

The Buncefield Major Incident

11 December 2005

Ten years on

A report by the COMAH Strategic Forum



Foreword

“How industry responds to incidents such as Buncefield and how the regulators respond on behalf of the public is a measure of our society. A decisive and dynamic response with all parties co-operating is the product of a democratic and advanced society.”

Buncefield Standard Task Group, 24th July 2007

Buncefield was a profound shock. No one expected that the overflowing of a storage tank containing petrol could lead to the largest explosion in Europe since the Second World War. The subsequent investigations led to significant changes in the way refineries, oil storage depots and chemical plants operate. The changes were not just technical. High standards of leadership were seen as essential to ensure effective control of major hazard risks. A set of core principles were established by the Process Safety Leadership Group, which went on to define the organisation and resources required to translate them into practice.

All this was achieved by regulators and industry working together. We have learnt that better outcomes and more effective management of major hazard risks comes from pooling experiences and insights.

Ten years on from Buncefield is an appropriate time to reflect on what has been delivered, what we have learnt and what more is there still to do.

Delivery is an essential part of building trust upon which this approach depends. Critically, success requires us to ‘say what we will do’ and ‘do what we say’. Part of the challenge is to translate “good” practice into “common” practice and there is much in this report that has relevance to other industries and beyond national boundaries.

The consequences of getting it wrong are becoming more severe – indeed major hazard incidents are often becoming “enterprise ending events”.

Please read this report, reflect on the learning and, if relevant to your workplace, identify how risks could be managed more effectively.

Ken Rivers, Chair of the COMAH Strategic Forum



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1. Executive Summary

The Buncefield explosion and fire was a landmark event and a powerful catalyst for change. One of the important outcomes of the various investigations and reviews carried out following the incident was that it brought about a closer more collaborative way of working between the regulator, industry and trades unions. The reports and recommendations from this work initiated many changes aimed at ensuring the circumstances leading to the Buncefield incident should not happen again.

There have been substantial improvements to prevention and control equipment as well as, importantly, to the leadership and management focus necessary for effective process safety control. This report outlines the achievements in these areas as well as the work that is ongoing.

The timetable for improvement plans was agreed between the COMAH Competent Authority¹ (CA) and operators of relevant fuel storage terminals and the CA has subsequently carried out inspection visits, where necessary, to check on progress.

Many of the principles and measures developed in response to the Buncefield incident are also applicable to COMAH establishments in other sectors. The CA designated a series of strategic topics for inspection that are directly relevant to many of the recommendations made following the investigation into Buncefield. The CA continues to provide ongoing regulatory scrutiny by carrying out inspection work against these topics and works together with the industry to seek continuous improvement in the wider management of major accident hazards.

¹ The COMAH Competent Authority (CA) is responsible for enforcement of the Control of Major Accident Hazards Regulations 2015. The regulations cover major accident risks to people and the environment. The CA for an establishment is HSE or the Office of Nuclear Regulation (ONR) for nuclear establishments, working jointly with the appropriate environment agency. In England the CA is HSE or ONR and the Environment Agency; in Scotland it is HSE or ONR and the Scottish Environment Protection Agency; and in Wales it is HSE or ONR and the Natural Resources Body for Wales.

2. The Buncefield Explosion and Fire

Early on Sunday 11 December 2005 a petrol storage tank was being filled from a pipeline at a supply terminal in Hemel Hempstead. The tank had safety systems fitted to prevent overfilling but they failed to operate and the tank overfilled. Petrol began to spill from the vents on the tank roof and formed a cloud of flammable vapour that was ignited by a spark causing a series of large explosions and subsequent fires.

It took about thirty-two hours to extinguish the main blaze and much longer to extinguish all other fires at the Buncefield site. Forty-three people received minor injuries. Extensive damage was caused to surrounding commercial and domestic properties, and local environmental pollution occurred from the use of fire-fighting foam and the loss of petrol and diesel from the storage tanks. The widespread damage to the site also resulted in temporary disruption of fuel supplies in the South East of England.



Aerial view of the Buncefield terminal before the incident (© Chiltern Air Support)



Aerial view of the Buncefield terminal after the incident (© Chiltern Air Support)

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The subsequent legal actions saw five companies prosecuted, with total fines in excess of £4M. The cost of investigating the incident and implementing the lessons learned run into many millions of pounds.

Details on the outcome of the trial can be found at <http://www.hse.gov.uk/news/buncefield/>.

More information on the Buncefield incident can be found in the HSE publication *Buncefield: Why did it happen?* Available here: <http://www.hse.gov.uk/comah/buncefield/buncefield-report.pdf>.

3. The Investigation and Reports

Major failures had led to the explosions at Buncefield and it was important to ensure that the causes were clearly identified and changes implemented as quickly as possible to prevent a similar incident occurring in the future.

3.1. Major Incident Investigation Board (MIIB) Report

An MIIB was formed to investigate the incident. It subsequently issued a number of recommendations for industry, regulators and the emergency services. Many of the recommendations related to the safety and environmental standards for fuel storage terminals and these are discussed in more detail in the following sections.

However the MIIB also identified other areas for improvement, including emergency response on which it produced a report *Emergency preparedness for, response to and recovery from incidents*. This report made a series of recommendations regarding emergency planning and how industry and regulators work with the emergency services and other organisations as part of the wider civil response arrangements. The CA working with industry, emergency planners and other external organisations, developed guidance in response to these recommendations, which is available here: [CA guidance on emergency planning arrangements for COMAH establishments](#). The CA also designated emergency response arrangements as a priority topic for inspection and developed further guidance to assist its inspectors in ensuring all COMAH businesses meet the requirements.

3.2. Process Safety Leadership Group (PSLG) Report

Through a new and collaborative approach industry, regulators from the CA and trade unions joined together and established first the Buncefield Standards Task Group (BSTG) and then the Process Safety Leadership Group (PSLG)² to address specific topics related to the MIIB recommendations. In 2009 the PSLG published a comprehensive response in the report *Safety and Environmental Standards for Fuel Storage Sites*.

More information on the MIIB's recommendations and the PSLG's response can be found at - www.hse.gov.uk/Comah/buncefield/response.htm.

Key improvements required by PSLG included:

- A review of the risks associated with filling large petrol storage tanks;
- Ensuring large petrol storage tanks do not lose containment;
- Ensuring effective leadership and an understanding of the risks associated with the management of sites that store petrol; and
- A review of how emergency services and industry respond to major incidents.

As a result of the PSLG's report, wide ranging improvements were introduced within the fuels storage industry and across other major hazard sites. Industry has adopted a closer working relationship with regulators and trade unions, which has resulted in a more collaborative approach to continuous improvement. These advances are described in more detail below.

² PSLG was chaired by a senior member of industry and comprised senior representatives from the United Kingdom Petroleum Industry Association (UKPIA), the Tank Storage Association, the United Kingdom Onshore Pipeline Operators' Association, the Chemical Industries Association, the Trades Union Congress, the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency.

4. Progress against the PSLG recommendations

The main purpose of the PSLG report was to specify the minimum standards that should be in place at all sites that store large volumes of petrol within 'in-scope' tanks³.

The report sets out the minimum standard of control that should be in place at fuel storage terminals like Buncefield, as well as good practice guidance on any additional measures necessary to further contain the fuel should a spillage or leakage occur.

The PSLG steering group provided leadership and support to expert working groups to develop guidance addressing each of the MIIB recommendations also incorporating recommendations and guidance from the earlier Buncefield Standards Task Group. Their report is set out in six parts and a further eight appendices providing additional detailed guidance.

Following publication of the PSLG report, operators of the 50 establishments with 'in-scope' tanks completed an analysis of their plant and operations against the guidance contained in the report. They provided their findings to the CA to reach agreement on action plans for any upgrades or changes that needed to be put in place. Some recommendations set a significantly higher standard than was generally in place in the sector. Implementation of these measures required detailed planning with installation taking place during major plant maintenance shut downs. CA inspection programmes have, where necessary, incorporated follow up work to verify implementation at the relevant sites.

Progress against key aspects of the six parts in the PSLG report is summarised below.

4.1. Systematic assessment of safety integrity level requirements

The PSLG report provided guidance to operators to help them re-evaluate the risks associated with overfilling a large petrol storage tank and understand where further automatic protection systems should be installed. This assessment was based on work done by the Health and Safety Laboratory following the Buncefield incident. Risk assessments have been completed by operators of fuel terminals and the results used to specify any additional protection that may be required (see section 4.2).

Risk assessments are required to be documented and for higher hazard sites these should be included in the operator's COMAH Safety Report – a legal document that demonstrates to the CA how the operator manages major accident hazard risks on its premises. The Safety Report and risk assessments should be periodically reviewed and revised to ensure they are kept up to date and take account of any new and significant learning within the industry.

4.2. Protecting against loss of primary containment

The most effective way of preventing overfill of a large petrol tank – and consequently the formation of a flammable vapour cloud – is to ensure that a high level in a tank is detected, and that filling is stopped as quickly as possible. Site operators have assessed their tank capacities, and ensured that the normal operating level, overfill level, and related alarm systems are appropriate, taking into account the expected response times of staff on site.

³ in summary an 'in-scope' tank is a vertical, cylindrical, non-refrigerated above ground storage tank with walls greater than 5m in height and filled at rates greater than 100m³/hour, see paragraph 24 of the PSLG report for the full definition.

In 2008, industry committed to install automatic overflow protection systems on all petrol storage tanks within scope of the PSLG report. The vast majority of these systems were upgraded and are operational.

The original timescales for upgrading were based on the levels of risk, equipment lead times and planned shut-downs at each of the sites. A small number of sites have not met the original timescales due to e.g. the complexity of the upgrade process requiring trials to test out the solution, a major business reorganisation or change in use of the site. Where this was the case, revised timescales for completing upgrade work were agreed with the CA and interim measures introduced, such as increased inspection and maintenance and changes to operating procedures, to ensure the ongoing integrity of the existing systems. CA verification to ensure full compliance with the standards is built into CA inspection plans.



An overfill protection system level transmitter

Protection systems are tested at suitable intervals to make sure that they are operational, and will work when a high level is detected in the storage tank.

4.3. Engineering against escalation of loss of primary containment

With the aim of ensuring their continuing fitness for use and mechanical integrity, storage tanks should be covered by a suitable, planned maintenance regime that requires them to be inspected to relevant standards⁴.

However, should there be a leak of petrol from a tank, Buncefield demonstrated that it is also important to understand where an explosive atmosphere might occur and to ensure that emergency equipment is located where it can be reached safely and used effectively. Operators of fuel storage terminals completed hazardous area assessments against the Dangerous Substances and Explosive Atmospheres Regulations 2002 and reviewed the equipment installed on site to make sure that it is properly located and protected.

Emergency plans and arrangements have also been reviewed and updated to ensure that the site, emergency services and other relevant agencies and bodies understand their role and responsibilities in response to an incident. These plans are regularly tested to ensure that everyone is prepared in the event of a real incident.

For new sites or those which have been significantly modified, industry is also investigating other systems which could detect a leak, such as Closed Circuit Television (CCTV) and gas detection (instruments that detect flammable vapour clouds). Further guidance has been

⁴ such as EEMUA 159 or API 653

developed to support this work by the *Chemical and Downstream Oil Industries Forum (CDOIF)*, for more details, see section 4.6.

4.4. Engineering against the loss of secondary and tertiary containment

Should failure of the storage tank or an overfill occur (i.e. the *primary* containment), reliance is placed on the bund surrounding the tank (called *secondary* containment) or measures outside of the bund (called *tertiary* containment) to contain the spill.

Several immediate improvements were implemented quickly, including sealing gaps around pipework that enters the bund and assessing and improving the integrity of concrete bund wall joints, including the installation of fire proof steel plates where appropriate.



Fire proof steel plate installation

To supplement the PSLG guidance, the CA published in 2008 a *Containment Policy* and supporting guidance, which established key principles and standards for primary, secondary and tertiary containment relating to the bulk storage of hazardous liquids. In terms of secondary and tertiary containment, which are primarily about environmental protection, a period of up to 20 years was set for necessary upgrades. Since then, the CA has inspected fuel storage terminals (including storage tanks at refineries) requiring operators to develop and, where necessary, implement an agreed improvement plan to meet the appropriate standards within the timescale.

A method for assessing the risk to the environment *Environmental Risk Tolerability for COMAH Establishments* was developed by the CDOIF joint industry/regulator group and published in September 2013. Its purpose is to help understanding of the risk to the environment from hazardous substances stored on a site, and from this to assess if any further measures are required. Using this approach ensures that improvements can be targeted appropriately. For further details see the CDOIF resources page at <http://www.hse.gov.uk/aboutus/meetings/committees/cif/resources.htm>.

Sites storing large quantities of petrol have committed to undertake these risk assessments. In some cases, work is ongoing to review and finalise the outcome of these with the CA. The assessment process has improved the site specific knowledge for operators and the CA regarding the potential impact of a major incident to the environment. Where improvements are necessary, prioritised risk based plans are being developed to ensure compliance by the 2028 deadline.



Installing a bund liner as part of secondary containment improvements

4.5. Operating with high reliability organisations

Whilst the physical hardware and systems associated with preventing an overfill are essential to maintaining safety, their full benefit can only be realised when human and organisational factors involved in their design, use and maintenance are also properly delivered.

A company should ensure that personnel involved at all levels within their organisation, from operators to managers, understand fully their roles and responsibilities and that they have the necessary competency to carry out those activities.

The wider chemical industry now has in place or is working toward embedding Competency Management Systems within their organisations to ensure that the right people have the right skills to manage and maintain major hazard controls on site.

Operators have also ensured that existing operating and management procedures have been reviewed and are maintained to reflect current good practice. This includes communications between fuel storage terminals and the sites that send them fuel via a pipeline; control room design; alarm management; shift working arrangements and management of change.

Measuring how well process safety management systems are working to control risk at major hazard sites is vital. The PSLG report recommends the adoption of both 'leading' (indicating that something could go wrong) and 'lagging' (indicating that something has gone wrong) process safety performance indicators to assess how effectively risks are being controlled. Companies collect this information to help identify potential weaknesses and improve performance. Trade associations representing fuel storage terminal owners also collect and publish aggregated performance information for the industry as a whole.

The CA has designated the adoption of process safety performance indicators as a strategic priority inspection topic. CA Inspectors in their verification visits promote the use of a suite of indicators as part of the monitoring arrangements for effective process safety management systems at all major hazard sites. The majority of 'in-scope' sites have now implemented a full suite of indicators.

4.6. Delivering high performance through culture and leadership

Hardware and management systems aim to control risk directly, but there is also a strong need for leadership in organisations to actively encourage continuous improvement.

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In addressing the need for high performance, the PSLG published its *Principles of Process Safety Leadership*, promoting involvement and competence in process safety at board level – this includes a commitment to actively manage process safety, engage with the workforce, monitor performance, share best practice and learn from relevant incidents from across industry sectors. See <http://www.hse.gov.uk/comah/buncefield/pslgprinciples.pdf> for further details.

In seeking to apply the Principles, industry has worked closely with their relevant trade associations to develop and improve sector and cross-sector collaboration. Some examples of new bodies formed to advance this agenda following the Buncefield incident include:

- Process Safety Forum – to share knowledge and good practice between industries, visit www.p-s-f.org.uk for more information.
- Chemical and Downstream Oil Industries Forum (CDOIF) – an existing forum which took over the collaborative working practices from PSLG to develop high level guidance on emerging topics and ensuring good practice is shared with industry and the CA, visit <http://www.hse.gov.uk/aboutus/meetings/committees/cif/> for more information.
- Process Safety Management Board – to develop and promote a suite of training standards and establish quality assured training provision.
- COMAH Strategic Forum – Industry and the CA working together to improve major accident hazard management to raise standards across industry.

Through the Process Safety Management Board, the CA, industry and unions have worked together to develop a package of standards and training courses for all levels of staff in both COMAH and non COMAH businesses – including for senior executives and board members. These provide one way to help leaders to develop appropriate competence in process safety and to establish a proactive process safety culture. Many companies who operate fuel distribution terminals and refineries have put their staff through this training.

5. Conclusions

The Buncefield explosion and fire highlighted major deficiencies that resulted in appropriate enforcement by the regulators. The investigation of the incident illustrated the need for lessons to be shared and implemented more widely and highlighted the value of greater collaboration in order to improve safety for the benefit of the public, environment and business. Businesses, working together across sectors, through trade associations, and more closely with regulators is pivotal to the successful management of risks associated with major hazards sites.

Implementation of the measures set out in the PSLG report should ensure that an accident of this nature does not happen again. Changes in operating practice and control have already been made. The COMAH Strategic Forum recognises the significant progress industry has made in responding to the MIIB recommendations and in fulfilling the obligations set out in the PSLG report.

However, delivering the recommendations for Buncefield is not about setting an end point, it is about continuous review, learning and ensuring on-going improvements in good practice. Industry, regulators and other relevant stakeholders need to work ever closer to ensure that we make improvements in the right places for the right reasons; and we should continue to share with other sectors and operators what we have learnt and how we work.

The legacy of Buncefield remains with us and in the way that we work. It has acted as a powerful catalyst for improved management and control in the fuel storage industry and for other industry sectors. The lessons learned are now having a far reaching impact on other industries, and as such our knowledge of safety, the standards which we use and our understanding of risks are continually improving.