

Learning the Lessons from Buncefield

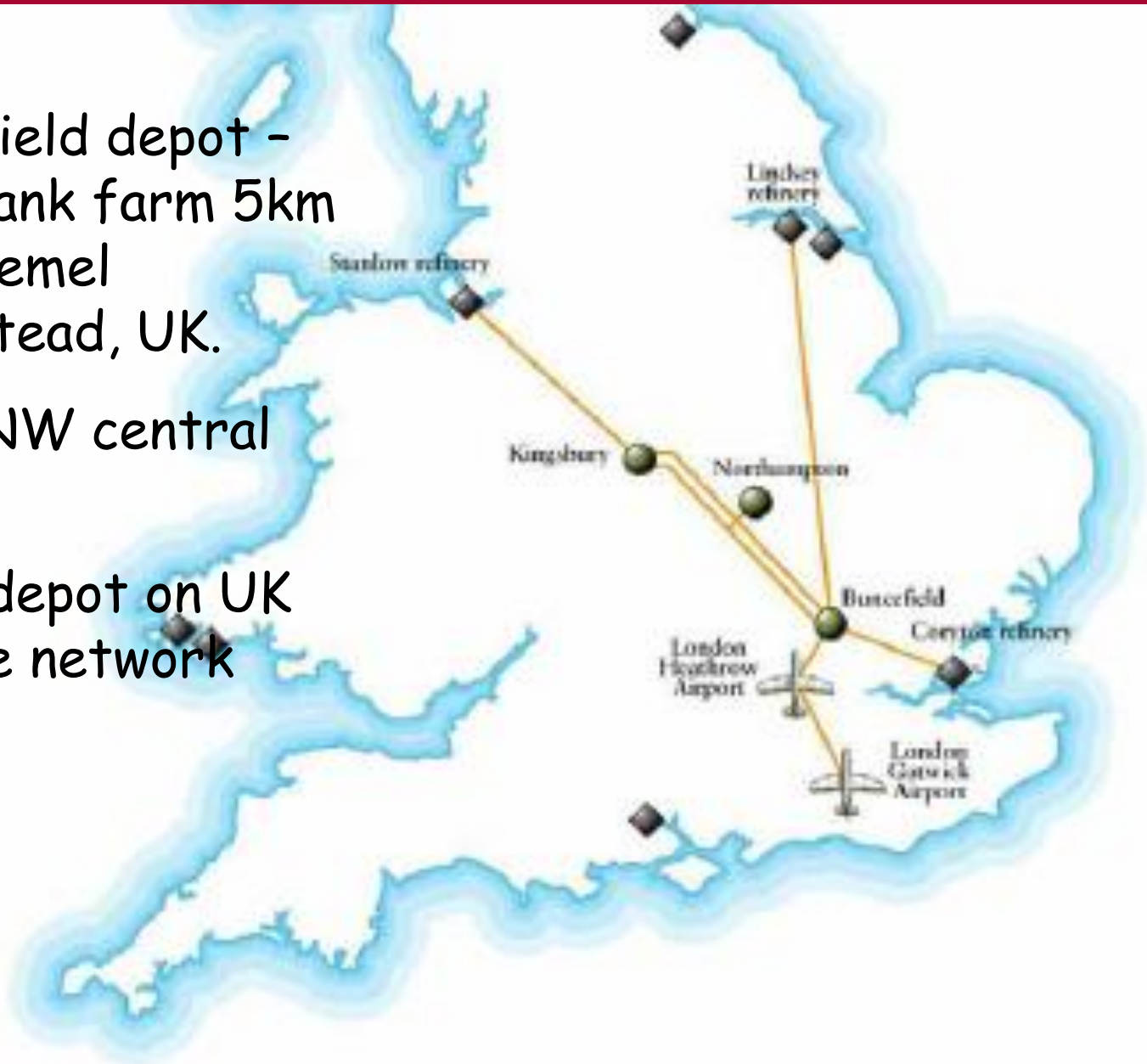
Clive Dennis

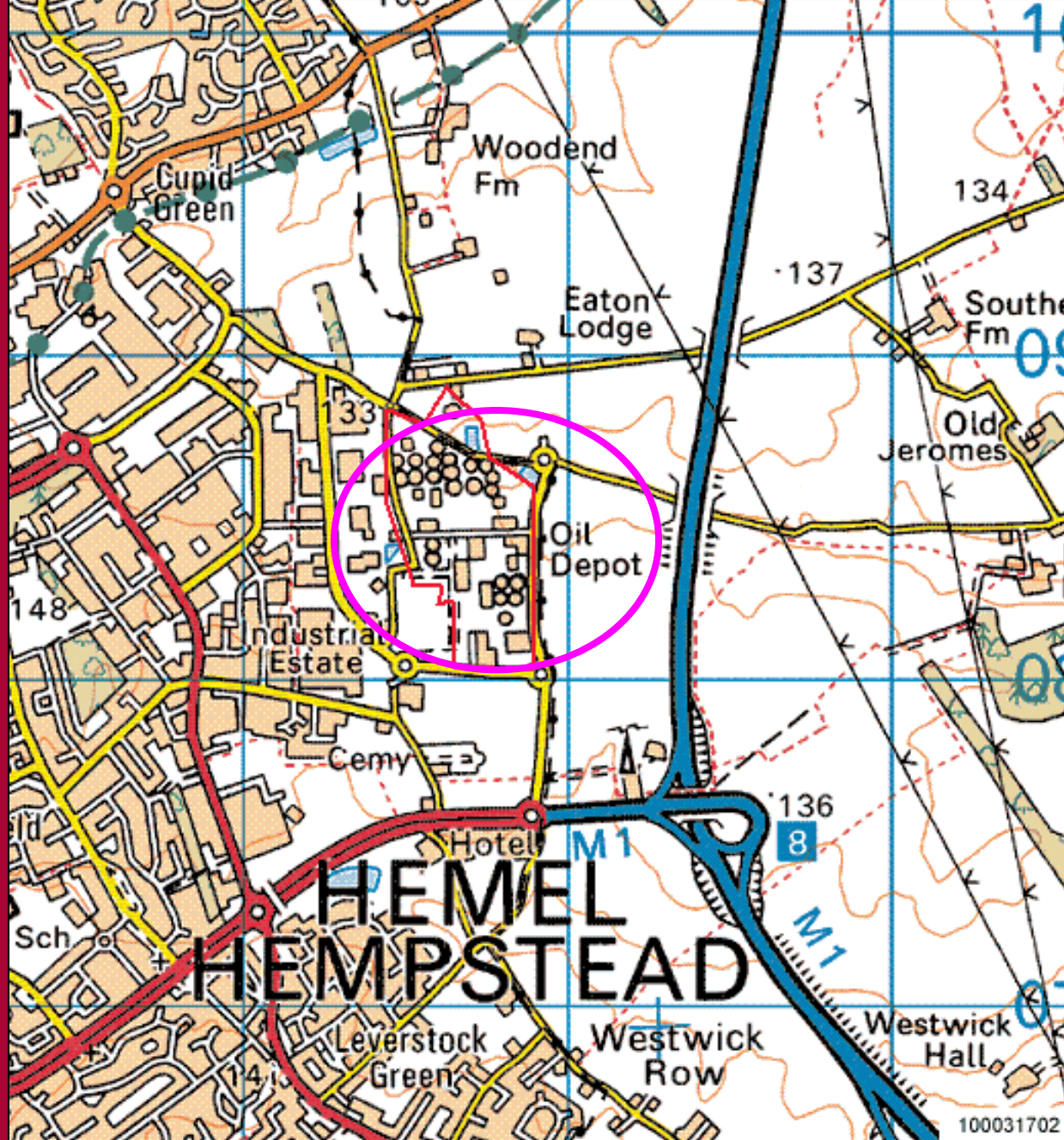
Health and Safety Executive, Great Britain

Buncefield depot -
large tank farm 5km
N of Hemel
Hempstead, UK.

40km NW central
London

Nodal depot on UK
pipeline network





1 km



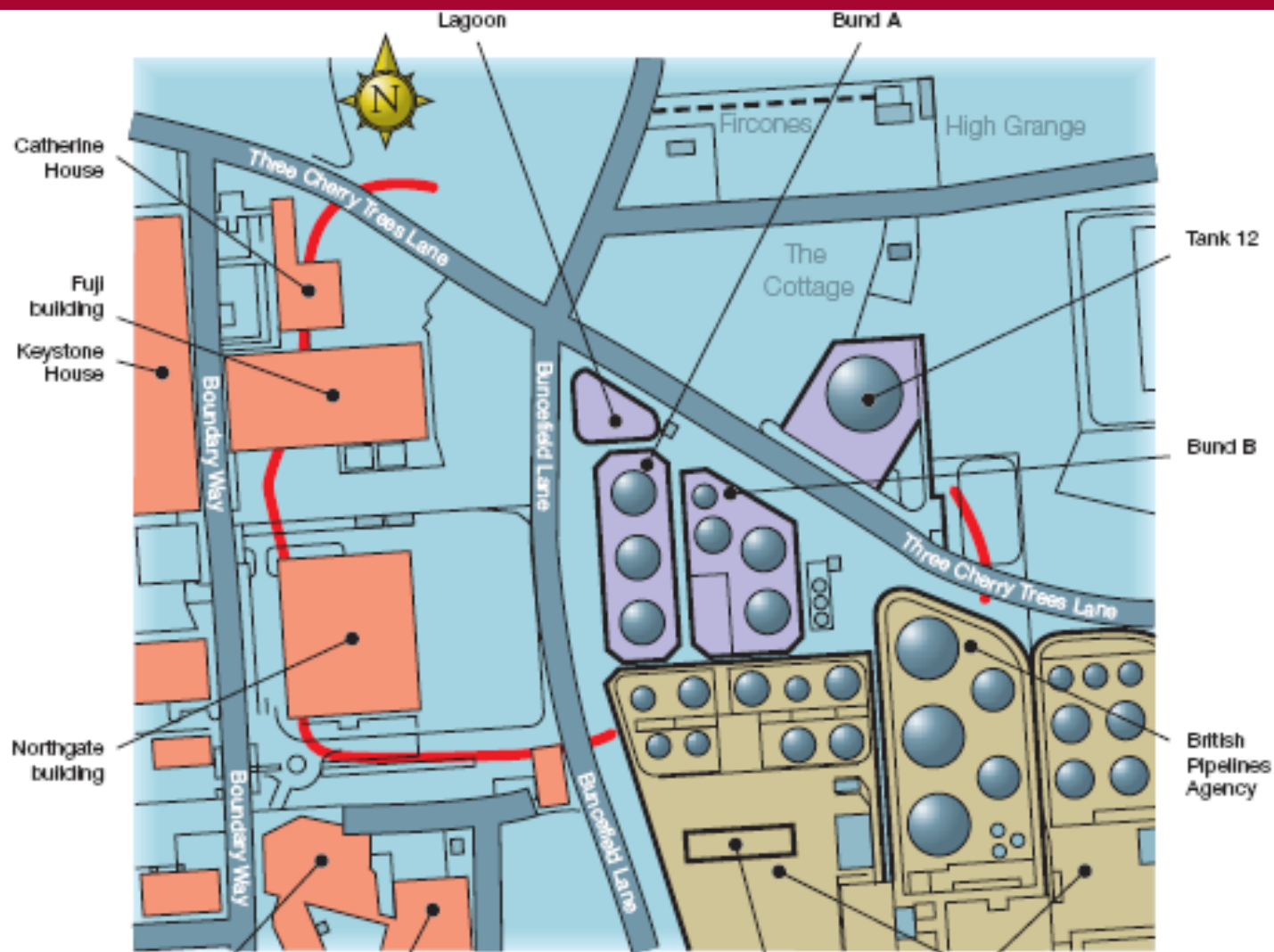


Figure 5 Layout of Depot and surroundings also showing limit of flammable mixture indicated by burned material

- | | | | |
|---|---------------------|--|-----------------------|
|  | Local area features |  | Buncefield depot site |
|  | Site features |  | Extent of burn damage |



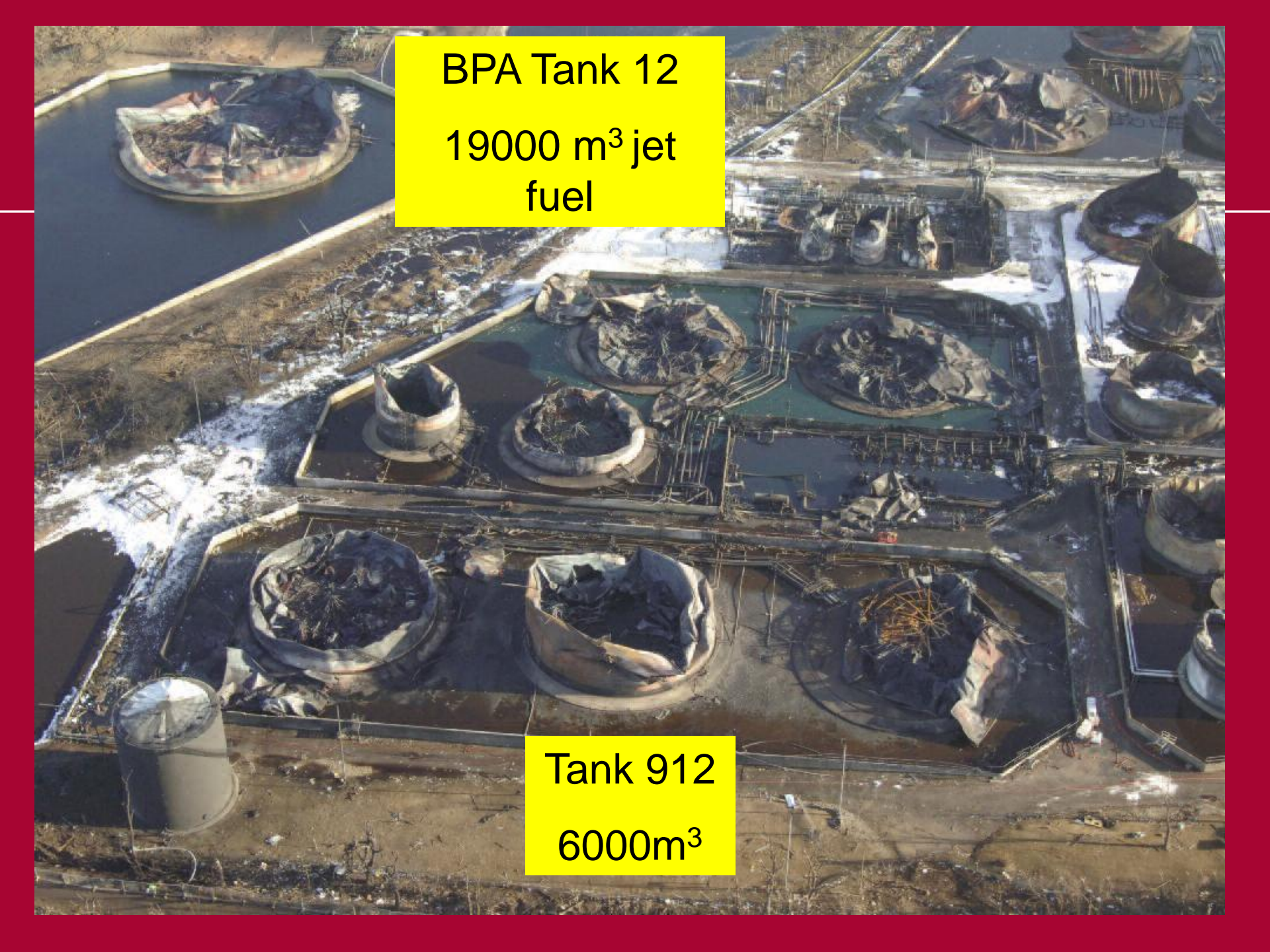
6 am, Sunday 11 December
2005 – explosions followed
by fire.

Developing incident

- Late evening 10 Dec 2005 tank 912 filling with gasoline
- 05.30 11 Dec tank overfilled
- Shut off system failed to operate
- Gasoline cascaded down the side of the tank, into bund. Vapour cloud flowed out of the bund. 300 te (80,000 us gal) gasoline escaped. 10% vapourised.
Vapour cloud = 120,000m² , 240,000m³

Developing incident

- 06.00 explosion
- Fire engulfed 23 fuel tanks
- 43 people injured.
- 2000 evacuated from their homes
- Fire took 5 days to extinguish
- 55 million litres of water & 750,000 litres foam concentrate.



BPA Tank 12
19000 m³ jet
fuel

Tank 912
6000m³

Tank 912
6000m³



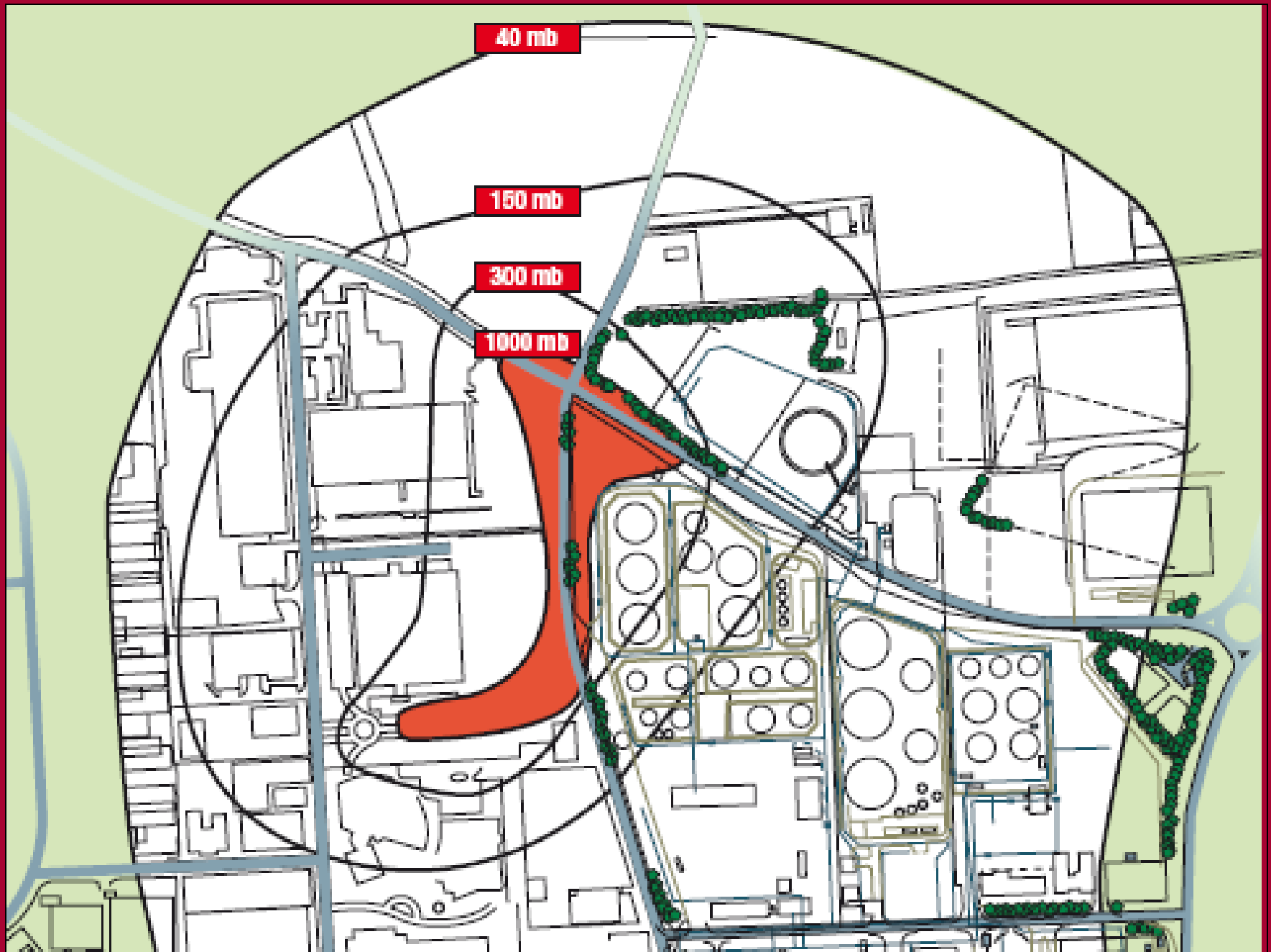






Overpressure

- Within vapour cloud + 200kPa
- Diminished rapidly with distance from edge of the gas cloud.









Investigation

- UK Health and Safety Commission established Major Incident Investigation Board, MIIB
- Published four reports:
 - Design of Fuel Storage sites
 - Emergency preparedness and response
 - Explosion mechanism
 - Land Use Planning
- www.buncefieldinvestigation.gov.uk

- Joint industry/Regulator Group established in 2006 – Buncefield Standards Task Group, BSTG
- Replaced by Process Safety Leadership Group, PSLG, in 2007.

UK / EU Legislation

- UK/EU major hazards legislation – goal setting. Based on risk. Risk to be reduced ‘so far as is reasonably practicable, so far as is reasonably practicable’.
- BSTG/PSLG agreed we wanted to raise the bar on standards of control at fuel storage depot.
- Establish good practice which we could apply within the law.

Safety and environmental standards for fuel storage sites

Final report

PSLG Final Report Dec
2009



www.hse.gov.uk/comah/buncefield/response.htm

Standards of overfill protection and control to take account of a large vapour cloud & potential for an explosion.

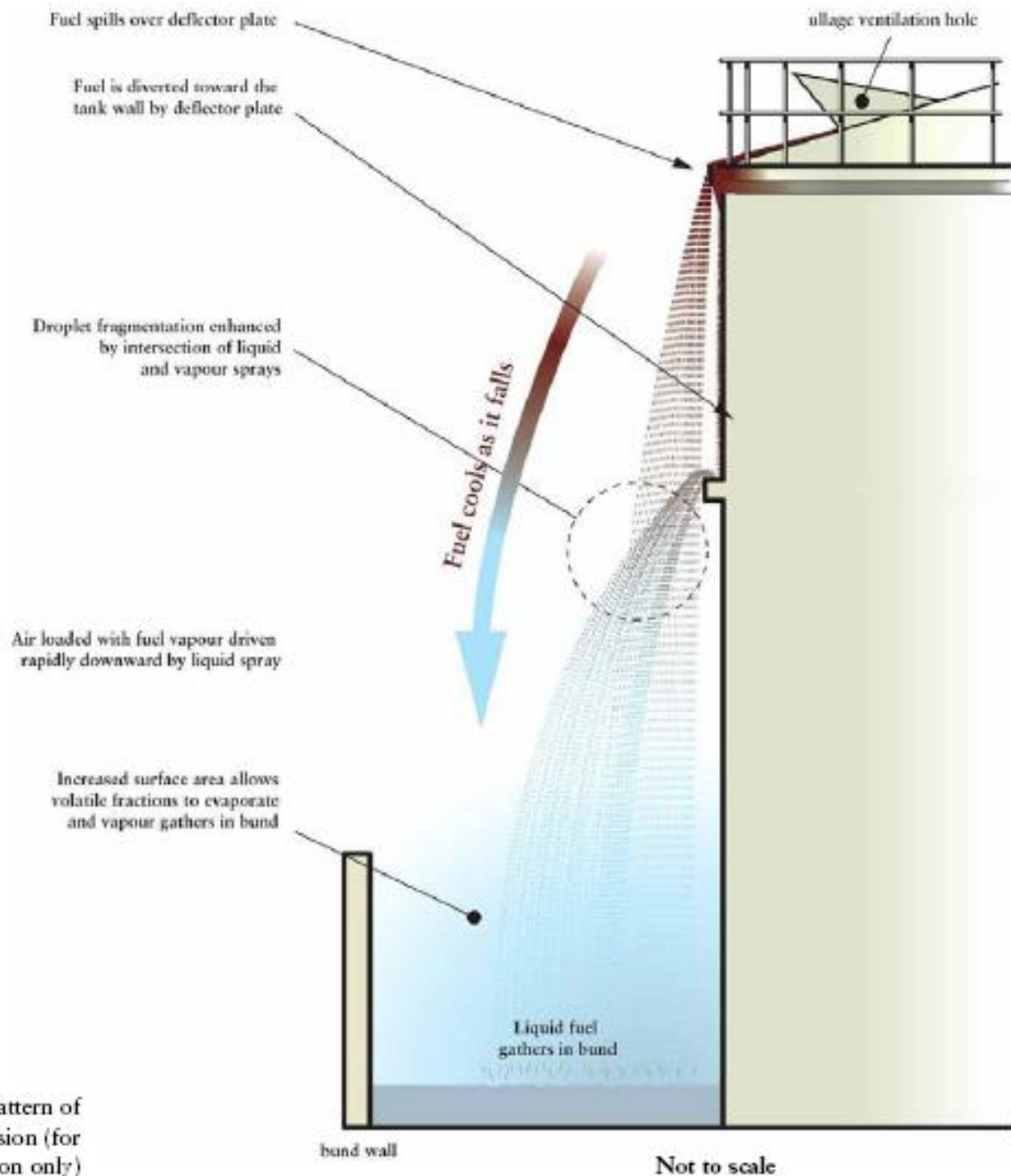


Figure 2 The pattern of fuel dispersion (for illustration only)

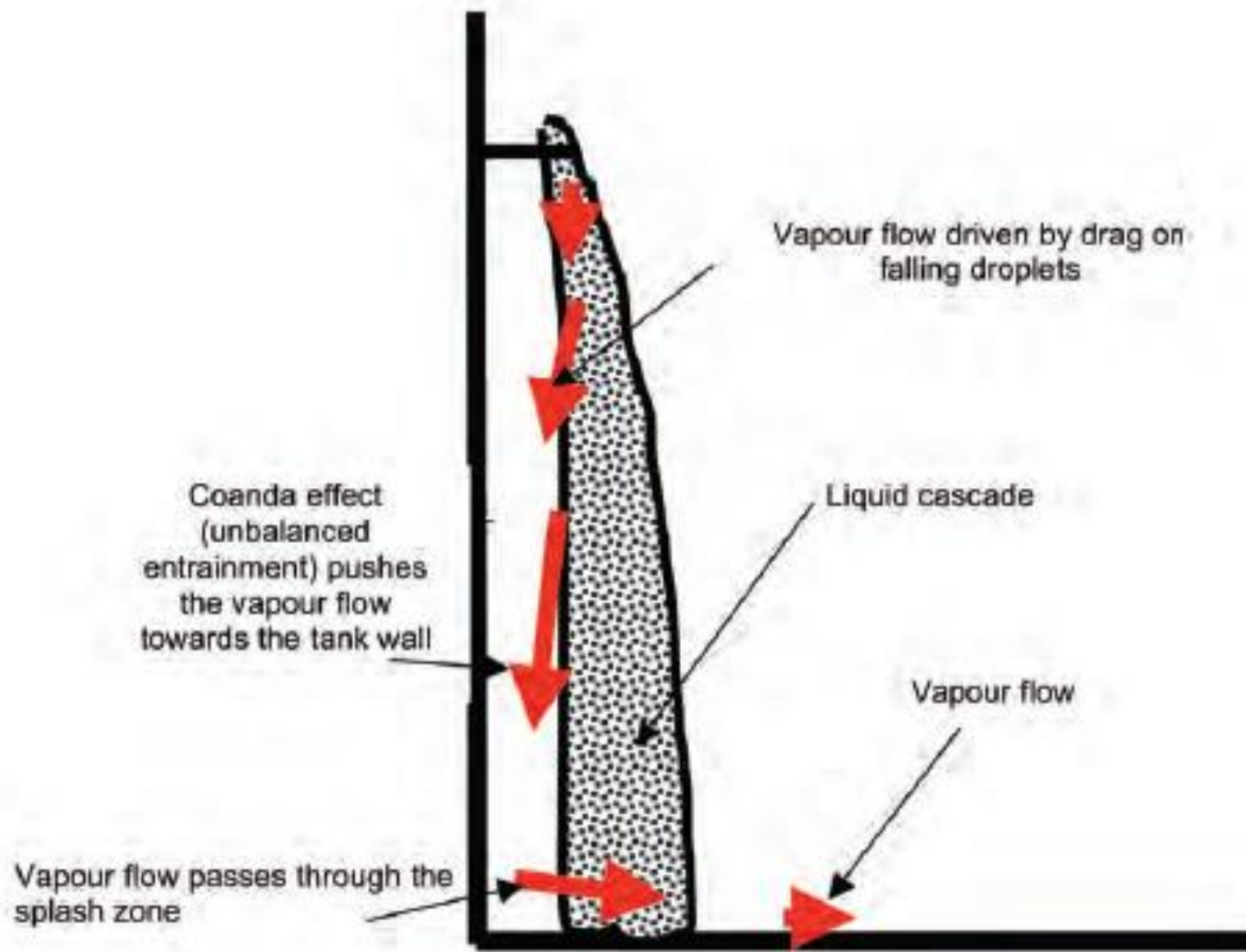


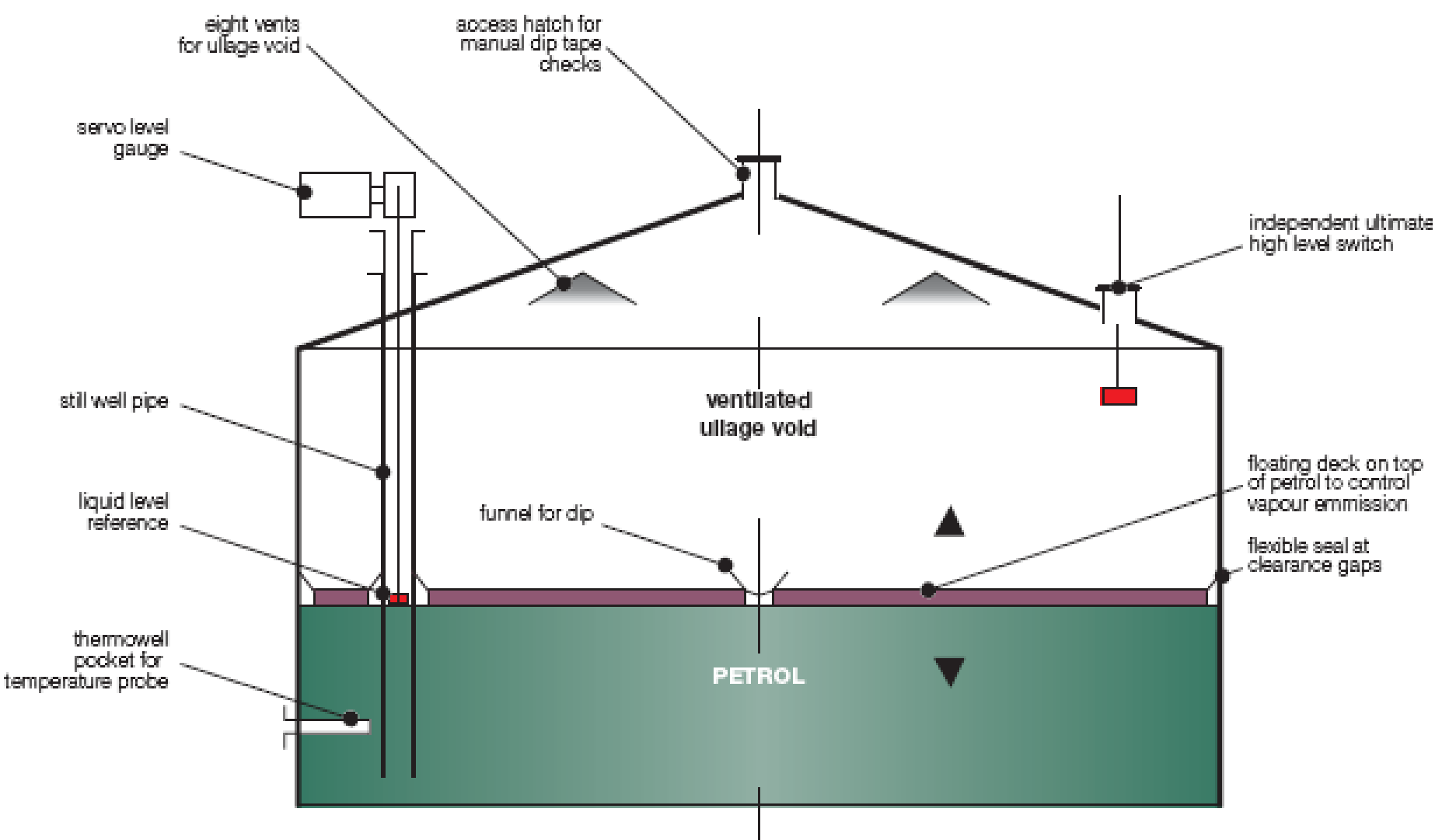
Figure 18 Schematic showing vapour flow driven by a free liquid cascade

PSLG Final Report - key themes

- Systematic assessment of safety integrity levels;
- Protecting against loss of primary containment using high integrity systems;
- Engineering against escalation of loss of primary containment;
- Engineering against loss of secondary and tertiary containment;
- Operating with high reliability organisations; and
- Delivering high performance through culture and leadership.

Systematic assessment of safety integrity levels

- adoption of BS EN 61511 “Functional safety, safety instrumented systems for the process industry sector”
 - design, installation, operation, maintenance and testing of equipment;
 - management systems;
 - redundancy, diversity, independence and separation;
 - fail safe, proof test coverage/frequency; and
 - consideration of common causes of failures.

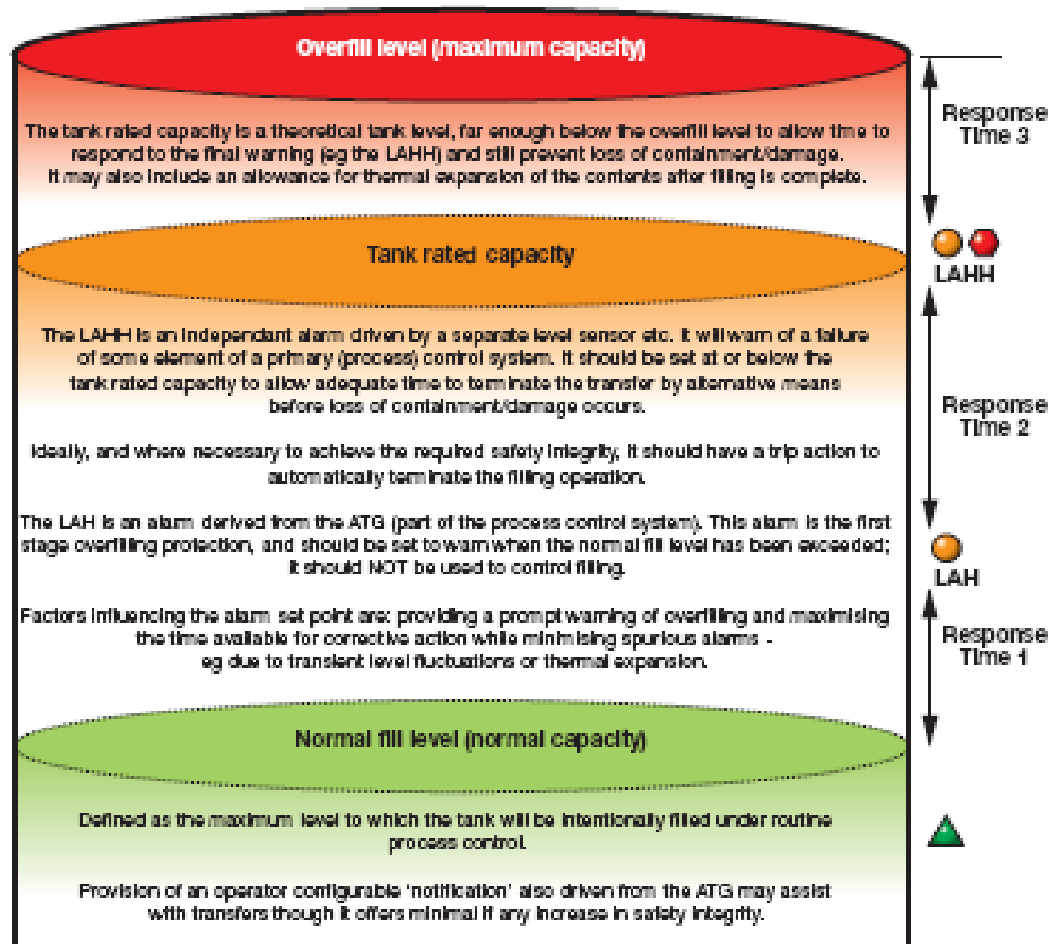


Overfill Protection for gasoline storage tanks

- Tanks filled at more than 100m³/hr:
 - Minimum SIL 1
 - Overfill protection automatic, physically and electrically separate to gauging system
- Applies to new and existing tanks
- Meet other aspects of BS EN 61511
 - New tanks – in full
 - Existing tanks - sfairp

Defining and Designating Tank Capacity

Any increase in level beyond the overfill level will result in loss of containment and/or damage to the tank. (All other levels and alarm set points are determined relative to the overfill level.)



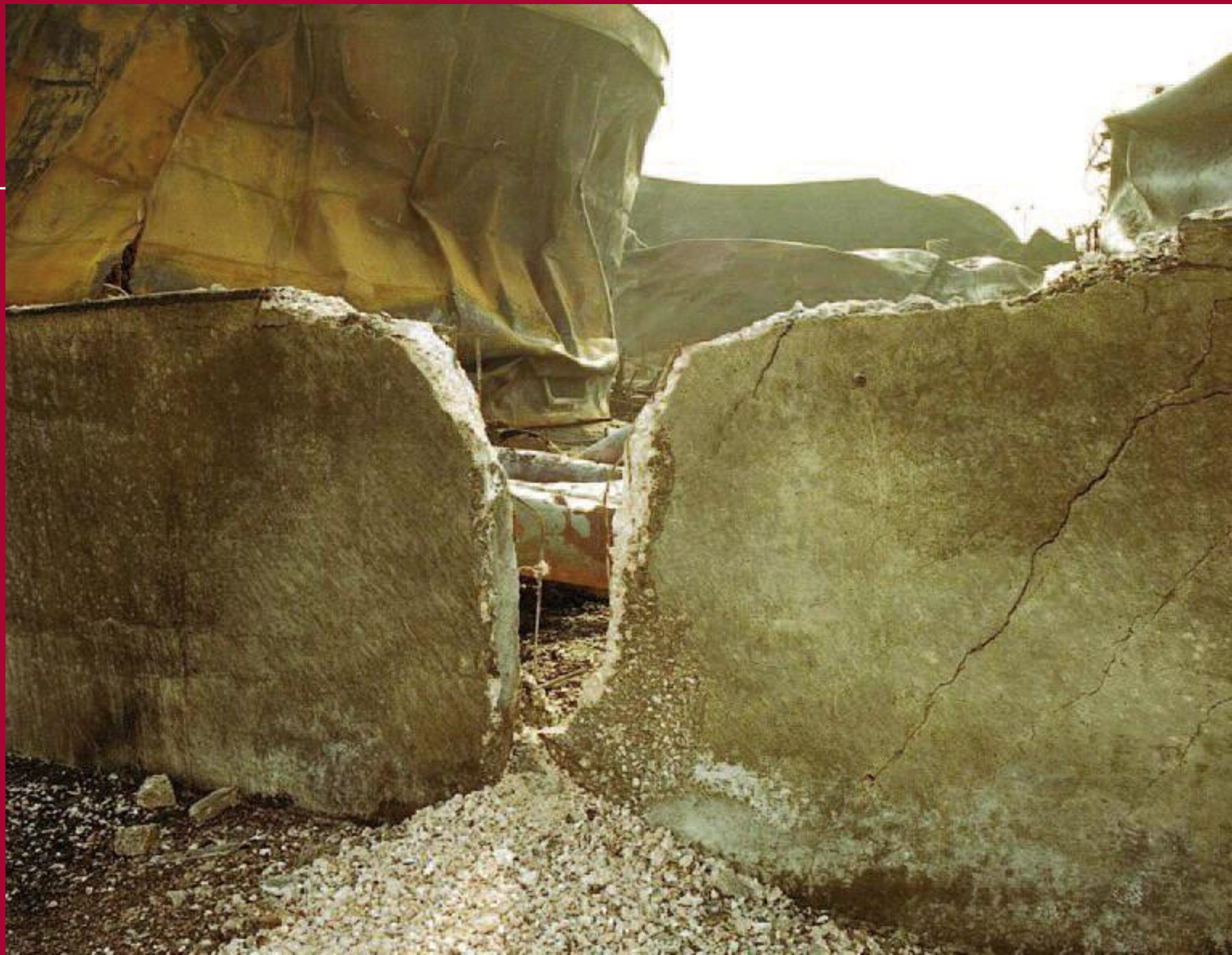
Engineering against escalation of loss of primary containment

- Adoption of appropriate design standards:
 - New tanks designed to BS EN 14015 or API 650
 - new tanks should be of single-bottom design
 - ‘frangible roof’ construction, or equipped with an emergency vent
- EEMUA 159 and API 653 basis of minimum standards for tank integrity management and repair

Engineering against loss of secondary and tertiary containment







Engineering against loss of secondary and tertiary containment

- Tank bunds (dykes) should be impermeable and bunds should have fire resistant structural integrity, joints and pipework penetrations
- steel plates to cover inside faces of joints provide enhanced fire resistance
- Fire resistant sealants
- no pipework through the bund floor; no pipework that penetrates through the bund walls

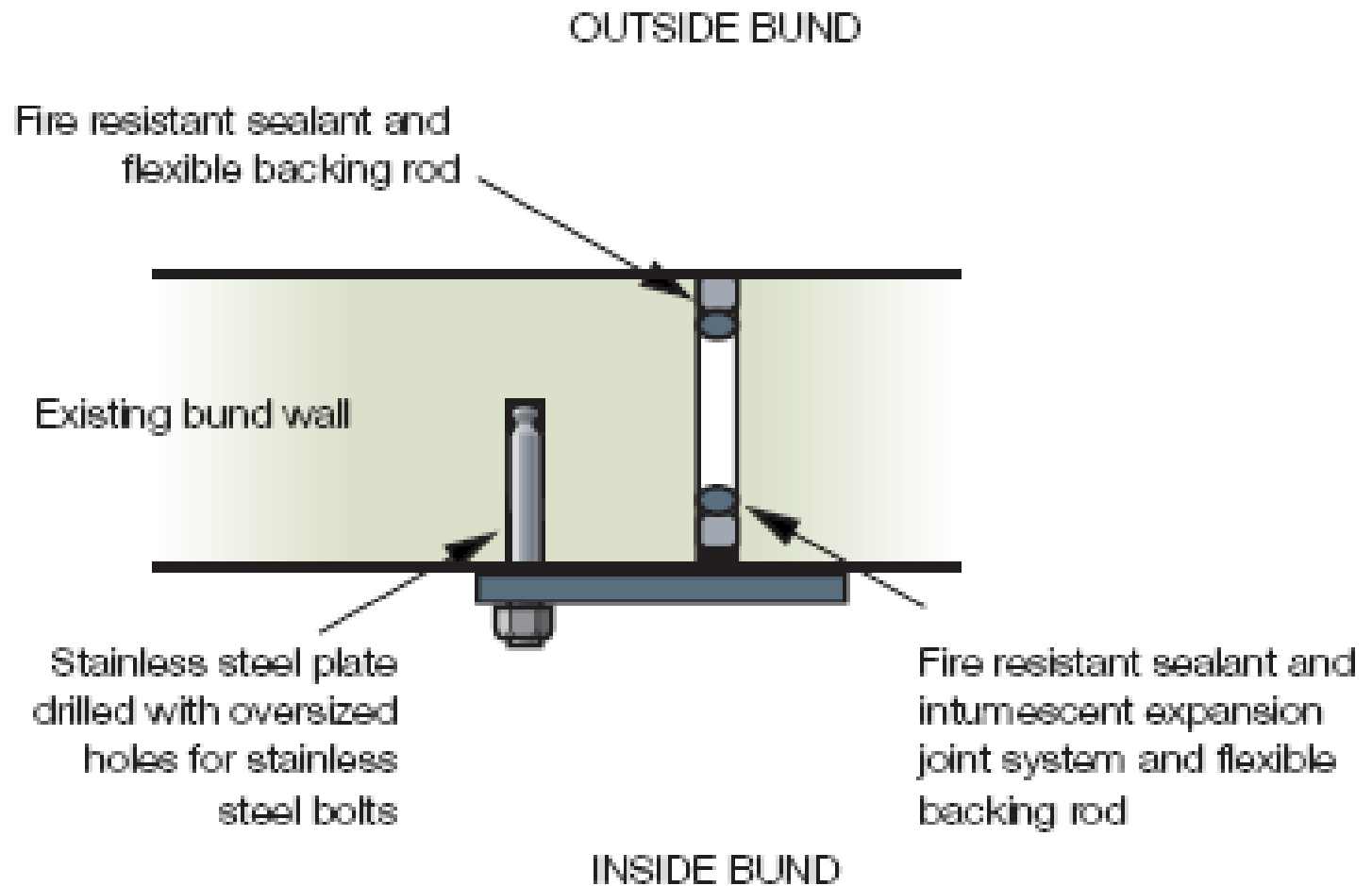


Figure 11 BSTG wall joint with stainless steel



Firewater management and Tertiary Containment

- Well-planned and organised emergency response
- Site-specific planning of firewater management
- Tertiary containment - additional barrier preventing the uncontrolled spread of hazardous liquid - site drainage and sumps, diversion tanks, impervious liners and/or flexible booms

Operating with high reliability organisations

- operates relatively error free over a long period of time. Two key attributes:
 - have a chronic sense of unease, ie they lack any sense of complacency; and
 - make strong responses to weak signals, i.e. they set their threshold for intervening very low.

Operating with high reliability organisations

- Clear understanding and definition of roles and responsibilities;
- Effective control room design and ergonomics, as well as alarm systems;
- Appropriate staffing, shift work arrangements and working conditions;
- Setting and implementing a standard for effective communication at shift and crew change handover; and
- Effective management of change, including organisational change as well as changes to plant and processes.

Leadership

The way in which:

- Process safety is given the right degree of attention and focus;
- Process safety considerations feature in key business decisions, and
- Understanding of major hazard risk and the importance of critical control measures is communicated and championed.

PSLG Process Safety Principles

- Clear and positive process safety leadership is at the core of managing a major hazard business;
- Process safety leadership requires board level involvement and competence;
- Good process safety management does not happen by chance;
- Board level visibility and promotion of process safety leadership is essential;
- Engagement of the workforce is needed in the promotion and achievement of good process safety;
- Monitoring process safety performance is central to ensuring business risks are being effectively managed;
- Publication of process safety performance information provides important public assurance; and
- Sharing best practice across industry sectors and learning and implementing lessons are important.

What we expect

- Delivery and maintenance of high standards of process safety leadership driving control of risk,
- Adopt and live the principles,
- Explain and demonstrate how they are being applied within their organisation,
- Secure and promote competence of CEOs and senior managers in process safety,
- Make decisions taking full account of the process safety implications,
- Develop an acute sense of vulnerability to a major incident, and
- Start to report their PS performance.

The key lessons



- Simple failures can, and often do, cause major disasters;
- Once a large loss of containment occurs it is almost impossible to control the consequence.
- One company's failure can impact on everyone in that sector.
- Major hazard businesses need to develop a sense of vulnerability
- There are always prior warnings of impending catastrophe.
- Leadership and process safety competence lies at the heart of effective decision making.
- Culture and organisational expectations drive the behaviour of employees.