearly 790 m^3 (5,000 bbl) of gasoline overflowed into a secondary containment bund. The resulting large vapour-mist cloud found an ignition source in the nearby wastewater treatment plant, leading to a vapour cloud explosion (deflagration). The resulting fire caused multiple secondary explosions, destroying 17 of the 48 tanks on site and damaging neighbouring businesses and homes. The fire burned for ~ 66 hours and significant environmental damage was inflicted by petroleum product and firewater/foam runoff. The operating company filed for bankruptcy in August 2010.

Incident Analysis

Basic cause was incorrect estimation of tank fill-time due to failure of the automatic tank gauging system.

Critical factors included: 1) The volume of the ship's gasoline cargo exceeded the capacity of any single available tank (requiring filling of multiple tanks), 2) Tank farm operators had to estimate tank fill times based on hourly level checks (using unreliable float and tape gauges) and adjust flow rate by manually adjusting tank fill valves, 3) The tanks had no independent high level alarm instrumentation, 4) The tank bund drain valves had inadvertently been left open (reported closed in valve inspection log), 5) The site topography allowed gasoline leaking from the bund drain to flow to the wastewater treatment plant area (which contained electrical equipment not rated for flammable atmospheres), 6) The tank farm lighting was inadequate (operators were unable to see the liquid overflow and resulting vapour cloud).

Root causes included: 1) Inadequate design (absence of independent high level alarms and automatic overfill protection system to stop product transfer) and use of inconsistent bund drain valve types (fixed stem and rising stem) making visual determination of valve position difficult, 2) Inadequate tank monitoring and control (manual operation), 3) Inadequate preventative maintenance (level sensors, transmitters and automatic tank gauging system), 4) Inadequate tank fill procedure, 5) Inadequate hazard awareness (failure to learn from similar incidents), 6) Inadequate emergency response planning (training, resources, mutual aid cover), 7) Inadequate emergency response capability (insufficient equipment to deal with multi-tank fire).

Lessons Learned

1) Safety integrity level (SIL) reviews should be conducted on all gasoline tanks in liquid fuel storage terminals to check if automatic overfill protection systems (fully independent of their tank gauging systems) are required.
2) Risk assessments should consider potential worst-case scenarios involving multiple tank/bund fires with large volumes of firewater run-off and review lessons learned from other liquid fuel storage terminal major incidents.
3) Severe vapour cloud explosions can occur in open areas in calm wind conditions; this may be the dominant risk for liquid fuel storage terminals.

More Information

1) "Caribbean Petroleum Tank Terminal Explosion and Multiple Tank Fires", US Chemical Safety and Hazard Investigation Board (CSB), Report No. 2010.02.I.PR (2015).
2) "Safety and Environmental Standards for Fuel Storage Sites", Process Safety Leadership Group, HSE Books, 2009, ISBN 978-0-7176-6386-6.
3) "Managing Risk: The Hazards That Can Destroy Your Business", COMAH Strategic Forum, 2017.

Industry Sector	Process Type	Incident Type
Oil & Gas	Oil Storage	Explosion & Fire
Equipment Category	**Equipment Class**	**Equipment Type**
Safety & Control	Instruments	Level

Peter Marsh
Director – XBP Refining Consultants Ltd.