When bunding costs too much

A COMAH inspired case study

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HSE Environment Agency SEPA Cyfoeth Naturiol Cymru Natural Resources Wales ONR Office for Nuclear Regulation

Bund capacity : exploring the 25% rule + ALARP

COMAH

- 25 % rule background & policy
- Remembering lessons from the past
- Case study
  - An establishment with an “undersize” bund
  - Establishment risk
  - Scenario risk (when a 25% rule bund is a potential barrier)
  - CBA … it’s grossly disproportionate!
  - Completing the ALARP demonstration

Sometimes it's worth it

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- An upgraded bund – increased area (with old bund retained to provide intermediate segregation)

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Multi-tank bunds – an increased risk

"Individual bunding is to be preferred to common bunding. Records show that when storage vessels containing flammable liquids are involved in a fire, the consequences are less severe when there is individual bunding."

HSE's Specialist Inspector report 39 "Guidance on the bunding of bulk chemical storage vessels" (1993)

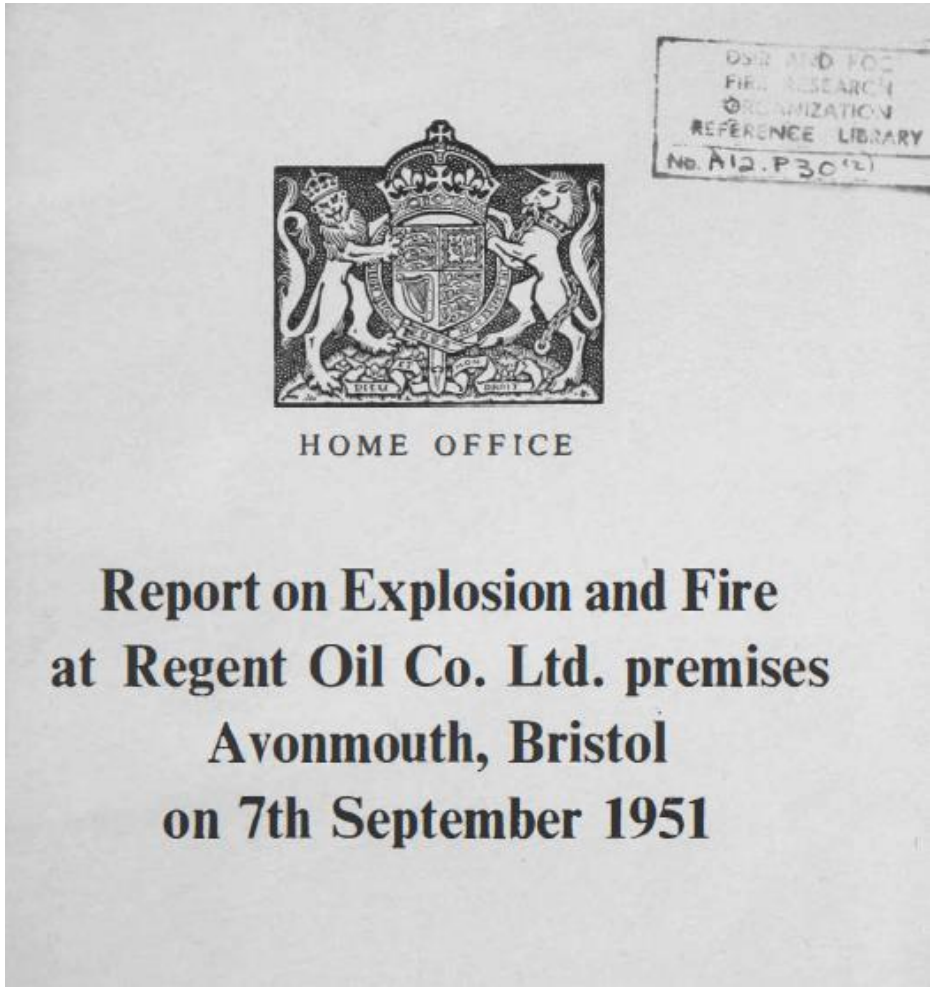
Multi-tank bunds – an increased risk

"multi-tank bunds are almost three times more likely to fail as single-tank bunds"

"Bund effectiveness in preventing escalation of tank farm fires",

Davies, Harding, McKay, Robinson and Wilkinson, IChemE symposium series No 139. Also published as Process safety and environmental protection, Trans IChemE vol. 74, no2, pp. 88-93, 1996

Incident learning – part 1



- 12 tanks in a common bund – escalation occurred so all tanks involved in fire
- Recommendations included : “Wherever practicable each tank of any size should be situated in its own imperforate bund” … use inter-bund walls almost as high as the external bund wall

Incident learning – part 2

Herts FRS – review of Buncefield fire response

4.8.7 On Monday at 13.18 a running fuel fire, caused by HOSL West bund E slightly overfilling and "slopping over", forced crews to withdraw to 20m away.

Damaged hose after running fuel fire

Bunds protect people, the environment and property

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At Buncefield some bunds worked, providing protection, but others failed…….

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Bund capacity – Containment Policy includes COMAH

- Bunds shall have sufficient capacity to allow for tank failure and firewater management. This will normally be a minimum capacity of either 110 % of the capacity of the largest tank, or 25 % of the total capacity of all the tanks within the bund, whichever is the greater.

CA containment policy (2008) and elsewhere

110% or 25% are normal minimums, but more capacity might be required in some cases

Application of containment policy

- The policy measures apply immediately to new establishments and, following discussions between the operator and the Competent Authority, to any existing establishments where significant changes in inventory or operation are proposed.

- Existing establishments will also be upgraded in line with the measures, **as far as it is reasonably practicable to do so**.

25% rule background

- 1990s, 25% rule introduced as good practice, a rule of thumb derived from incident experience (e.g. CIRIA R164, 1997 included the 25% rule)
- 2000 onwards – 25% rule adopted into certain laws (e.g. oil storage regulations and EPR - waste) and used as benchmark for BAT for all EPR bunds
- Post Buncefield – 25% rule widely adopted as good practice, including Containment Policy and other guidance (e.g. Energy Institute, CIRIA C736) for fuels and other chemicals

25% rule background - justification

- Protects against loss of secondary containment by overtopping for multi-tank incidents (but remember individual bunding is preferable!)
- Why 25%? – one theory
  - Typically, operational bund inventory is 50% of max bund capacity (all tanks)
  - Typically 50/50 chance of bund event escalating to cause losses from each of the other tanks (i.e. assume half fuel present escapes primary)

    ➡ Credible scenario: ~ 25% of total tank capacity lost from primary containment during multi-tank incident
  - Firefighting can reduce escalation, but adds more firewater….
  - Also, a 25% compliant bund more likely to have sufficient wall height allowing freeboard for foam (though this needs verifying independently)

110 % and 25% rules are a start….

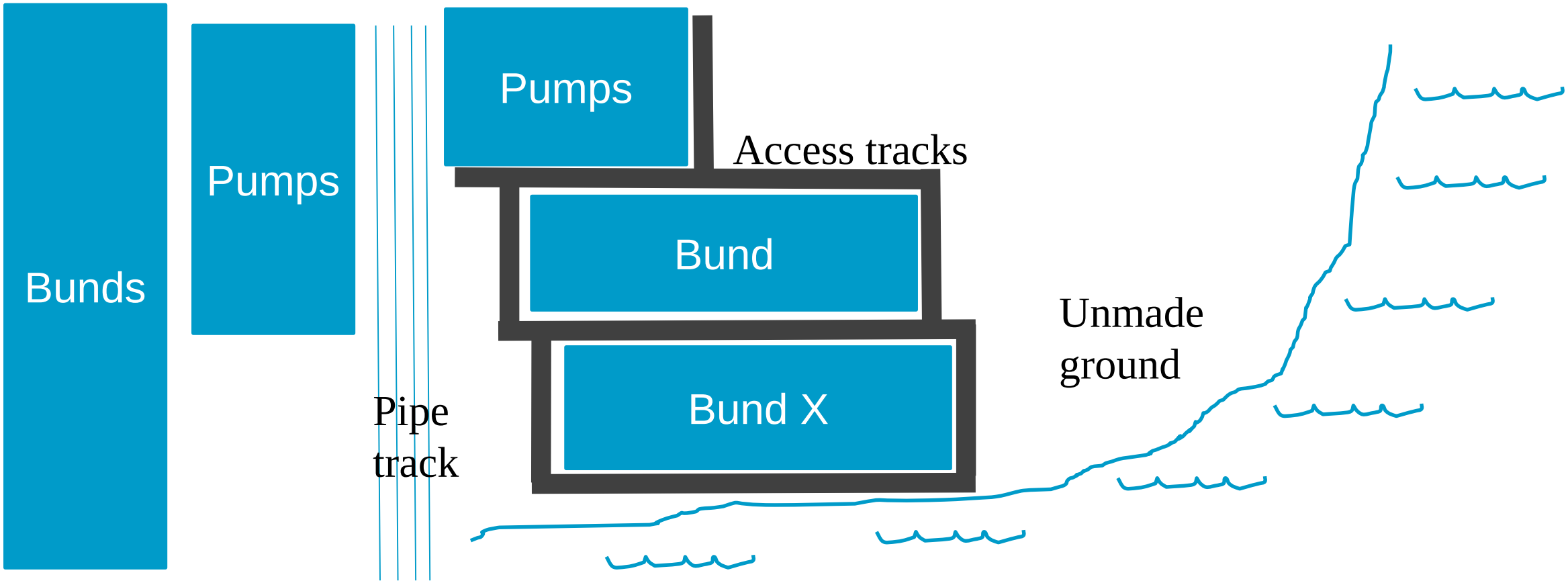
"Bunds shall have sufficient capacity to allow for tank failure and firewater management. This will normally be **a minimum capacity of either** 110 % of the capacity of the largest tank, or 25 % of the total capacity of all the tanks within the bund, whichever is the greater."

- Good practice includes the need to review tank inventory as well as firewater / cooling water rates and volumes, plus rainwater, plus foam freeboard to conclude on overall containment strategy.
- Bund design is multi-criteria, including safety aspects (more on this later)
- In France there is a 50% rule! (but is there the same emphasis on tertiary containment?)

Case Study – Existing bund with 8 tanks

- Multi product tank farm
  - Estuarine location with designated conservation sites as key receptors
- Bund X - 2 spirit tanks, 6 other tanks (Flammable Liquid 2)
- No common pipework between the 8 tanks
- Bund is mostly Containment Policy compliant, including 110% rule compliant (so OK for single tank events) …
- BUT - deficient against 25% rule and no local tertiary containment

General Arrangement



Claimed mitigated establishment risk

	Frequency per establishment per receptor per year (**mitigated**)						
Frequency at which CDOIF Consequence Level is equalled or exceeded	10^{-8}–10^{-7}	10^{-7}–10^{-6}	10^{-6}–10^{-5}	10^{-5}–10^{-4}	10^{-4}–10^{-3}	10^{-3}–10^{-2}	>10^{-2}
D - MATTE						Intolerable	
C - MATTE				TifALARP			
B - MATTE	Broadly Acceptable						
A - MATTE							
Sub MATTE	Tolerability not considered by CDOIF						

The mitigated risk is depicted above by **X**.

Scenario frequency (challenge on bund capacity)

- Single tank events most frequent, but mitigated by 110% rule bund
- Tanks do not share common pipework, so a Multi tank incident credible only for catastrophic tank failure (ctf) / explosion / large bund fire causing escalation
- ctf might cause multi-tank scenario, but would not benefit significantly from bund enlargement, so discounted from scenario (a heightened wall might in fact be more likely to fail during ctf)
- Large bund fire scenario ~ 4×10^{-4} per yr for 8 tank bund
  - Supported by data from various sources, either event tree and ignition or bund fire rate : see Appx 1 of CA AMN – environmental aspects guidance

Scenario frequency (challenge on bund capacity)

- Post Buncefield improvements should reduce risk - Overfill protection, fire safe ROSOVs, improved mechanical inspections, installed tank fire systems, improved leak detection and emergency response
- MATTE A from multi-tank fire incident involving bund overtopping

→ ~ 4×10^{-6} per yr

- In practice this figure is supported by LOPA or Fault & Event trees considering failure rates of each barrier in place

What Justified Spend?

- Benefit – avoidance of £5M-50M harm & recovery

  Note: this is for people and environment but not the entire incident cost

- Use disproportion factor of 1 to 2 for low end TifALARP risk
- Bund lifetime 25-50 yrs – Assume 50 (consistent with CIRIA C736)

- Justified Spend = Benefit x DF x lifetime x demand frequency

  = (£5M-£50M) x (1 to 2) x 50 yrs x 4x10-6 per yr

  = £1,000 to £20,000

What upgrade options?

- Enlarge bund area
  - Limited space?
  - Need to maintain access?
  - Increase pool fire risk?
- Increase wall height
  - Sufficient wall strength?
  - Modify existing over wall pipework?
  - Behaviour in fire?
  - Confined space / escape issues?

- Project cost £100,000 to £2M+ (tbc?)
- Cost significantly exceeds £1-20 k justified spend, **so grossly disproportionate** (as well as technically challenging)

Dislodged bund capping after Buncefield fire

Sensitivity & business risk (beyond COMAH)

- Justified spend could increase if ….
  - Increased establishment risk (resulting greater DF as risk moves towards intolerable)
  - More costly environmental receptors (Major Drinking Water supply?)
  - Large number of possible fatalities (School? Shopping centre? Airport?)

- What if wider costs such as asset loss due to escalation and reputational harm are factored into CBA – what business risk? What is corporate policy on this?

Dronka, 1994 "Preventable" with better containment (and flood preparedness)

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ALARP principles

- Good practice measures should be adopted so far as is reasonably practicable. It might not be reasonably practicable to apply retrospectively to existing plant, for example, all the good practice expected for new plant. However, there may still be ways to reduce the risk e.g. by partial solutions, alternative measures etc.
- CA does not normally accept a lower standard of protection than would be provided by the application of current good practice; and
- CA will, where the duty-holder wishes to adopt a different approach to controlling risks, seek assurance that the risks are no greater than that which would have been achieved through adoption of good practice and so are ALARP for that different approach.

Compensatory measures?

- To demonstrate ALARP there is a need to explore what more could be done to compensate for under capacity bund?
  - Bund foam pourers
  - Intermediate bund walls
  - Installed transfer systems for liquid transfer to remote secondary
  - Tertiary containment
  - Emergency plans reviewed to recognise increased overtopping risk – shifts plan in favour of rapid extinguishment or controlled burn? – to be discussed…
- Justified spends for alternate measures will differ
  - e.g. tertiary containment will protect against multiple bund failure modes, including ctf, and unbunded equipment (i.e. significantly higher demand rate)

When bunding costs too much…

- Go beyond good practice elsewhere and improve:
  - primary containment, maintenance and control systems (e.g. reduce tank inventory and increase response time between LAH & LAHH),
  - procedures (e.g. stock transfer procedures)
  - remote secondary & tertiary containment (and transfer systems),
  - emergency response
- Demonstrate ALARP for all barriers

- Process Safety culture… is your business sitting comfortably?