Buncefield Incident

CCTV footage, vapour production and dispersion

VCE or UVCE:
(Unconfined) Vapour Cloud Explosions

INERIS – TOTAL Journée Technique
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Simon Gant
Outline

• Summary of basic facts
• CCTV footage
  – Vapour dispersion
  – Explosion
• Tank overfilling source term
• CFD simulations of vapour dispersion
• Reports and papers
Summary of Basic Facts

- Hertfordshire Oil Storage Terminal
- Fifth largest fuel depot in UK
- Linked via pipelines to refineries
- Storage of petrol, diesel, kerosene
## Summary of Basic Facts

<table>
<thead>
<tr>
<th>Fact</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>11 Dec 2005</td>
</tr>
<tr>
<td>Overfill</td>
<td>(during pipeline transfer)</td>
</tr>
<tr>
<td>Loss of containment</td>
<td>180 tonnes</td>
</tr>
<tr>
<td>Duration of overfill</td>
<td>23 minutes</td>
</tr>
<tr>
<td>Tank (Height/Diam.)</td>
<td>14m / 25m</td>
</tr>
<tr>
<td>Bund area</td>
<td>5,000 m²</td>
</tr>
<tr>
<td>Cloud area</td>
<td>~150,000 m²</td>
</tr>
<tr>
<td>Fatalities</td>
<td>None</td>
</tr>
<tr>
<td>Serious injuries</td>
<td>None</td>
</tr>
<tr>
<td>Total losses</td>
<td>~ €1.2 billion</td>
</tr>
</tbody>
</table>
CCTV Footage of Vapour Dispersion

- Around 6 am, 11 December 2005
- Tank 912 over-filled with petrol, during pipeline transfer
- CCTV footage shows spread of vapour cloud
CCTV Footage of Vapour Dispersion

- Cause of release:
  - Level gauge stuck: false reading
  - Independent high-level switch inoperable
- Weather conditions: cold, calm, stable
CCTV Footage of Explosion

- Vapour cloud ignited following activation of site emergency system (fire pump)
CCTV Footage of Explosion

- Explosion registered 2.4 on Richter scale
Analysis of CCTV footage
Tank Overfilling Releases
Tank Overfilling Releases

- Initial work on vapour production rate:
  - CFD modelling tested, but abandoned due to degree of uncertainty
  - Instead, assumed sufficient mixing that conditions reach equilibrium, i.e. saturated vapour
  - Entrainment rate of air into spray found using simple CFD model
Tank Overfilling Releases

- Later work on vapour production rate
- Experimental release from single vent (Buncefield tank had 8 vents)
- Far more efficient at producing vapour than pool evaporation from bund
Tank Overfilling Releases

- CFD model tuned to experiments
- Provided good predictions of independent tests
- Used to develop FABIG Technical Note 12

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Dispersion Modelling

- Started with simple models

- PHAST
  - Limited to finite wind speeds

- WAFT
  - Integral model for slumping of cylindrical cloud in zero wind
  - No account taken for obstructions
  - Predicted spreading rate far too rapid
Dispersion Modelling

Time = 0 [mins] 0 [sec]

Isosurface: Petrol Vapour Molar Fraction 1.6%
Dispersion Modelling

CCTV Footage

After 19 minutes, the mist covers the ground here

Thin mist here after 22 minutes, perhaps earlier

No mist here ever

Arrival times of the vapour cloud

CFD
Dispersion Modelling

CCTV Footage

Final cloud depths

CFD

- > 4 metres
- 3 – 4 metres
- 2 – 3 metres
- 1 – 2 metres
- 0 – 1 metres
- unknown

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Reports and Papers


• Gant S.E. and Atkinson G.T. "Buncefield investigation: dispersion of the vapour cloud" HSE Research Report RR1129, 2018
Acknowledgment

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Thank you

Questions?