



Intentionally Staged BLEVE as a Threat to Critical Infrastructure

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Motivation

- There have been several attempts around the world to intentionally stage a BLEVE for the purposes of terrorism.
- The questions for emergency professionals are:
 - Can this be done?
 - What will happen?
 - What can we do to stop or mitigate the consequences?

BLEVE

- Boiling liquid expanding vapour explosion
- The explosive release of expanding vapour and flashing liquid resulting from the total loss of containment of a pressure liquefied gas (PLG).
- Hazards usually associated with a BLEVE
 - Overpressure and blast wind
 - Projectiles
 - Possible toxic release
 - Possible fireball, flash fire or vapour cloud explosion (VCE)



PLG

- Pressure liquefied gas
 - A substance that is contained at ambient temperature as a liquid under pressure, in equilibrium with its vapour.
 - Liquid is stored at a temperature well above its atmospheric pressure boiling point.
 - If containment is suddenly lost then the liquid is superheated and will spontaneously and rapidly change phase.
- Examples, Propane, LPG, Anhydrous Ammonia, Chlorine, ...

Total Loss of Containment

- When the containment vessel fails catastrophically to allow full and sudden expansion of the contents into the atmosphere.
- The pressure on the contents of the vessel is suddenly reduced sending the liquid deep into a state of superheat.

Liquid Superheat

- When a liquid is superheated, part of it will change phase to vapour to re-establish equilibrium.
- A large degree of superheat can result in a very rapid and powerful change in phase from liquid to vapour, which usually involves a very large increase in volume.



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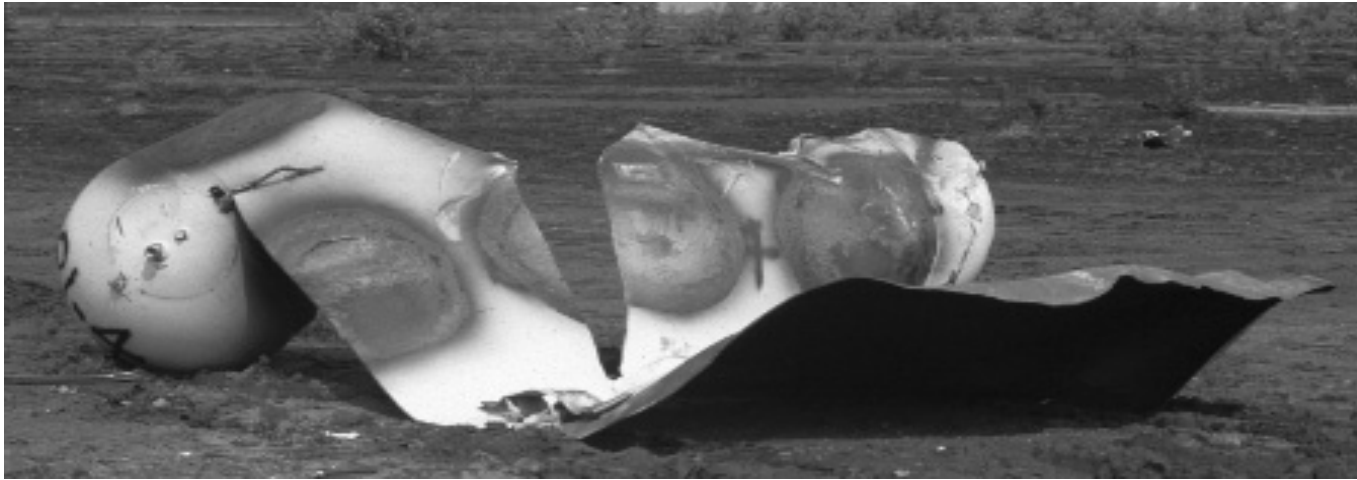
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BLEVE Mechanisms

- Something weakens the vessel causing it to fail catastrophically.
 - Fire heating
 - Corrosion
 - Overpressure
 - Overfill
 - Reaction
 - No pressure relief
 - Manufacturing flaws
 - Poor welds
 - Poor steel
 - Defects, cracks
 - Impact (collision, explosion)
 - Or combination of the above.

BLEVE Hazards

- Blast overpressure
 - Projectiles
 - Toxic cloud
 - Fireball, flash fire, VCE
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- We will consider flammable materials in this presentation

BLEVE Hazards

- Consider 45 m³ LPG tank truck
- Propane mass = 16000 kg
- Fireball Diameter 150 m, t = 11 sec (zone of severe destruction)
- 35 kW/m² out to R = 140 m (clothing will burn, buildings will burn, high probability of fatality)
- 99% of projectiles fall within 1000 m
- BLEVE blast 7 kPa at 185 m (windows shattered)
- 10% VCE 7 kPa out to 420 m

Staged BLEVE/VCE

- Could a BLEVE be staged?
 - We have done it many times
 - With fire, explosive devices, mechanical weakening.
- Could a BLEVE/VCE be staged?
 - Fuel-Air Explosives (FAE) are an example.
 - Not so easy with LPG or propane.

FAE

- **fuel-air explosive** - a device consisting of a container of fuel and two explosive charges; the first charge bursts open the fuel container at a predetermined height and spreads the fuel in a cloud that mixes with atmospheric oxygen; the second charge detonates the cloud which creates an enormous blast wave and incinerates whatever is below (From FARLEX Free Dictionary)

Staged BLEVE

- There are numerous examples in the news about terrorist attempts involving propane tanks of various sizes (Sacramento California 1999, Glasgow Airport 2007, Times Square NY, 2010, ...)
- So far they have not been very successful.
- Will the perpetrators figure out how to do it?

Propane/LPG Scenario

- propane and LPG are widely available in our society
- Little or no security/tracking in place
- Highway tank truck, stationary storage tanks, cylinders can easily be stolen and hidden.

Precautions

- Can we take precautions?
 - GPS tracking of tank trucks
 - Remote disabling of vehicle if necessary
 - No trucks/vans indoors or near critical infrastructure
 - Search/scan vehicles entering specified areas
 - No parking of trucks, vans near CI
 - Thermal imaging to detect heated or modified tanks
- Is this practical – how can we protect against every possible vessel?

USA Homeland Security

- Hazmat Transport Security Plan
- Required on specified materials and quantities
- Eg. Class 2.1 flammable gases -- Propane and lpg
 - $V > 3000$ litres (793 gal)
 - Called “ a large quantity”.
- Plan must include measures to manage
 - Personnel security
 - Unauthorized access
 - En-route security

Singapore

- Since 2004 – Hazmat Transport Vehicle Tracking System (HTVTS)
- Installed on trailers, bulk tanks, ISO containers, tube trailers, trucks with bulk tanks, and others
- Able to track and remotely immobilize vehicles by Singapore Civil Defense Force

Singapore

- Effective at detecting vehicles not conforming to regulations
 - Vehicles not staying on authorized routes
 - Vehicles not keeping to speed limits
- No terrorist attacks to date

Emergency Response

- Mitigation
 - Active ... water curtain, mist
 - Passive ...
- What can emergency responders do
 - Evacuation – is there time?
 - ???

Conclusion

- Tank trucks or stationary storage tanks could be used as threat against critical infrastructure.
- Several attempts have been made but with little or no success.
- It is a matter of time before there is a staged BLEVE/VCE.
- Will we wait for them to be successful before we take this threat seriously?

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END

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