The Buncefield incident - experiences and lessons learned

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Buncefield 11 December 2005 - the fuel depot before the incident
Fig 1 - T912 Predicted Gross Volume, Alarm, Trip and Tank Overfill times from 03:15 on 11/12/05

Notes
Calculated Volume escaping from T912
Between 222,096 and 269,560 Litres

Time that T912 Overfilled
Between 06:37:11 and 05:42:18
Height/volume referenced to base of T912 sump

Petrol spilling out of Tank Vent
15.062mm = 7,212.892 Litres around 05:40:00 (See note)

Floating deck reaches roof trusses 13,530mm
6,491.248 Litres around 04:15:00

Ultimate high level alarm 87/1p 13,096mm
6,727.965 Litres around 03:55:00

ATG User high level alarm 12,530mm
5,929.638 Litres around 03:40:20

ATG High level alarm 12,630mm
6,049.173 Litres around 03:29:20

ATG High high level alarm 12,730mm
6,992.282 Litres around 03:34:45

Time on morning of 11/12/05
Liquid flow from the tank top
Liquid cascade - water
Liquid cascade - hexane
Buncefield 11 December 2005
- the extent of the vapour cloud

Forensic examination of the evidence from:

• Burn damage
• Damaged objects (particularly cars)
• Off-site CCTV records

Allowed a good estimate of the cloud size which extended between 150 and 200 metres from the side of the overfilled tank
Extent of vapour cloud
Buncefield 11 December 2005 - the explosion

There were over forty injuries – fortunately no fatalities

The explosion caused massive damage on and off site (around £1 billion)

Extensive building damage and business disruption

M1 motorway closed, nearby homes evacuated

Reduced fuel supply to London airports
Buncefield 11 December 2005
- building damage
Buncefield 11 December 2005
- property damage
Buncefield 11 December 2005
- the fire

The explosion caused a fire that engulfed at least 20 storage tanks

This burned for five days consuming thousands of tonnes of fuel

Required a massive fire fighting response

Resulted in pollution of the local aquifer by firewater and foam
Buncefield 11 December 2005 - the fire fighting response
Buncefield 11 December 2005 - after the fire
Buncefield 11 December 2005
- immediate causes of the event

Loss of control of tank filling process

Failure of level measurement and independent high level trip

Leading to loss of primary containment

During the fire, failure of secondary & tertiary containment
Buncefield 11 December 2005
- underlying causes

Poor management of key risk activity – tank filling (human factors)

Poor design & maintenance of overfill protection equipment

Inadequate change management

Poor design of bunds to deal with prolonged fire event

Lack of adequate tertiary containment

Overall poor process safety management
In general the risks from tank storage operations were not well understood:

• the very efficient vapour formation in the event of an overfill of gasoline

• the severity of an explosion of a large shallow vapour cloud

As a result tank storage operations had not received the attention they should have done
Industry and regulators worked together to define good practice covering:

- fuel transfer operations
- tank overfill protection
- staff competence & staffing levels
- emergency preparedness
- secondary & tertiary containment
Process Safety Leadership Group

Final report published 2009

“Safety and environmental standards for fuel storage sites”

this covered 6 main themes plus emergency planning:
Part 1: Systematic assessment of safety integrity levels

• Overfill protection systems for storage tanks

• BS EN 61511 – agreed standard
  • Application of layers of protection analysis (LOPA) to the overflow of atmospheric tanks (appendix 2)
Part 2: Protecting against loss of primary containment using high integrity systems

- Management of instrumented systems
- Preventative maintenance
- Automatic overfill protection for gasoline tanks – (appendix 4)
- Defining tank capacity – (appendix 3)
Part 3: Engineering against escalation of loss of primary containment

- Siting of emergency response facilities – (appendix 6)
- New tanks to BS EN 14015 or API 650
  - Single bottom design
- Tank integrity management – EEMUA 159 / API 653
- Competence – inspectors to EEMUA 159 level 1 or API 653
Appendix 6

- Routemap to emergency planning guidance
- Template for completion of COMAH on-site plan
- Assessment of vulnerable emergency response equipment & resources
- COMAH off-site plan exercising/auditing record
- Communicating with the public

(Note: COMAH = Control of Major Accident Hazards Regulations 1999)
Part 4: Engineering against loss of secondary and tertiary containment

- COMAH Competent Authority Containment Policy
- Bund lining
- Pipe penetrations & expansion joints
- Bund capacity & strength
- Firewater management
- Tertiary containment
Part 5 & 6: Operating with high reliability organisations – culture & leadership

Appendix 5

- Leadership & safety culture
- Process safety management
- Hazard identification & layers of protection
- Roles responsibilities & competence
- Staffing, shift work & working conditions – shift handover
- Organisational, plant & process change
- Principles for safe fuel transfer
Buncefield response – Key points

This way of working requires certain commitments:

• Responsibility for controlling risk remains with site operators
• The regulators must allow sufficient time for improvements to be made
• Industry Trade Associations must be able to commit on behalf of member companies
• Must be clear on what each new standard means in practice
• Engagement and commitment is essential
Buncefield – land use planning

• Following public consultation HSE revised its approach to providing land use planning advice for new fuel sites and developments near to existing sites

• This included an accident scenario to take account of the potential for a large vapour cloud explosion

• Research continues in this area
Buncefield – research

Vapour cloud formation & prevention
Explosion mechanism
Event frequency
A reminder – Buncefield was not unique

Puerto Rico 2009

Jaipur 2009

Venezuela 2012
Buncefield – references

Buncefield Investigation reports (MIIB)
http://www.buncefieldinvestigation.gov.uk/reports/index.htm

Buncefield: why did it happen

PSLG final report
http://www.hse.gov.uk/comah/buncefield/fuel-storage-sites.pdf

Vapour cloud formation & FABIG TN12

Explosion mechanism
http://www.hse.gov.uk/research/rrhtm/rr718.htm
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