Lessons Learned Database
Individual Incident Summary Report

IChemE
Safety & Loss Prevention
Special Interest Group

Incident Title	**Reactor Inventory Release Via Settling Leg**	
Incident Type	Explosion and Fire	
Date	23rd October 1989	
Country	USA	
Location	Pasadena, TX	
Fatalities	**Injuries**	**Cost**
23	314	US$ 1.8 bn (2021) – Ref. 3

Incident Description

Credit: AP/Shutterstock/E. Kolenovsky

A reactor in a slurry phase catalytic loop process for manufacturing high density polyethylene (HDPE) had been taken off-line to enable removal of blockages from 3 of 6 product settling legs at the bottom of the reactor by specialist maintenance contractors. (As the polymerisation-condensation reactions proceed, HDPE particles drop out of the circulating reaction mixture and flow through the settling legs to a product flash tank.) Each settling leg had an 8" NS (DN 200) air-actuated ball valve at the top of the leg to isolate it from the loop reactor. The settling leg isolation procedure required the valve to be closed and its actuator air hoses to be disconnected. The day before the incident, the first leg was cleared without problems but the following day, a blockage in the partially dismantled second leg cleared suddenly and dumped almost the entire 40 tonne (88,000 lb) reactor inventory to atmosphere in seconds. A huge vapour cloud formed which was ignited by an unidentified source and exploded. More explosions followed later when a polyethylene reactor and 2 isobutane storage spheres failed catastrophically.

Incident Analysis

Basic cause was loss of containment of highly flammable reactor inventory via an open ball valve in a partially dismantled reactor settling leg.

Critical factors included: 1) Air hoses had not been removed from the ball valve actuator (contrary to maintenance procedure) and had been incorrectly fitted (cross-connected in the reverse position), 2) Absence of fixed gas detection equipment (early warning of emergency situation), 3) Damage to firewater supply system (impeded emergency response), 4) Close proximity of process equipment and control room (exacerbated severity).

Root causes included: 1) Inadequate isolation (no lockout device in place on ball valve actuator), 2) Inadequate design (actuator had interchangeable air hose connections and firewater system was part of process water system rather than a dedicated system), 3) Inappropriate plant layout (control room too close to plant), 4) Inadequate risk assessment (potential for reverse operation of ball valve not recognised), 5) Inadequate control of work (permit to work system not enforced), 6) Inadequate process safety management system (local maintenance procedures deviated from corporate procedures and standard industry practice which required double valve isolation or a blind flange insert for breaking containment), 7) Normalisation of deviance (failure to enforce procedures), 8) Inadequate training (maintenance contractors), 9) Inadequate inspection, maintenance and testing (standby firewater pumps), 10) Inadequate emergency response planning (escape routes too close to plant).

Lessons Learned

1) Worst case scenarios should be considered and escalation impact studies should be carried out to inform plant design (e.g. plant layout, equipment spacing) and emergency response planning strategies,
2) Safeguards on live plant should not be removed for any reason except for maintenance and testing, regardless of how inconvenient this might be.

More Information

1) “Phillips Petroleum Chemical Plant and Fire”, US Fire Administration, Report No. USFA-TR-035 (1989).
2) “Explosion at the Phillips’ Houston Chemical Complex, Pasadena, 23 October 1989”, Dr. J. Bond, IChemE Loss Prevention Bulletin 097 (1991).
3) “100 Largest Losses in the Hydrocarbon Industry”, Marsh Property Risk Consulting Practice, 27th Edition (2022).

Industry Sector	Process Type	Incident Type
Petrochemicals	Polyethylene (HDPE)	Explosion & Fire
Equipment Category	**Equipment Class**	**Equipment Type**
Mechanical	Valves - Actuated	Ball Valve

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