

RISK 2014 Conference



Assessing the risk to occupants within process buildings



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- Previous incidents
- Use of planning strategies
- Locating occupied buildings considering blast impact
- Evaluating impact of toxic release

- A vertical crack in reactor No.5 was leaking cyclohexane.
- Reactor was removed with a bypass assembly installed
- Bypass ruptured releasing a large quantity of cyclohexane
- Formed flammable vapour mixture found a ignition source
- 28 workers killed with 36 suffered injuries
- 18 fatalities in the collapsed control room

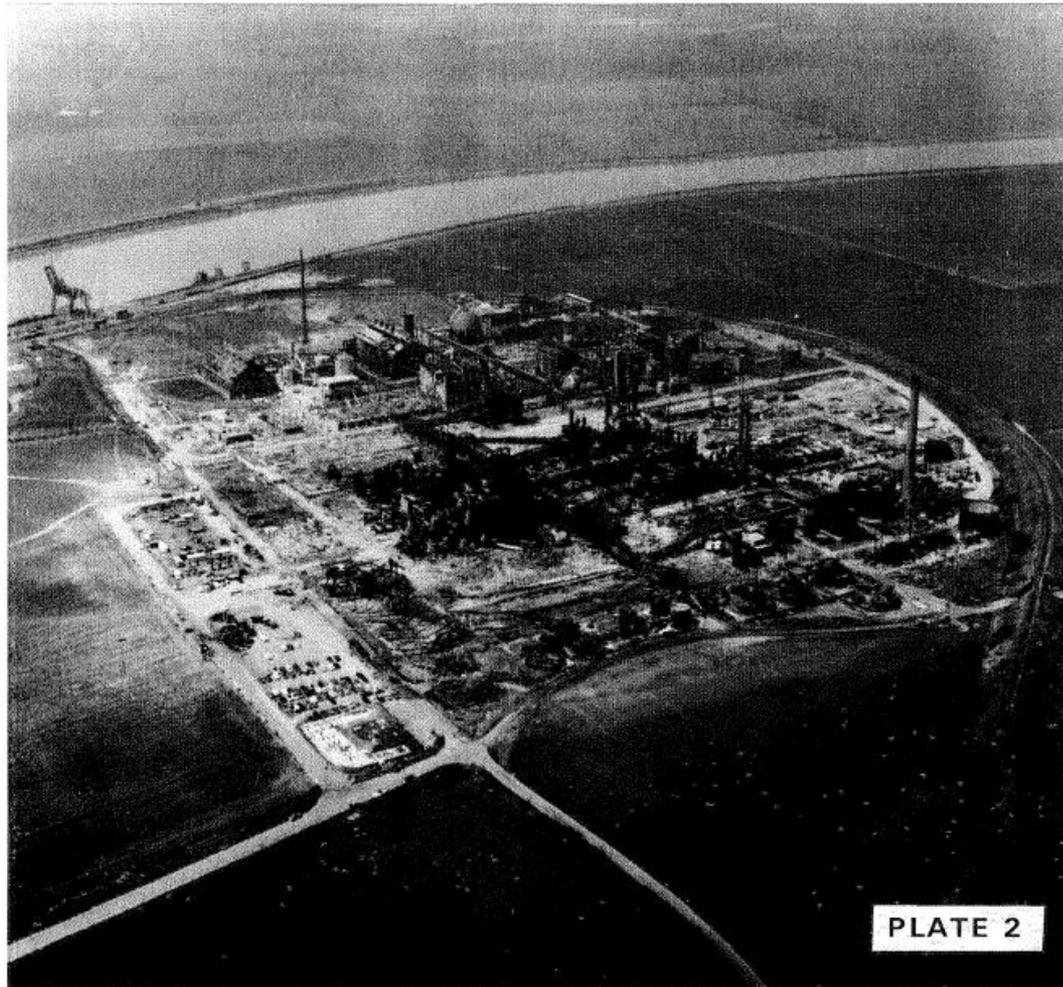


Plate 2 Works after the explosion. View from the south-east.

Department of Employment (1975), "The Flixborough Disaster", Report of Court of Inquiry, HMSO.

- Restarting of a hydrocarbon isomerisation unit
- Overpressure of flooded distillation tower causing a release from the vent stack
- Large flammable vapour cloud (~19,000 m² area)
- 15 workers killed with 180 injured
- Majority of fatalities where personnel in trailers near vent stack

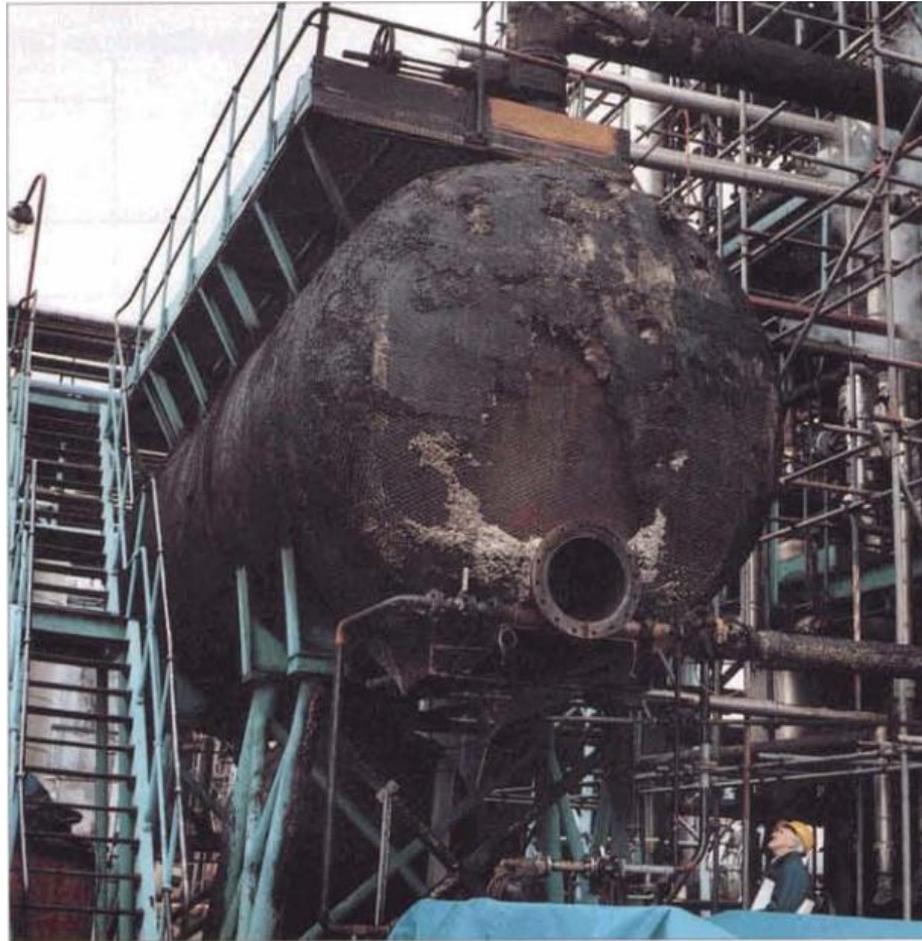


CSB (2007), "Investigation Report of Refinery Explosion and Fire, BP Texas City, Texas"

- Cleaning operation to remove residue (MNT, organic nitro products) was heated to assist removal
- Exothermic reaction within residue leading to the jet flame erupting from manway, approx. 50 m
- Flame cut through an office / control building nearby and reached four-storey office block
- 5 workers killed numerous injured (during the emergency response)

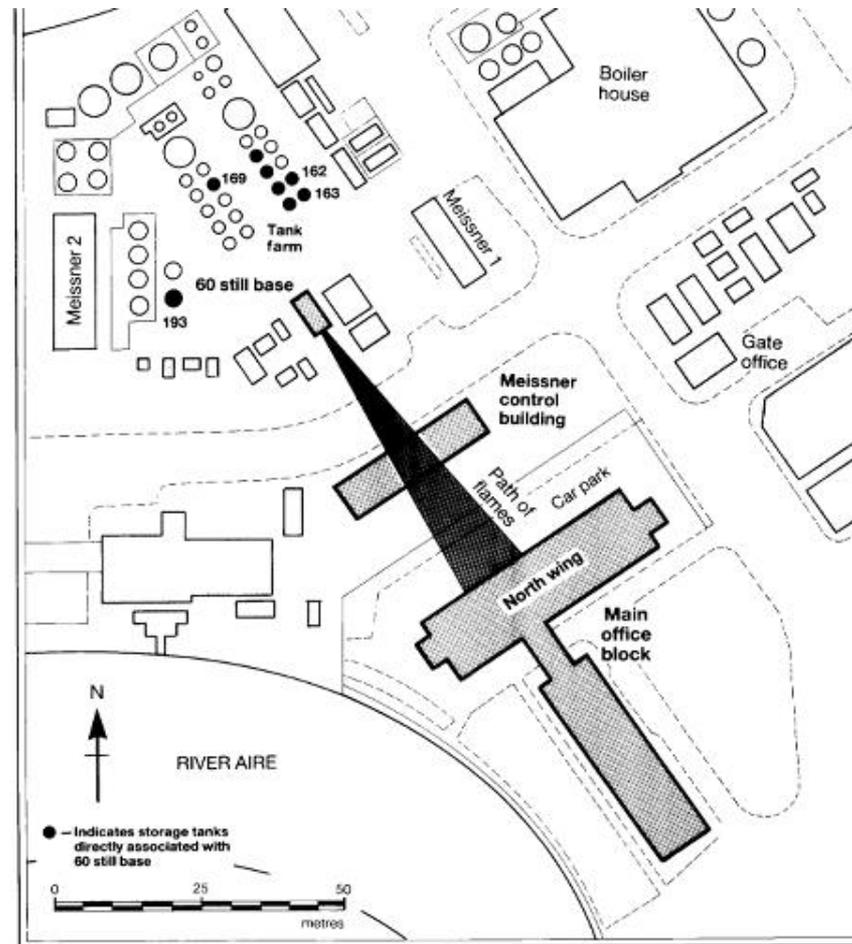
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Jet Fire at Hickson & Welch, 21 September 1992



HSE Books (1994), "The Fire at Hickson and Welch Ltd", HMSO.

Jet Fire at Hickson & Welch, 21 September 1992



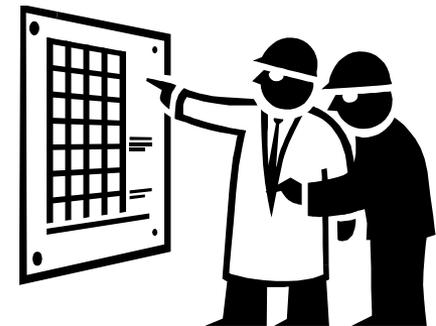


HSE Books (1994), "The Fire at Hickson and Welch Ltd", HMSO.

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Development of Planning Strategies

- Planning strategies developed for building occupants
 - API RP 752: Location of Process Plant Buildings (2009)
 - API RP 753: Location of Process Plant Portable Buildings (2007)
- Planning strategies address different hazards:
 - Building collapse when subject to blast loads from explosion
 - Thermal hazards from fires near buildings
 - Ingress of toxic vapour
- Assessment approach
 - Consequence based
 - Risk based
 - Spacing tables



- Determine buildings to be included in assessment scope
- Identify process hazards with potential to impact buildings
- Model related scenario(s) to determine impact
- Evaluate building response to determined impact
- Compare impact with building siting evaluation criteria
 - *Siting evaluation criteria set by Operator*

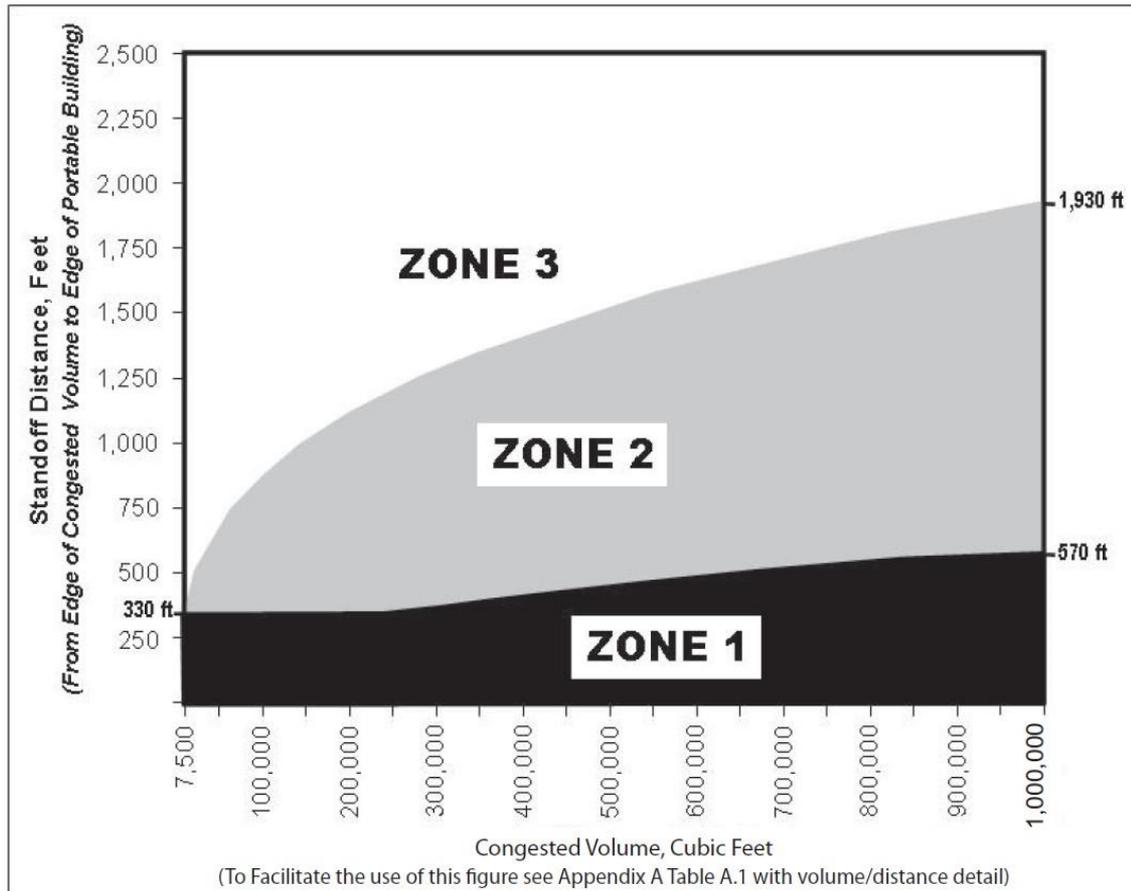
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Consequence-based v. Risk-based

- Consequence-based approach
- Risk-based approach
- In scenario development both consider:
 - Site specific data: material, inventories, operating conditions, process layout
 - Industry knowledge on history of incidents at similar sites

- Portable buildings
- Guiding principles similar to API RP-752
- Restrictions on personnel
- Guidance for VCE hazards

API RP-753: Location of Portable Buildings



Zone 1

No wood trailers
Other portable buildings require detailed analysis
Essential personnel only

Zone 2

Wood trailers and other portable buildings require detailed analysis
No restrictions on occupancy

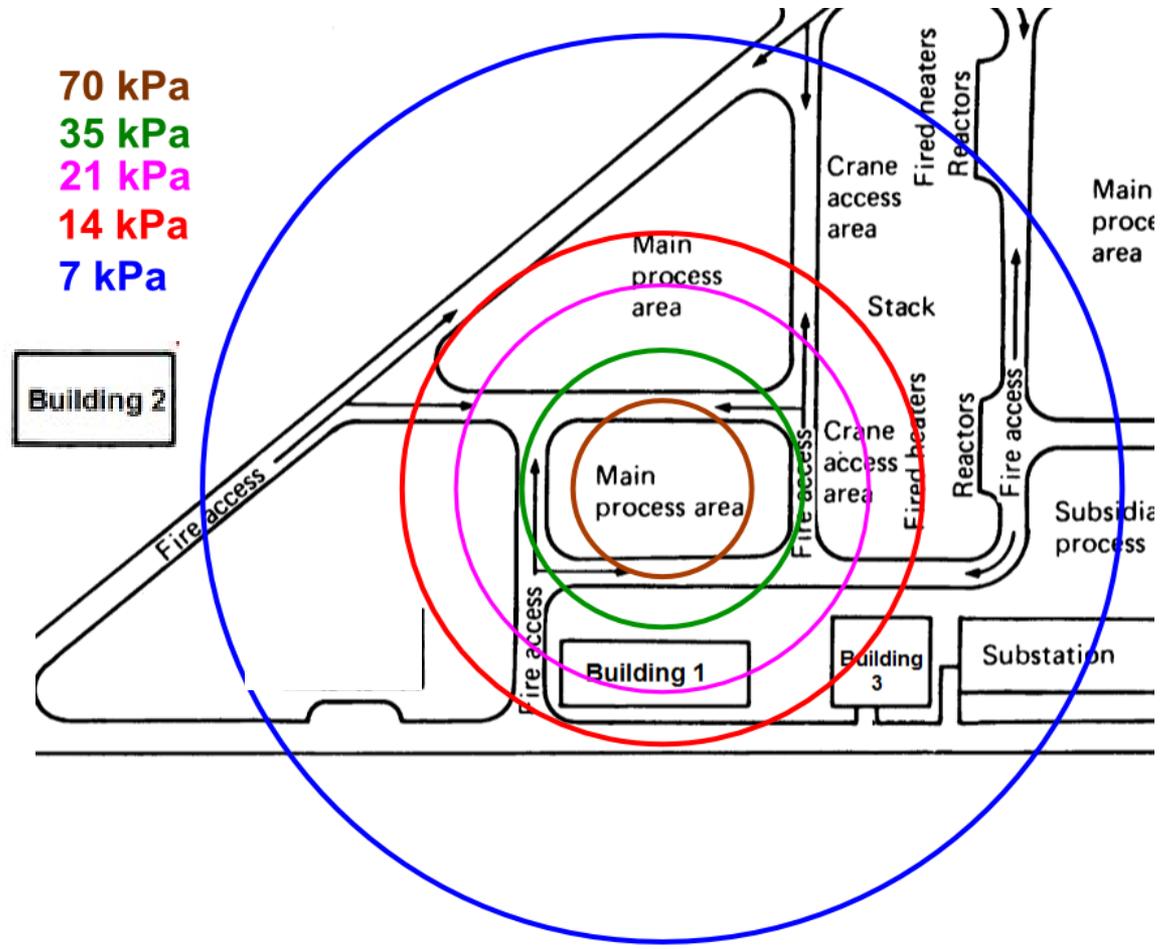
Zone 3

No restrictions

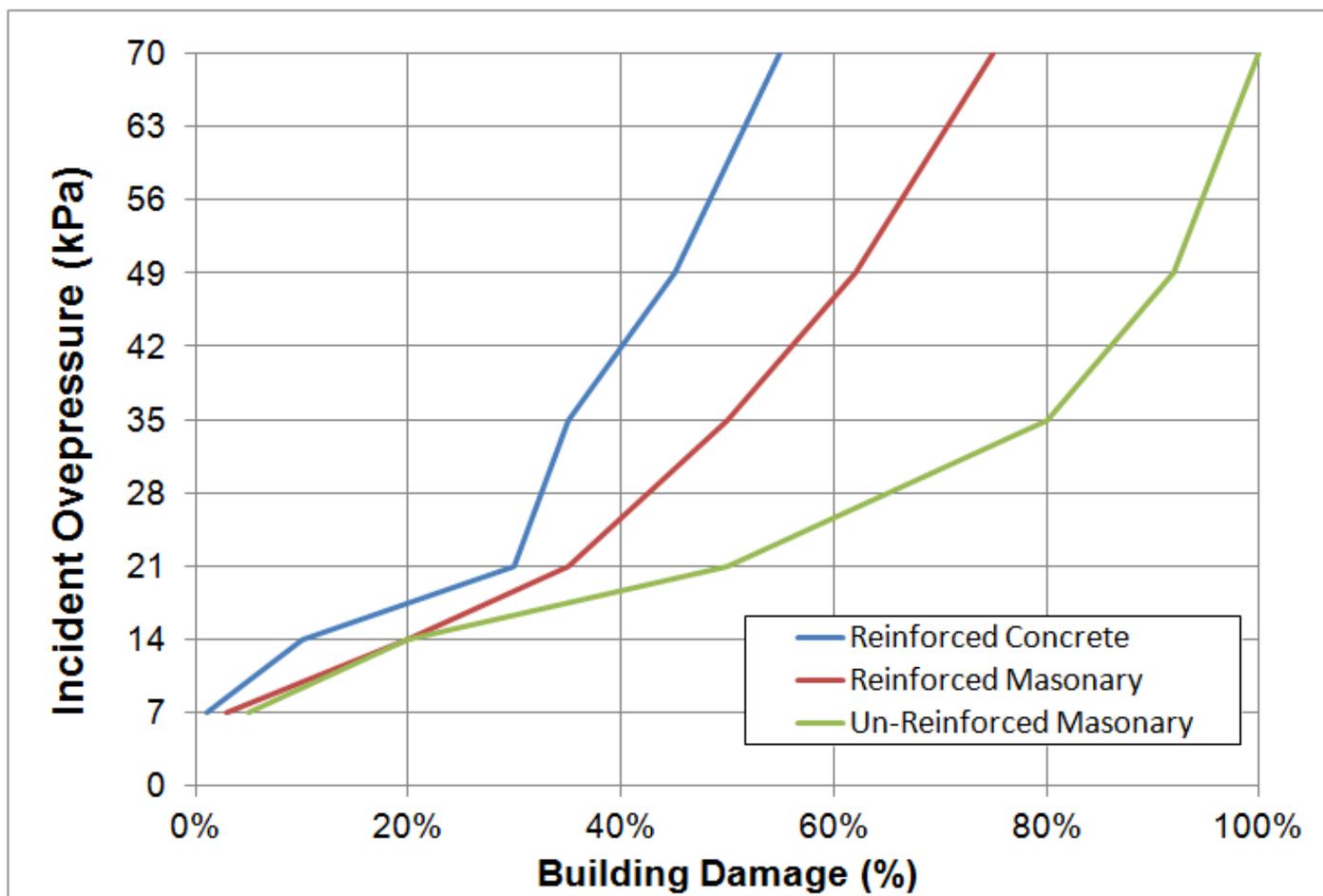
Figure 1 – Portable Buildings Location Guide, API 753 – Management of Hazards Associated with Location of Process Plant Portable Buildings June 2007

- Facilities established prior to development of planning strategies reflecting current knowledge of hazards
- High-cost of relocating existing buildings
 - Competing capital priorities
- Facilities established → limited space
 - Expense of surrounding land purchase (if available)
- Risk-based approach

Identify VCE Scenarios



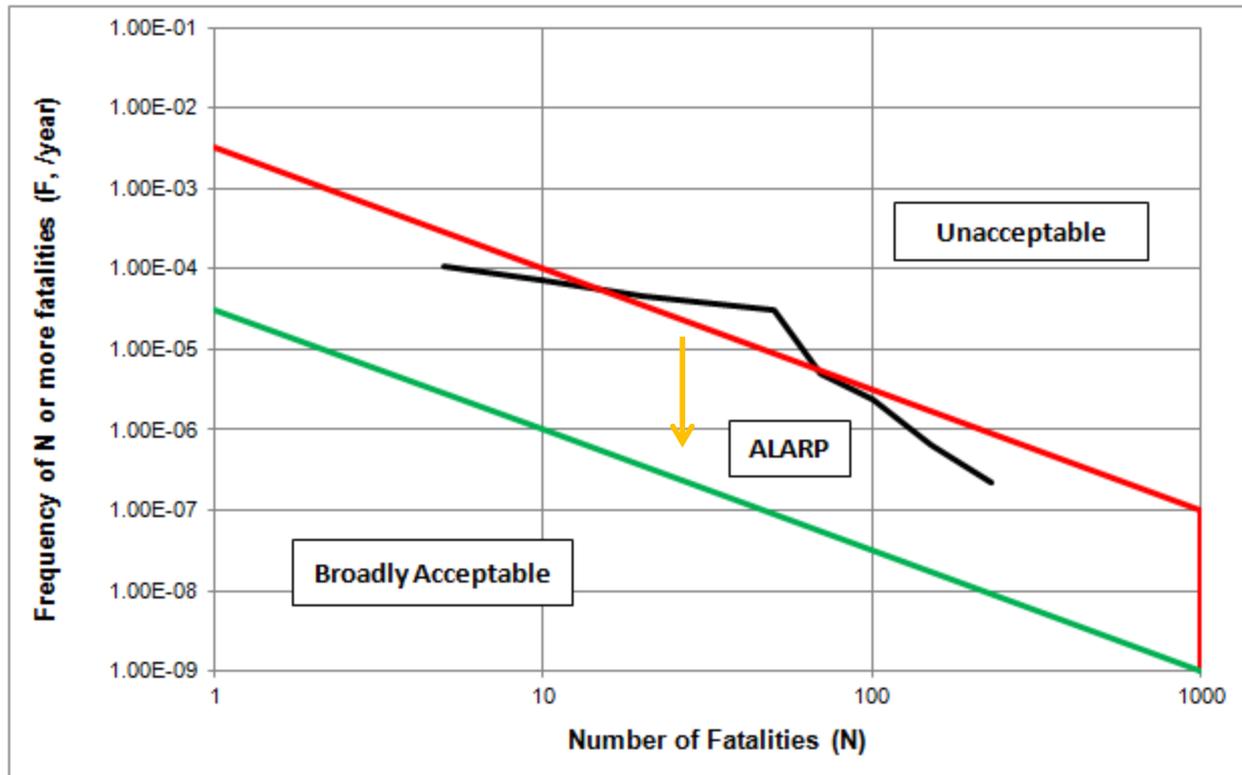
Assess Impact on Buildings: Building Damage Curves



US DDESB (2009), "Approved methods and algorithms for DOD Risk-Based Explosive siting"

- Consider Hierarchy of Mitigation Measures
- Typical options used
 - Reduce consequence of release
 - Strengthening of building
 - Relocation of personnel to alternate locations
 - Abandon the building

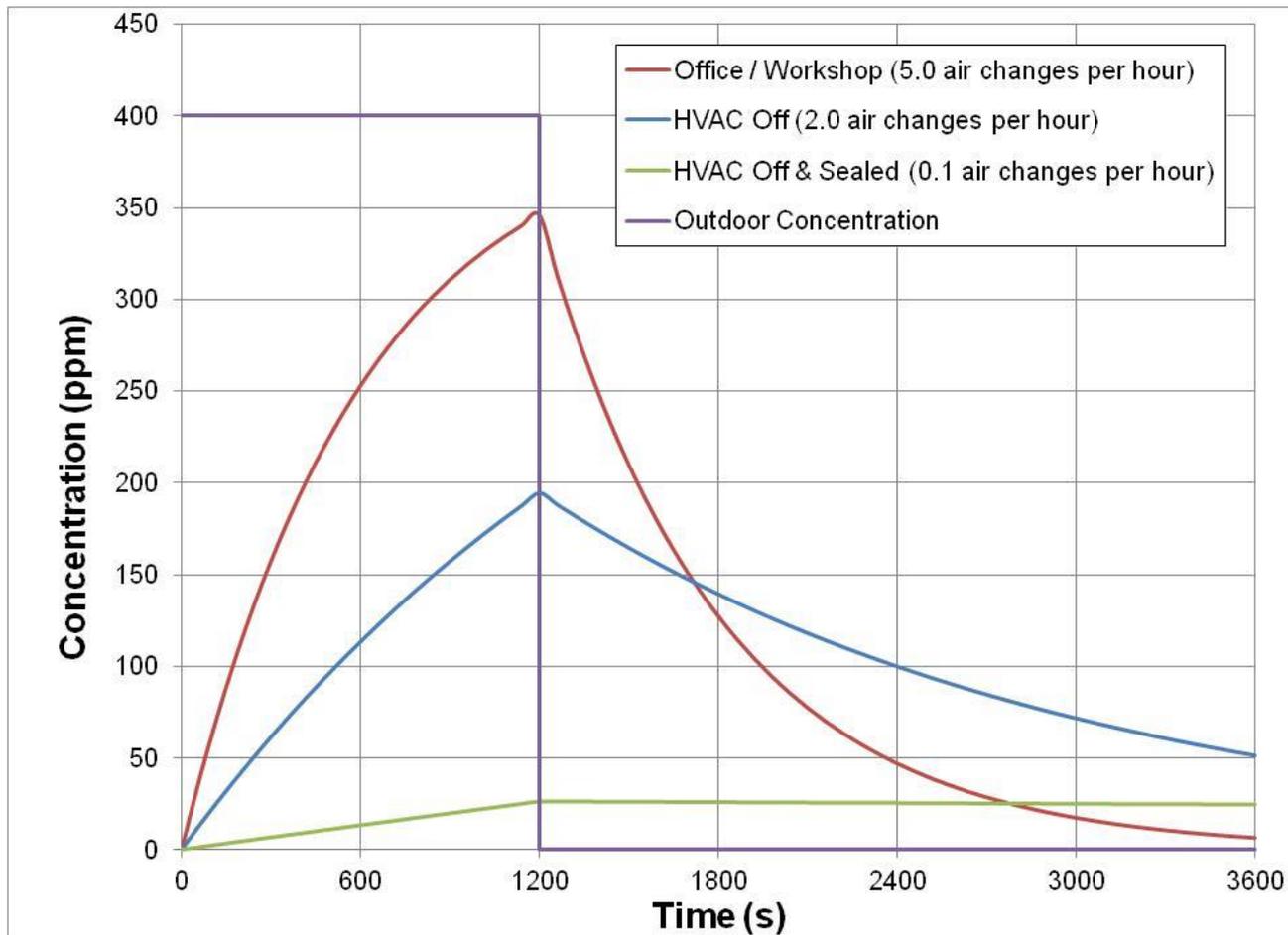
Assess Risk Result against Siting Evaluation Criteria



Toxic Incident: Richmond, California, USA, 1993



- Apply general approach in assessing toxics
 - Set Criteria (e.g. ERPG-3), Identify, Quantify, Assess
- Modelling use to quantify the toxic impact
 - External to a building (*Dispersion Model*)
 - Inside a building (*CSTR Model*)
- Toxic levels inside the building depend on:
 - Outdoor concentration derived from dispersion model
 - Ventilation rate
 - Time personnel within building



- Shelter-in-place should have the following features:
 - HVAC system capable of rapid shutdown or recirculation mode
 - Exhaust with a positive seal on air-intakes to prevent infiltration
 - Emergency communication equipment
 - Seals for windows and doors
- Sufficient volume to meet physiological requirements of occupants
- Number & location depends on exposed worker groups
- Mechanism to determine whether toxic cloud has passed
 - Determines whether to restart the HVAC or exit building

- Development of emergency response plan
 - Adequate training and procedures
- Direct people to either:
 - Personnel to a designated “Shelter-in-Place”; OR
 - Specified assembly areas
- Where required, provide personnel evacuating with PPE

- Use industry developed planning strategies for locating buildings in process areas
- Consequence-based approach used in the placement of portable buildings and / or where space is not an issue
- Risk-based approach can be used to address legacy issues of buildings in process plant areas