Buncefield – A Legacy of Lessons for Process Safety Management

On 11 December 2005, a series of explosions and subsequent fires devastated the Buncefield oil storage depot and was the biggest peacetime explosion in the UK. The incident was caused by the overfilling of Tank 912, leading to the formation of a massive vapour cloud which ignited and lead to another 20 tanks being severely damaged. There were also a total of 43 people injured, and two hospitalised but fortunately there were no deaths. While the immediate technical causes involved equipment failure, the investigation revealed failures in leadership, safety management systems, and the understanding of major accident hazards.

20 years on from that explosion, this paper summarises the critical lessons for modern process safety professionals and what has changed since the event.

The Failure of Primary Containment
The loss of containment was precipitated by the failure of two distinct layers of protection:

- **Automatic Tank Gauging (ATG):** The servo-gauge on Tank 912 stuck intermittently 14 times in the three months leading up to the incident. Despite this known unreliability, it was not logged as a defect, and control room staff relied on it to manage tank filling.
- **Independent High-Level Switch (IHLS):** The ultimate high-level switch failed to operate because a test lever had been left in an inoperable position. Crucially, a padlock designed to secure the lever in the active position was missing because contractors and site staff misunderstood its safety-critical function, believing it was merely for security.

Lesson: Redundancy is useless if common cause failures (e.g. lack of maintenance culture) affect all layers. Safety-critical equipment must be understood by those who install, test, and operate it.

The Explosion Mechanism
The severity of the explosion surprised experts. Investigations revealed that the vapour cloud covered approximately 120,000 m^3.

- **Congestion and Detonation:** While the site appeared relatively clear, trees and undergrowth along adjacent lanes provided sufficient congestion to accelerate the flame front from a deflagration to a detonation.

Lesson: Congestion is not just pipework, plant and machinery; environmental features (vegetation) can significantly alter blast overpressures. Risk assessments must consider the surrounding terrain.

Secondary and Tertiary Containment
The environmental impact was exacerbated by the failure of bunds (secondary containment) and drains (tertiary containment).

- **Bund Failure:** Bunds leaked fuel and firewater because joints lacked water stops and were not fire-resistant. Tie-bar holes from construction had not been properly sealed.

Lesson: Bunds are safety-critical equipment. They must be impermeable and fire-resistant, not just treated as civil engineering structures.

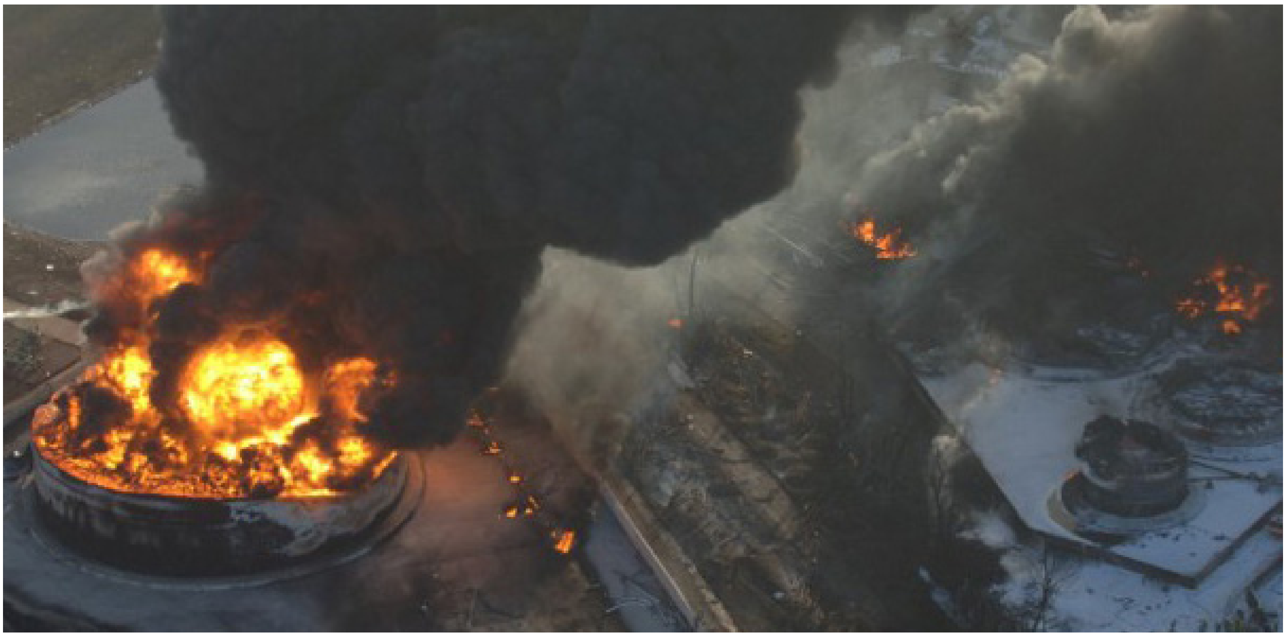
Leadership and Management Systems
The deepest root causes lay in management failures:

- **Normalisation of Deviance:** Staff tolerated unreliable equipment and worked excessive hours. A "can-do" culture prioritized keeping the process running over process safety.
- **Lack of Leading Indicators:** Management focused on personal safety (slips, trips, falls) rather than process safety indicators. There needed to be a "critical parts list" and better tracking of near-misses.
- **The "Intelligent Customer":** The operator failed to act as an intelligent customer regarding contractors, assuming expertise rather than verifying it.

Broad improvements have been introduced within the petroleum storage sector and across other major hazard industries. The role industry took in leading improved process safety has changed dramatically and seen an improved working partnership between industry, regulator and trade unions which has resulted in a more collaborative approach to continuous improvement.

What has changed?
Industry led the response to the incident, by introducing a higher standard of storage control and protection for those sites where these measures are appropriate, with the benefit of experience from the Buncefield incident. In addressing the Major Incident Investigation Board's (MIIB) recommendations, the first step was to share existing good practice for safe management of the risks associated with storing petrol.

- Improved inspection and maintenance guidelines were published in the Process Safety Leadership Guidance report.



- As a result automated systems have now become common-place for preventing over-filling of large petrol storage tanks.
- Systems to contain both product (petrol and diesel) and fire-fighting material (foam, fire water) have been reviewed as well as on-site and off-site emergency plans, and improvements implemented where necessary.
- Local and national mutual aid schemes have also been developed to ensure that sufficient fire-fighting equipment and foam is readily available in case of emergency.

Industry, regulators and unions developed the Principles of Process Safety Leadership which are applicable to all major hazard businesses and have been widely adopted.

Conclusion: The Principles of Process Safety Leadership

Buncefield highlighted deficiencies which resulted in appropriate enforcement by the regulators and led to the establishment of the Process Safety Leadership Group (PSLG) Principles. Those principles, apply to many industries who carry out similarly potentially hazardous activities and emphasise that process safety requires board-level competence and active engagement. As we move forward, the sector must guard against "corporate memory loss" and the normalisation of deviance to prevent recurrence. Our commitment to the Principles of Process Safety Leadership can be found here.

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