

When Isolations go WRONG

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Case 1: North West Aerosols

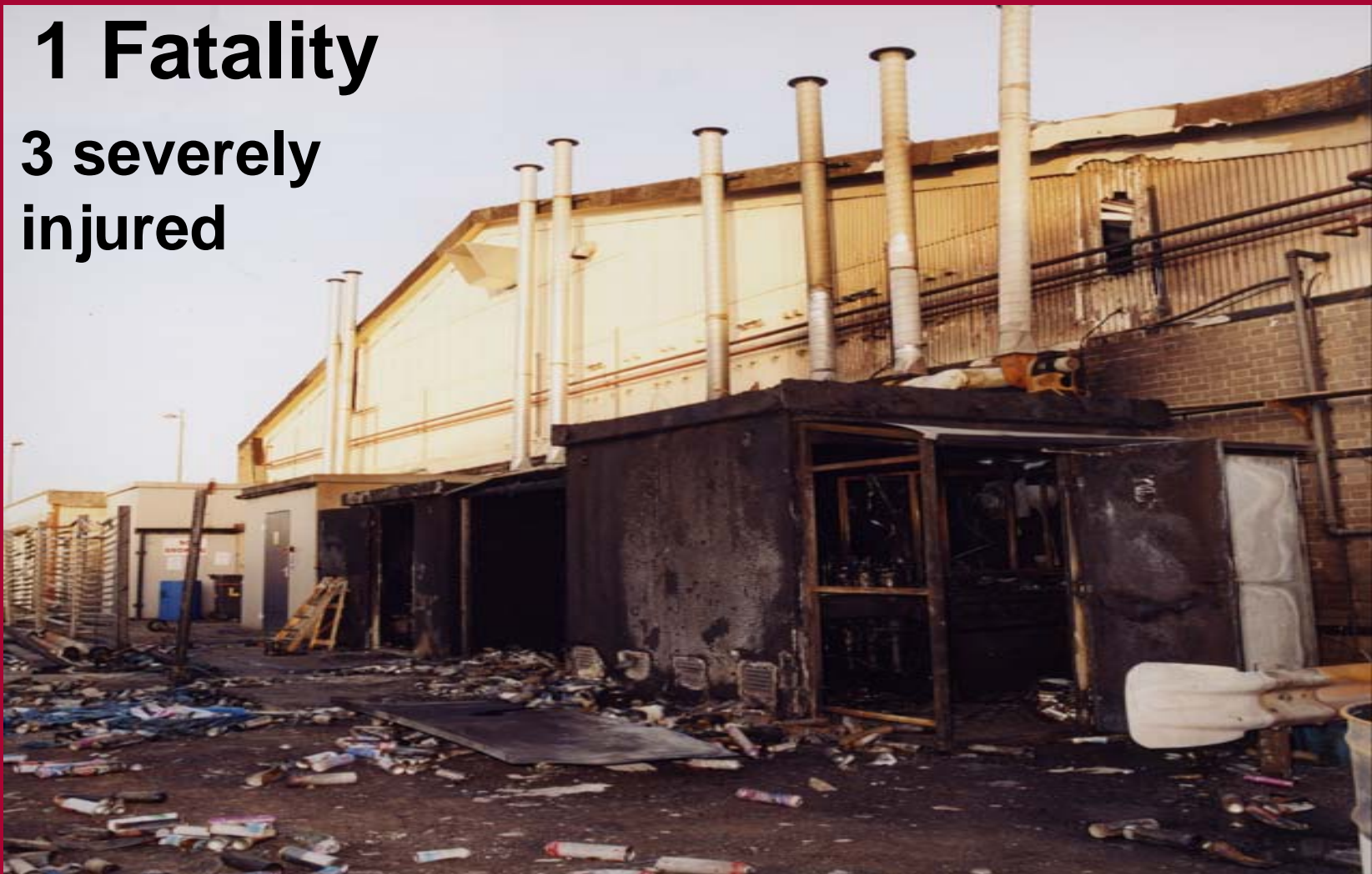
13th December 2005 –

Fire at North West Aerosols Ltd, Liverpool



1 Fatality

**3 severely
injured**



The site had 5 x 9000 litre LPG bullets feeding any 1 of 4 gas houses used to fill aerosols with LPG propellant



The ISOLATION

- Gas house 1 had been isolated from the LPG supply to use compressed air for filling aerosols
- The LPG manifold connections used to supply LPG to the filling lines were only isolated by a pneumatically operated control valve
- The only other valve on the line was a manually operated ball valve that had been left open
- The LPG supply manifold pipe work had not been blanked off as per BAMA recommendations (self seal, quick release couplings) representing good practice

Unblanked LPG Supply Manifold



On the day of the fire, 4 employees were trying to start the LPG supply to the filling lines



They did this by:

- Overriding the safety interlocks on the control panel to access internal wiring
- Tripping control circuits at their own discretion
- They shorted and activated the pneumatic valve on the LPG supply line thereby supplying LPG at 250 kg/hr to gas house 1 via the two unblanked manifold ports.
- The LPG entered the plant, found an ignition source, ignited and caused a flash fire that then spread throughout most of the plant.

Internal Plant Fire Damage



Causes

- MAH's are prevented by layers of protection - Some were in place but others were not:
- Gas detection was thought to be non-functional
- Control valves were defeated - (HS(G) 253 recommends that control valves are not generally suitable for isolations)
- No end caps on manifold
- Manually operated valve left open
- Line change-over procedures were not followed
- No specific isolation procedure

CONSEQUENCES



- The fire destroyed two of four gas houses associated with their aerosol filling lines
- The factory production area was also fire damaged
- 1 FATALITY
- 3 other employees severely injured
- **It is thought the external location of the gas house prevented further fatalities**

Further CONSEQUENCES



- North West Aerosols ceased trading
- Criminal Prosecution returned 'Guilty Verdict'
- Crown Court made financial checks and imposed a nominal penalty
- Judge indicated a £250,000 fine for the company had it still been trading
- Loss of Reputation
- Civil Litigation

Legal Aspects

- The Health and Safety at Work etc Act 1974 Section 2 (1) says:

"It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees."
- Section (2) (a) says:

"The provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe without risks to health"

Legal Aspects

- Section 2 (2) (c) says:
The provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees."
- Northwest Aerosols went into voluntary liquidation in November 2006. It was considered the circumstances of the incident were so serious that it was important to proceed with the prosecution to place on record and give a broader warning to the chemical industry.

Case 2: Methanol LoC 20 - 35te

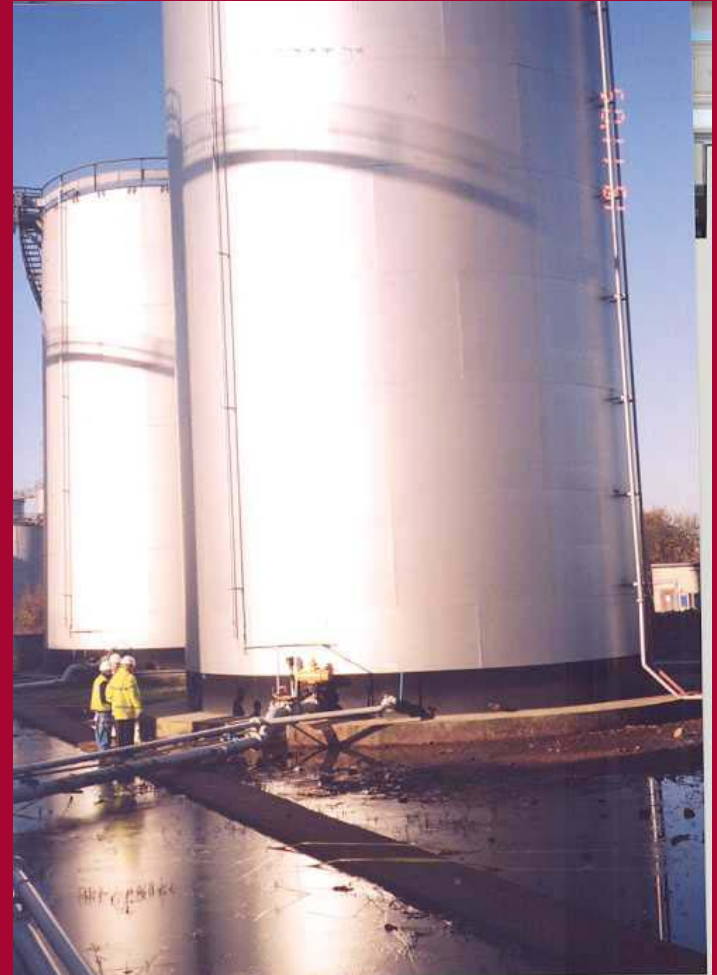
- Loss of Containment of 20 to 35 te of Methanol when filling tank - ship to shore
- This incident had the potential to be a COMAH major accident
- 1/2" drain valve had been left open and unplugged after maintenance work to fit a ROSOV and new valve on a thermal relief line

Open 1/2 " Drain Valve



Methanol Storage Tank

The site failed to identify that the methanol was pouring into the bund for approximately 25 hours



Causes

- Human error, inadequate management systems and inadequate safe system of work
- Work authorisation was poorly completed, with no details of valves to be replaced, tank isolations, reference to drawings P&ID's
- Method statement for work raised without training - It did not identify the isolation of valves or checks to return the system to a safe condition
- The completed permit was not signed off as being completed. Despite the permit remaining open for work to be carried out on the tank, the site permitted the filling of the tank from the ship

Case 3: Chlorine Gas LoC Overview



- Chlorine gas was introduced into a plant during a routine short duration plant shutdown
- The chlorine entered ducting and entered the workshop via a fan housing
- This resulted in a chlorine release into the workshop
- The chlorine gas also reacted with hydrocarbon contamination within the ducting that resulted in a local fire
- The level of gas present adjacent to the housing was thought to be substantial enough to cause **fatal injury** to any unprotected individual.

The Process

- Gaseous Chlorine was introduced into the plant via a manually operated isolation valve, a power operated shutoff ball valve (for isolation) and a diaphragm valve (used for flow control)
- Ferric Chloride was pumped to a steel dissolver
- From there the pickle liquor was recycled to 2 towers

The Incident in Detail

- Chlorine gas supply was not isolated effectively
- The power operated shutoff valve used to isolate the chlorine gas was passing and the manually operated isolation valve was left open
- Chlorine gas entered the towers main extraction system, built up and migrated to the adjoining extraction system of the steel dissolver vessel because the tower extract system wasn't running
- The Chlorine gas (heavier than air) flowed down the dissolver extract duct (only intended for hydrogen and air) and collected at the fan housing at ground level

The Incident

- The gas vented into the plant from the fan housing

ALSO

- The gas exothermically reacted with hydrocarbon deposits in the ducting causing a small fire
- Estimated LoC was 50kg/hr Chlorine Gas over a 21 minute period

Fan Housing





Causes



- The manually operated isolation valve should have been closed
- The power operated shutoff valve was confirmed faulty after the incident and was passing
- Vent system had only been designed for hydrogen and air

Causes (cont.)



- Failure to comply with standard operating procedures (SOPs)
- The SOP did not detail clearly that the manually operated isolation valve should be shut when the plant is stopped
- Wrong PPE used when investigating LoC

Case 4: Ammonia LoC

- This incident related to a failure to isolate redundant pipework
- The incident started with a pipe blockage resulting in a loss of additive to a crude liquor system
- A hot water line was connected to back-flush the system
- As the hot water was turned on a jet of ammonia liquor hit the operator in the face from a redundant rotometer when the gauge glass failed from thermal shock





Causes

- The rotometer had been redundant for over 6 years but the unit and redundant pipework had not been effectively isolated or removed
- The rotometer was not designed to withstand hot product / water
- MoC relating to a modification had not considered this scenario
- Redundant pipework was capable of reconnection
- Inadequate PPE (no safety goggles)

Case 5

- JCB involved in an excavation in close proximity to a buried electricity cable
- Cable was thought to be redundant (not spiked) and it was not known what it had serviced
- Cable confirmed dead at 8am in the morning before commencement of work but not isolated
- The JCB bucket hit the cable at 5pm when it was automatically switched live at 240V
- The reason – it was a supply for site lighting automatically energised after dark
- Luckily, no one was hurt in this incident

Case 6 – Refinery Fire

- Ice ruptured unused pipe in refinery and caused fire
- A section of piping was taken out of service during a process modification
- The pipe was not physically removed

OR

- Isolated from the pipework using spades
- It was isolated by closed isolation valves

Case 6 – Refinery Fire

- The active piping contained liquid propane at high pressure
- The propane contained a small amount of water entrained as a separate water phase
- Debris jammed in the seat of one of the isolation valves and stopped the valve closing
- Wet propane then leaked into the unused piping

Case 6 – Refinery Fire

- The water (heavier than propane) accumulated in a low point in the unused pipework
- During the winter this water froze
- It expanded and cracked the pipe
- When the warmer weather came, the ice melted and propane leaked past the isolation valve and out of the pipework via the crack

What happened next?

- A large flammable vapour cloud formed, found an ignition source and ignited







Consequences

- Four persons injured
- Refinery was evacuated
- Refinery shut for 2 months
- Major fire damage to that plant
- Major fire damage to other plant releasing other flammable materials
- 2 te of chlorine was also released to atmosphere from fire damaged containers

Their recommendations

- Make sure all process modifications including removal of piping from service undergo a MoC review
- Make sure all equipment in your plant is either physically disconnected from active equipment and piping
- OR
- By using spades or other reliable isolation methods

In Summary

- Consider potential hazards of accumulation of material in pipe branches that are not routinely used or that have low-flow rates
- Be prepared for cold weather in winter
- Make sure procedures are followed in preparation for, and during cold weather spells to prevent freezing of critical Plant & Equipment

Accident Triangle



The greater the incidents in the bottom half of the triangle the greater the likelihood of an accident in the top half of the triangle, e.g. Injury or Death

Some Potential Consequences



- Damage to buildings & plant
- Plant Shutdown / Loss of revenue
- Redundancies
- Business ceases trading
- **Injuries and Deaths**
- Prosecution & fines
- Contamination of the environment
- Loss of reputation

Ask Yourself?

- Have you appropriate isolation procedures that fully address all activities
- Are your procedures reviewed and updated periodically?
- Have you adequate supporting documentation? P&ID's, GA's or piping isometric drawings, valve line ups, isolation certificates, etc?

Ask Yourself?

- Have you trained and competent persons that perform and supervise isolations?
- Are roles and responsibilities defined and recorded?
- Do you have effective communication at all levels and particularly at shift handovers?
- Do you audit and review isolations to ensure standards are achieved and maintained?

AND

- Have you isolation KPI's?

Thank You

Any Questions?

