Bunding issues – EI guidance

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www.energyinst.org

What is EI?

- Learned society promoting sound science.
- Registered charity – not for profit.
- Incorporated in the UK by Royal Charter.
- All energy forms in scope.
- International.
- Main areas of activity:
  - Knowledge – research on energy topics.
  - Skills – professional membership (MEI etc).
  - Good practice:
    - Develops and publishes good practice guidance.
    - Independent industry-led technical research.
    - 'Honest broker' between industry, regulators, policy makers, etc.

Bunding issues – EI guidance: Contents

- Drivers
- Secondary/tertiary containment – using liners to improve bund integrity
- Tank bases – using liners and leak detection to improve tank base integrity
- Tertiary containment
- Bund sealant integrity, selection and asset management
- Environmental recovery periods

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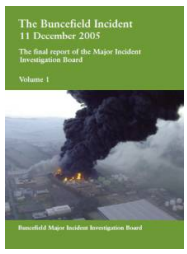
Drivers

- Legislation
- Incidents
- Policies
- Social responsibility
- Etc.

Drivers

GB Buncefield incident 2005:

- Fire involving 23 storage tanks – Seveso major accident
- 0 fatalities, 43 injuries, physical and environmental damage onsite and offsite, 2000 people evacuated, £1 billion economic loss, reputational impact
- Buncefield Major Incident Investigation Board defined recommendations for improvement



Drivers

GB Buncefield incident 2005:

- Industry/ regulators/ trade unions worked to define standards
  - Part 1 Systematic assessment of safety integrity level requirements
  - Part 2 Protecting against loss of primary containment using high integrity systems
  - Part 3 Engineering against escalation of loss of primary containment
  - Part 4 Engineering against loss of secondary and tertiary containment
  - Part 5 Operating with high reliability organisations
  - Part 6 Delivering high performance through culture and leadership

} Containment engineering

} PSM leadership

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Secondary/tertiary containment – using liners to improve bund integrity

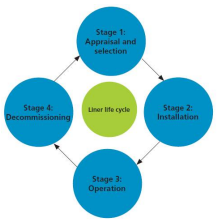
- COMAH CA *Containment policy* states that 'The bunds shall …. be impermeable [and] … be subject to periodic inspection and certification by a competent person regarding their condition and performance'.
- Part 4 of HSE *PSLG Final report* refers to 11 lining system options, however, no further information is provided on longevity, and their long term assurance.
- COMAH CA *Containment policy – supporting guidance* provides a permeability performance standard.

Secondary/tertiary containment – using liners to improve bund integrity

- EI's Containment Systems Working Group (CSWG) commissioned IKM Consulting to fill knowledge gaps.
- *Guidance on conceptual design, selection and life cycle assurance of liners intended to improve integrity of bunds to above-ground storage tanks for bulk storage of petroleum, petroleum products or other fuels* (1st edition, February 2014).

Secondary/tertiary containment – using liners to improve bund integrity

- Explains aspects of bund design, and categorises these aspects to enable proposed individual bund systems to be gauged against expected performance specifications.
- Provides a method for applying liner design criteria, the appraisal of liner options, and planning and managing the installation, operation and decommissioning of bund liners.
- Describes methods for the evaluation of bund performance (during both installation and operation) are also provided.



Secondary/tertiary containment – using liners to improve bund integrity

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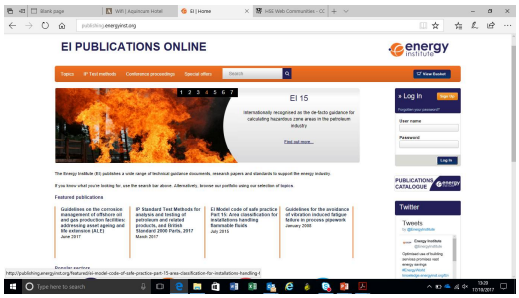

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Tank bases – using liners and leak detection to improve tank base integrity

- COMAH CA *Containment policy* states that 'ASTs … shall be …. designed and constructed to withstand impacts on their integrity from normal operations and foreseeable events; designed, constructed and installed to prevent failure due to corrosion ….; installed on appropriate and sound foundations; etc.'
- Part 4 of HSE *PSLG Final report* paragraph 173 states 'There is no consolidated set of standards and guidance covering the options for lining systems for existing tanks addressing both the issue of what to do under the tank and the application of the selected system.'

Tank bases – using liners and leak detection to improve tank base integrity

- EI's Containment Systems Working Group (CSWG) commissioned IKM Consulting to fill knowledge gaps.
- New guidance (in press) addresses the selection, installation and ongoing assurance for product options like under-tank liners and leak detection systems that are used to provide additional integrity underneath ASTs.

Tank bases – using liners and leak detection to improve tank base integrity

- Engaged:
  - operating companies and regulators (e.g. by interviews and surveys to ascertain product options in use and experiences);
  - product suppliers (by reviewing product option data sheets);
  - installation contractors (to ascertain operational experiences), etc.
- Apprised incident reports of tank failures.
- Takes cognisance of European and international knowledge, experience and information (e.g. from API standards).
- References CDOIF work on leak detection, publications like EEMUA 159, API Std. 653, etc.

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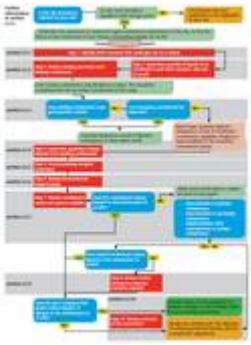
Tertiary containment

COMAH CA *Containment policy* requires that a risk assessment should be carried out to determine the extent of the requirements for tertiary containment at bulk storage installations.

- EI publications provided little information on how to address this issue, nor did they cover the conceptual design criteria for tertiary containment systems.
- Some limited, additional guidance is provided in COMAH CA *Containment policy – supporting guidance*, COMAH CA *Containment policy – implementation principles* and Part 4 of HSE *PSLG Final report*.

Tertiary containment

- EI commissioned Atkins to develop guidance to fill the risk assessment & conceptual design knowledge gaps.
- The guidance:
  - Provides risk assessment process set around 10 step decision tree.
  - Uses risk assessment to review liquid containment requirements, so environmental impacts of liquid releases are ALARP.
  - Engineered passive solutions are an option; so are active drainage/containment measures and emergency response measures.



Tertiary containment

- *Guidance on risk assessment and conceptual design of tertiary containment systems for bulk storage of petroleum, petroleum products, or other fuels* (1st edition, July 2013)

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Bund sealant integrity, selection and asset management

Bund wall gap and pipe penetration sealant integrity:

- COMAH CA *Containment policy* requires 'fire resistant [bund] ….. joints and pipework penetrations'.
- Part 4 of HSE *PSLG Final report*, paragraphs 176-185 provides guidance on fire resistance and integrity of pipe penetrations, and paragraphs 209-217 provides guidance on bund wall expansion and construction joints.

Bund sealant integrity, selection and asset management

- Part 4 of HSE *PSLG Final report: Safety and environmental standards for fuel storage sites*, paragraphs 176-185 provides guidance on fire resistance and integrity of pipe penetrations, and paragraphs 209-217 provide guidance on bund wall expansion and construction joints. A critical element is the fire resistance of the sealant used to keep the pipe penetrations or expansion and construction joints leak tight.
- Para 177 states 'Improvements should be made to the fire resistance of bund joints and penetrations where the existing arrangement has inadequate fire resistance.'.
- Para 179 states '… The fire-resistance standards commonly referenced are BS 476-20:1987 and BS 476-22:1987. The maximum fire resistance quoted in BS 476 is four hours.
  - …. but these standards are not referenced to hydrocarbon pool fires.

Published 2009

Bund sealant integrity, selection and asset management

- Commercial sealant products marketed; but, lack of detail in manufacturer literature regarding their performance against pertinent fire resistance test methods
- EI tested commercial sealant products in medium scale realistic hydrocarbon fires.

Bund sealant integrity, selection and asset management

- Fire testing – Phase 1: 'Dry burn' fire testing

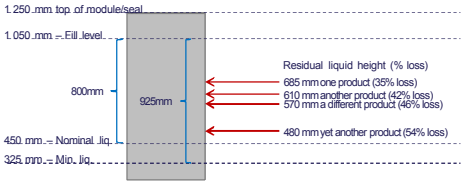
Test cell with 2 seals installed

Bund sealant integrity, selection and asset management

- Fire exposed test specimen – intumesced toward top of wall section and on top face as 'in flame'

Bund sealant integrity, selection and asset management

- 'Overnight' leak test – after fire exposure
  - 35-55% water losses, all within flame exposure zone



Bund sealant integrity, selection and asset management

- In bund pool fire incidents, carefully consider implications of adding firewater and/or fire-fighting foam.
  - Rising liquid level will come into contact with the fire exposed sealant joint and push it outwards, increasing the likelihood of loss of containment from the bund.
  - Involve Fire Authorities in incident planning.
- Guidance under development – publication expected Q2 2018.

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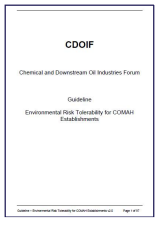
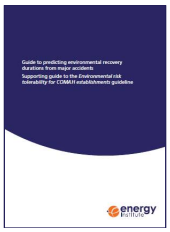
Environmental recovery periods

- New guidance that builds on CDOIF *Guideline: Environmental risk tolerability for COMAH establishments*.
- CDOIF methodology refers to ultimate consequences of environmental incidents depend on the (natural) recovery time of the environment.
  - Longer term harm will produce a less tolerable consequence than one of only short duration.
  - Notes limitation in that duration/recovery criteria for the relevant receptors are broad-brush for screening purposes.



Environmental recovery periods

- New EI guidance fills that gap for some receptors – surface water and land. Excludes groundwater and groundwater or surface water drinking water sources.
- *Guide to predicting environmental recovery durations from major accidents. Supporting guide to the Environmental risk tolerability for COMAH establishments guideline* (1st edition, October 2017). http://publishing.energyinst.org
- The guidance will remain under review, so as to capture user experience.



Environmental recovery periods

- Incudes relevant data points for water receptors:
- Water habitat 1 includes reservoirs, estuaries etc

Table 2: Recovery duration of water habitats for commonly occurring chemicals at petroleum facilities

Chemical	Chemical group	Recovery duration[1]		
		Water Habitat 1	Water Habitat 2	Water Habitat 3
BTEX	Volatile	<1 year	<1 year	<1 year
Crude oil	Break down or transform	<1 year	>1/2 years	>20 years
Ethanol	Volatile	<1 year	<1 year	<1 year
ETBE	Volatile	<1 year	<1 year	<1 year
HF	Volatile	<1 year	<1 year	<1 year
PFAS[2] firefighting foam	Break down or transform	<1 year	>1/2 years	>20 years
MTBE	Volatile	<1 year	<1 year	<1 year
Sodium hydroxide	Break down or transform	<1 year	>1/2 years	>20 years
Sulfuric acid	Break down or transform	<1 year	>1/2 years	>20 years

Footnotes:
[1] Recovery duration is based on the fuel oils, benzene and heavy fuel oils that will remain in the environment longer than the more volatile components, naphtha and gasoline.
[2] Categorisation of per- and polyfluorinated alkyl substances (PFAS) is based on hexadone glycol, which is a primary constituent of firefighting foams.
[3] Refer to Figure 1 for details on the specific water habitats included in each group.

Environmental recovery periods

- Incudes relevant data points for land receptors:
- Land habitat 2 includes agricultural land; land habitat 5 includes woodland

Table 3: Recovery duration of land habitats for commonly occurring chemicals at petroleum facilities

Chemical	Chemical group	Recovery duration[1]		
		Land Habitat 1 and 2	Land Habitat 3 and 4	Land Habitat 5
BTEX	Volatile	<1 years	<1 years	<1 years
Crude oil	Break down or transform	>1 years or 2 growing seasons[2]	>20 years	>50 years
Ethanol	Volatile	<1 years	<1 years	<2 years
ETBE	Volatile	<2 years	<1 years	<2 years
Hydrogen fluoride	Volatile	<1 years	<1 years	<2 years
PFAS[3] firefighting foam	Break down or transform	>1 years or 2 growing seasons[2]	>20 years	>50 years
MTBE	Volatile	<1 years	<1 years	<1 years
Sodium hydroxide	Break down or transform	>1 years or 2 growing seasons[2]	>20 years	>50 years
Sulfuric acid	Break down or transform	>1 years or 2 growing seasons[2]	>20 years	>50 years

Footnotes:
[1] Recovery duration is based on the fuel oils, benzene and heavy fuel oils that remain in the environment longer than the more volatile components, naphtha and gasoline.
[2] Two growing seasons limited to agricultural land only.
[3] Refer to Figure 1 for details on the specific land habitats included in each group.

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Final thought ….. Where do you store your foam concentrates and are they properly managed?

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