RISK 2014 Conference

Efficient incorporation of a Buncefield-type explosion in QRA analysis

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Buncefield Oil Storage Depot

The Buncefield Incident: December 2005

- At 5:30 am, gasoline is transferred to Tank 912
- Safety systems in place to shut off supply fail to operate
- Tank overfills shortly after with approximately 10 w/w% of released material feeding a vapour cloud
- A white mist observed as vapour cloud formed by the mixture of petrol and air flowed over the bund wall
- At 6:01 am, explosion of massive proportions

Buncefield Site and Surrounds

Presentation Plan

- Buncefield Incident Review
- Local Implications
- QRA
- Method of Analysis
- Frequency Assessment
  - Fault Tree
  - Event Tree
- Consequence Assessment
  - Estimating explosion impact
- Risk Evaluation

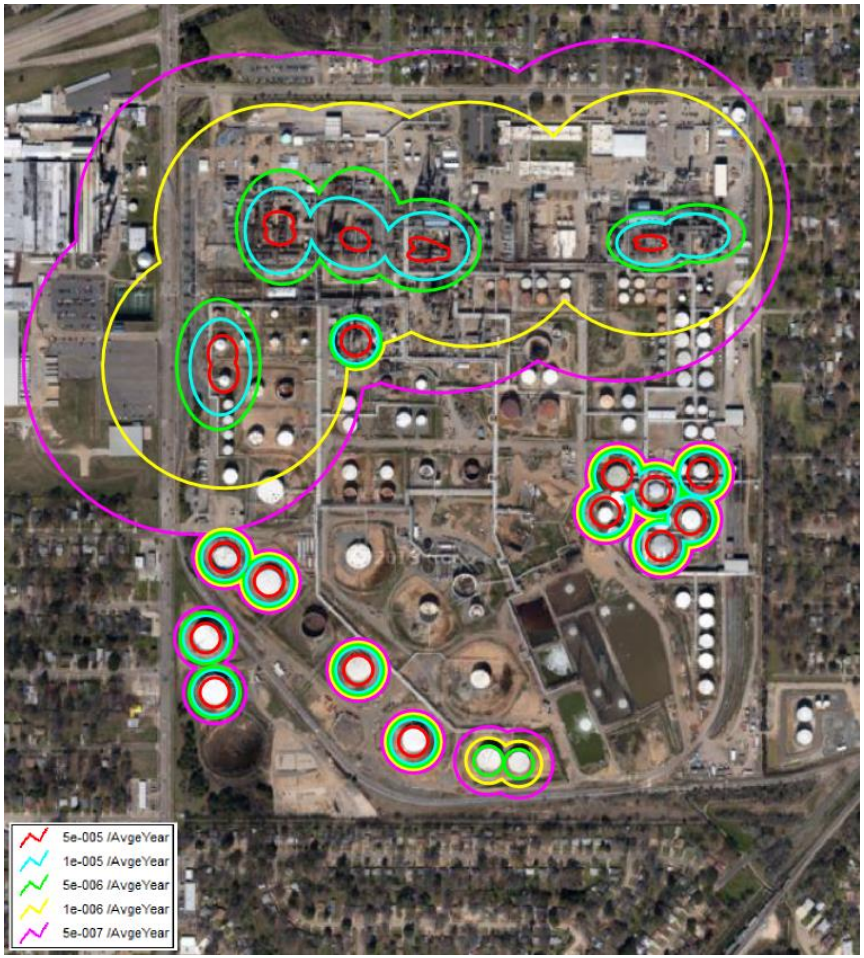
Local Implications of the Buncefield Incident

- Regulators are asking Operators to consider a Buncefield type incident

- Operators request risk analysts to assess the potential for a Buncefield type incident at their facilities
  - Terminals, Tank Farms

- Requests arise whilst conducting a risk assessment on the whole facility
  - LOPA / Bowtie Analysis; OR
  - Quantitative Risk Assessment (QRA)

QRA & Land Use Planning



QRA and the Buncefield Incident

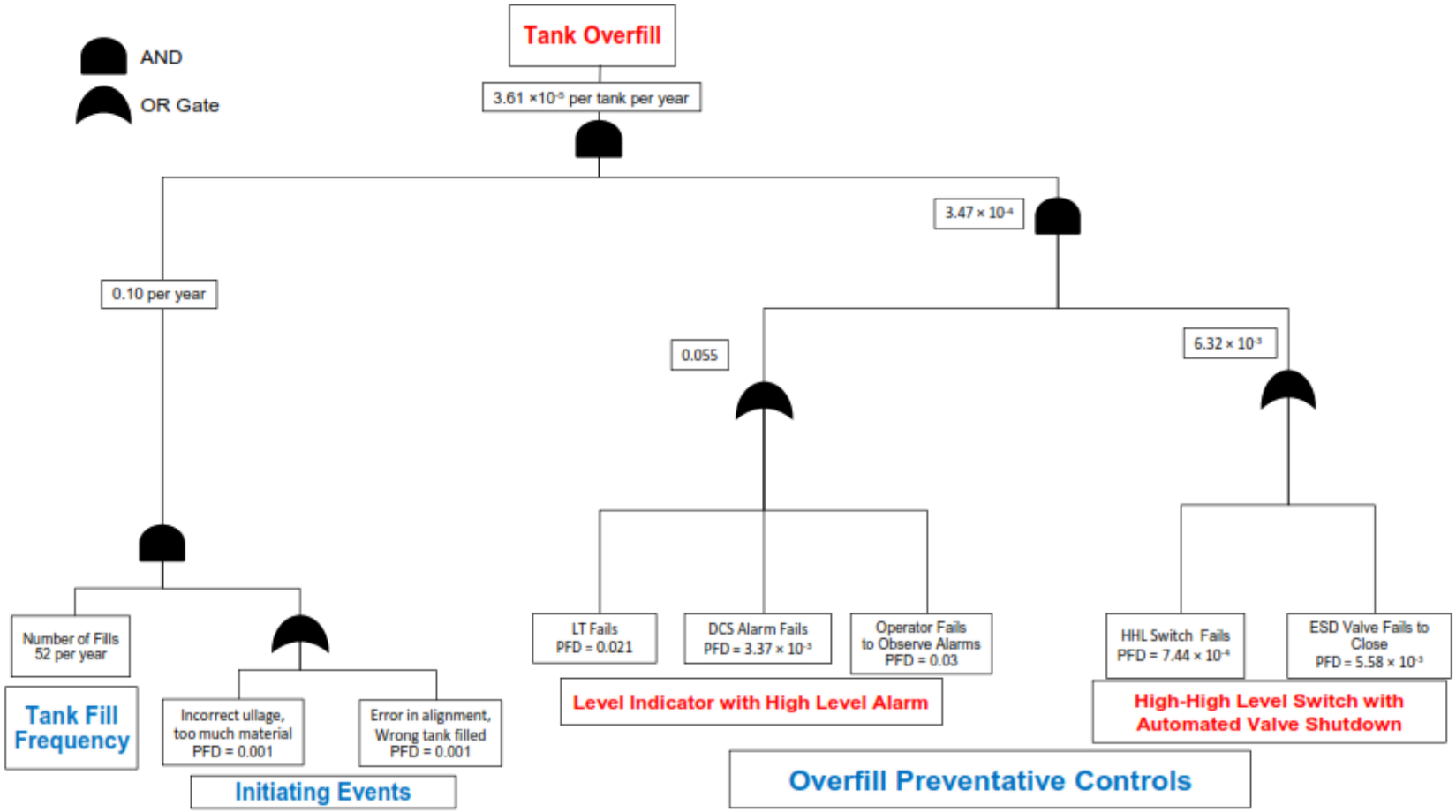
- QRA
  - Large number of scenarios (100's)
  - Outcomes are generally well-understood
  - Expectations based on the established techniques

- The Buncefield Incident
  - A single scenario
  - Explosion unexpected and it's magnitude unusual
  - Immense effort invested into investigation to understand event

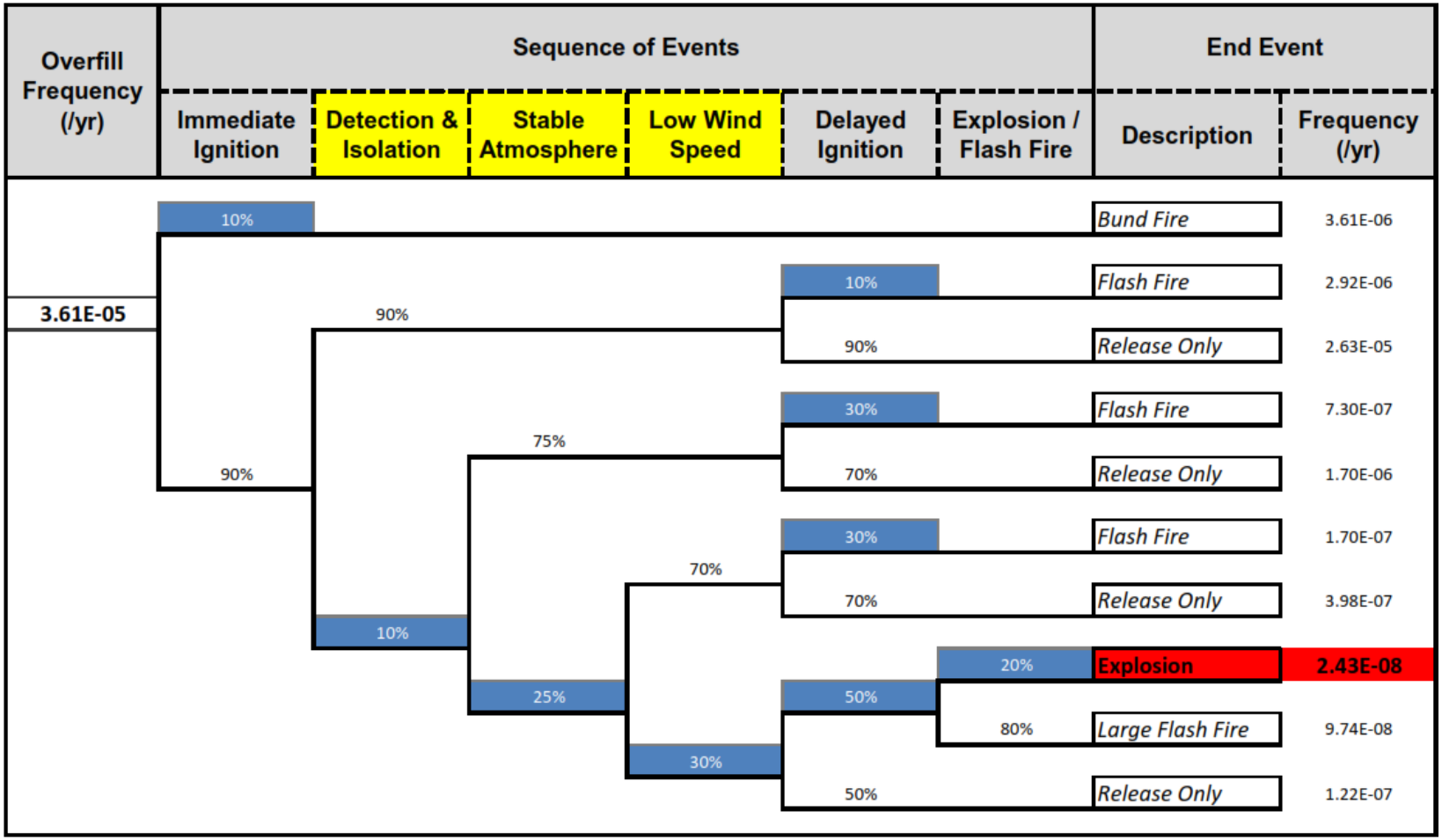
Method of Analysis

- Balance detail against needs of the assessment
- Review reports by the Major Incident Investigation Board
- Quantify critical parameters for facility being assessed
  - Overfill protection
  - Composition of Material involved
  - Local weather conditions
- Explosion mechanism discussion beyond scope

Frequency Assessment: Fault Tree Analysis



Frequency Assessment: Event Tree Analysis



Consequence Assessment: Overview

- Consequences assessment based on documents prepared for the Buncefield investigation

- Assessment involves the following steps:
  1. Compare key parameters for out Site and Buncefield
  2. Examine potential cloud size using dispersion modelling
  3. Evaluate overpressure impact distances using *Illustrative Model*

Consequence Assessment: Comparison of Key Parameters

Key Parameters	Site	Buncefield
Fill Rate (m^3/h)	Up to 1,000 m3/h	Up to 890 m^3/h
Fraction feeding vapour cloud	**5 vol%**	10 w/w%
Fraction Lights Available	1.0	1.0
Vapour Rate (kg/s)	**8.3**	19.0
Cloud Slumped Height (m)	2.0	2.0
Cloud Area (m^2)	**50,000**	120,000
Cloud Volume (m^3)	**100,000**	240,000

Consequence Assessment: Estimating Cloud Size and Impact

- Dispersion modelling used to estimate the influence of wind speed / stability on cloud size

- Compare estimated cloud size with ranges considered in the *Illustrative Model*
  - Range considered appropriate 50,000 m^3 -150,000 m^3

- Used *Decay Curves* used in *Illustrative Model* to calculate overpressure for selected cloud size range
  - Curves developed based on damage observed at Buncefield

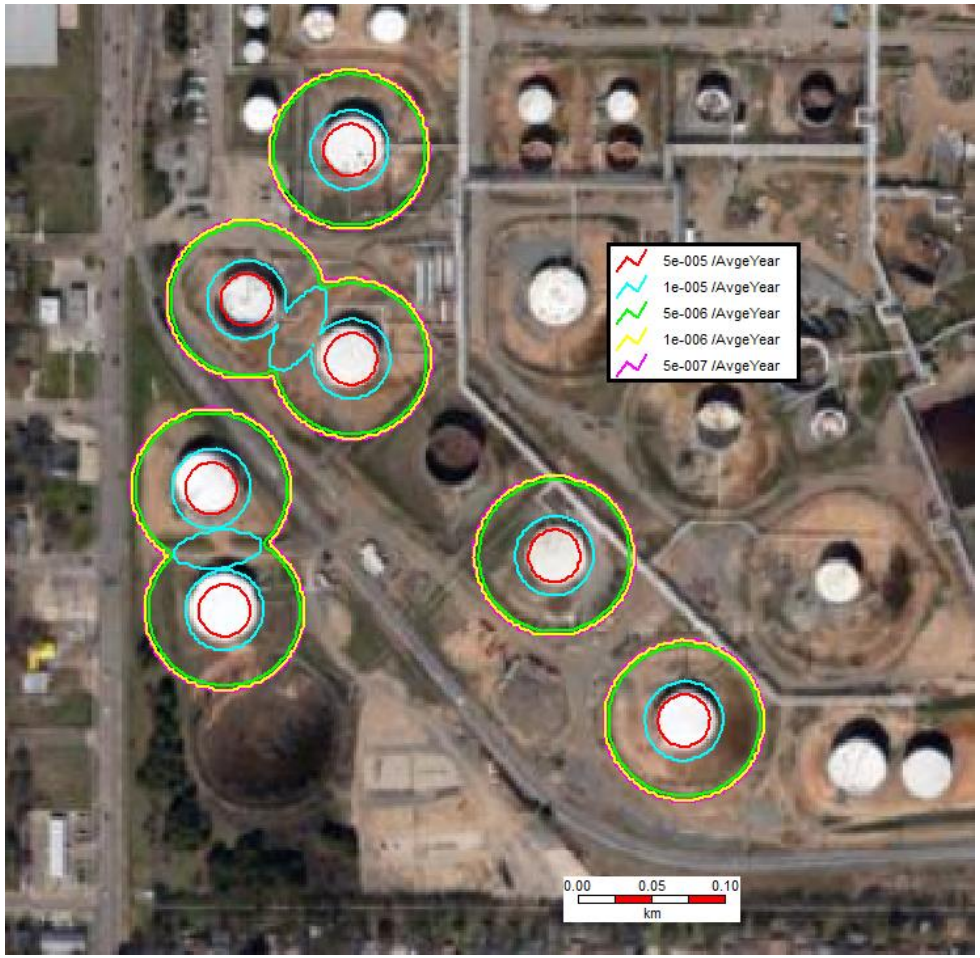
Risk Evaluation: Frequency and Consequence

- Low frequency:
  - **2.43×10^{-8}** per tank per year (0.02 per million per year)

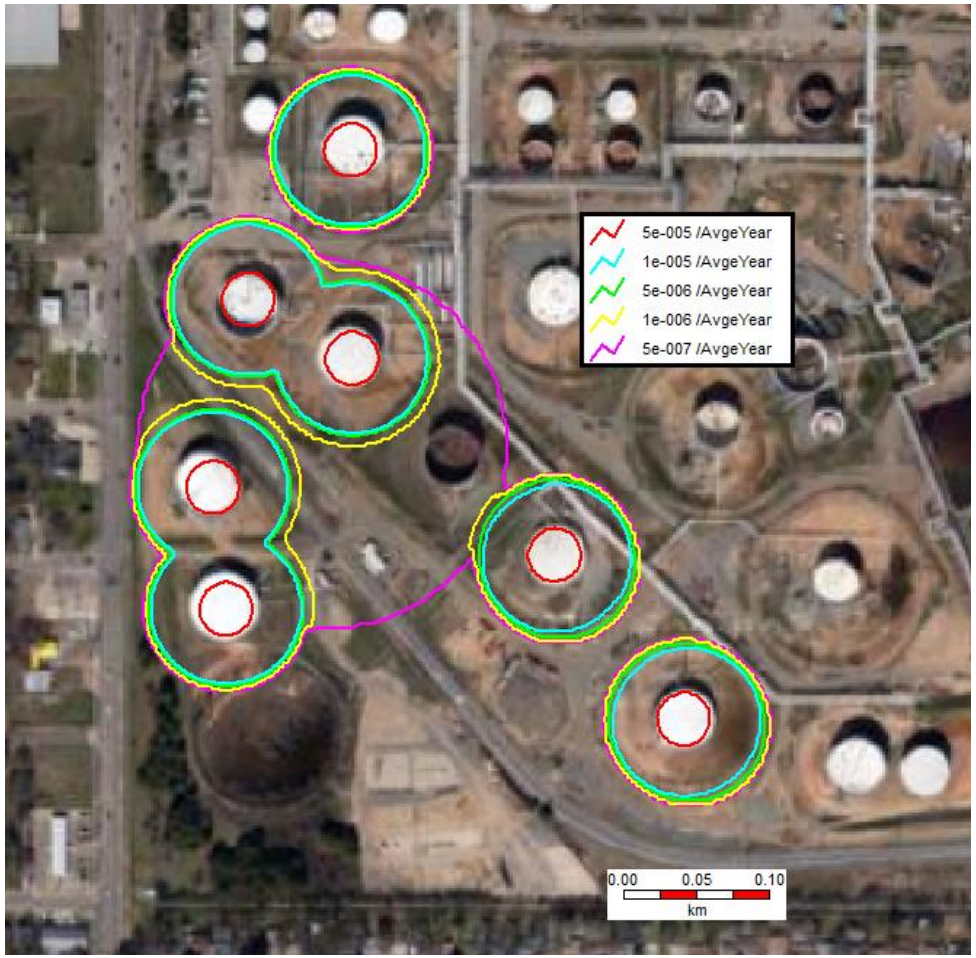
- Far-reaching consequence:
  - Overpressures impact estimated from *50,000-150,000 m^3 Max*:
    - 35 kpa 126 m (*cloud edge*)
    - 21 kPa 212 m
    - 14 kPa 255 m
    - 7 kPa 367 m

- Include derived values in QRA model to generate risk contours for facility

Risk Results for Seven ULP Tanks: QRA Output **without** Tank Overfill



Risk Results for Seven ULP Tanks: QRA Output **with** Tank Overfill



Conclusion

- Buncefield scenario can be efficiently incorporated into a QRA whilst capturing site specfic elements

- Event not a significant contributor to overall risk profile

- Higher contribution if there are concerns around controls

- Long-term focus on an assessing and maintaining control adequacy

Thank you