Ensuring Safety in Occupied Buildings

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Your Speaker

- Elio Stocco
- Director & Principal Risk Consultant
- CEng, RPEQ, Feng (TÜV Rheinland)
- Over 30 years' experience
  - Operations / process safety / risk management consulting
- Technical Expertise:
  - Hazard identification and risk assessment (HAZOP, SIL, LOPA, CHAZOP)
  - Safety case development and auditing
  - Emergency response planning
  - Fire, toxic and explosion modelling
  - Occupied buildings risk assessment

R4Risk – Risk Management & Process Safety

Technical Studies

- Hazard Identification (HAZOP, HAZID)
- Layer of Protection Analysis (LOPA)
- Safety Integrity Level (SIL)
- Fire Safety Studies
- Quantitative Risk Assessment (QRA)
- Consequence Analysis
- Emergency Response Planning
- Hazardous Area Assessment
- Occupied Building Risk Assessment (OBRA)

Process Safety Management

- Dangerous Goods Management
- Major Hazard Facilities Safety Management
- Process Safety Management Studies
- Safety Case Development
- Safety Case Compliance Auditing
- Safety Case / Report Approved Assessor
- Safety Management System Development
- Accident Investigation

Business Risk Management

- Business and Operational Risk Management
- Enterprise-Wide Risk Management

Training

- Process Safety and Risk Management Training
- Risk Mentoring

Overview

- Previous incidents
  - Fires, explosion and toxic events
- Describe the guidance to manage the risk to personnel inside buildings
- Siting evaluation based on explosion

Flixborough: June 1, 1974

- 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

Jet Fire: Hickson & Welch, 1992

- Clean operation was organised to remove residue from vessel used to distil organic liquid in a batch process
- 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
- Flame reached four-storey office block, shattering windows and setting rooms on fire
- 5 workers killed and numerous injured

BP Texas City: 23 March 2005

- Restarting of a hydrocarbon isomerisation unit
- Overpressure of flooded distillation tower causing a release from the vent stack
- Large flammable vapour cloud (~19,000 m^2 area)
- Suspected ignition source an idling diesel pickup truck
- 15 workers killed with 180 injured
- Majority of fatalities where personnel in trailers near vent stack

Texas City: Overpressure Impact

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

Toxic Releases

- Richmond, California USA (July 26, 1993)
  - Oleum release from tank car
  - Employees in the direct path sheltered indoors
  - No injuries reported to employees but 22 hospitalised in the community
- Nitro, West Virginia USA (December 5, 1995)
  - Release of a phosphorus chloride compound
  - Rain results in formation of HCl cloud that drifted off-site
  - 800 employees sheltered-in-place, no injuries reported
- Ludington, Michigan USA (February 7, 1993)
  - Release of bromine gas
  - Sheltered-in-place for 3 hours
  - No injuries

Management of Hazards for Occupied Buildings

- Guidance developed for building occupants
  - API RP 752: Location of Process Plant Buildings (2009)
  - API RP 753: Location of Process Plant Portable Buildings (2007, Reaffirmed Aug 2020)

- Planning strategies address different hazards:
  - Building collapse when subject to blast loads from explosion
  - Thermal hazards from fires
  - Ingress of toxic vapour

- Assessment approach
  - Consequence based
  - Risk based
  - Spacing tables

API RP-752:
Location of Process Plant Buildings

- New and existing rigid structures permanently placed

- Management process for siting evaluations:
  - Locate personnel away from process areas
  - Minimise the use of buildings close to process areas
  - Manage occupancy within those buildings close to process areas
  - Buildings intended for occupancy should be designed, constructed, modified and maintained to protect against hazards
  - Manage the building occupancy as part of facility operation

API Assessment Approach

- Determine buildings to be included in assessment scope
  - Permanent / temporary / new
- Identify process hazards with potential to impact buildings
  - For each hazard, model related scenario(s) to determine impact
- Chose the building evaluation criteria
  - Consequence-based
  - Risk-based
  - Spacing tables

API Assessment Approach (Cont'd)

- Evaluate building response to determined level of impact
- Compare impact with building siting evaluation criteria
- For an existing building, mitigation options need to be considered when the criteria is not met
- Develop and implement the mitigation plan
- Personnel performing building site evaluation must have competence in analysis techniques

API RP-752:
Management of Change (MOC)

- Operator should identify the situations requiring MOC:
  - A new building intended for occupancy
  - Modification to existing building that may alter vulnerability to different events
  - Moving from not intended for occupancy to occupied
  - Change in number of personnel or time spent
  - Change in the process operation
    - Hazardous material inventory
    - New equipment

Siting of New Buildings

- For new buildings
  - Similar overall approach
  - The building is then designed to meet the building siting evaluation criteria

API RP-753:
Location of Portable Buildings

- Portable buildings
  - Offices, Training Rooms, Conference Rooms, Change houses
- Guiding principles similar to API RP-752
  - Modified for portable buildings
- Restrictions on personnel
  - Only essential personnel are allowed close to process units
  - Placement requires detailed analysis
- Guidance for explosion hazards
  - Zones

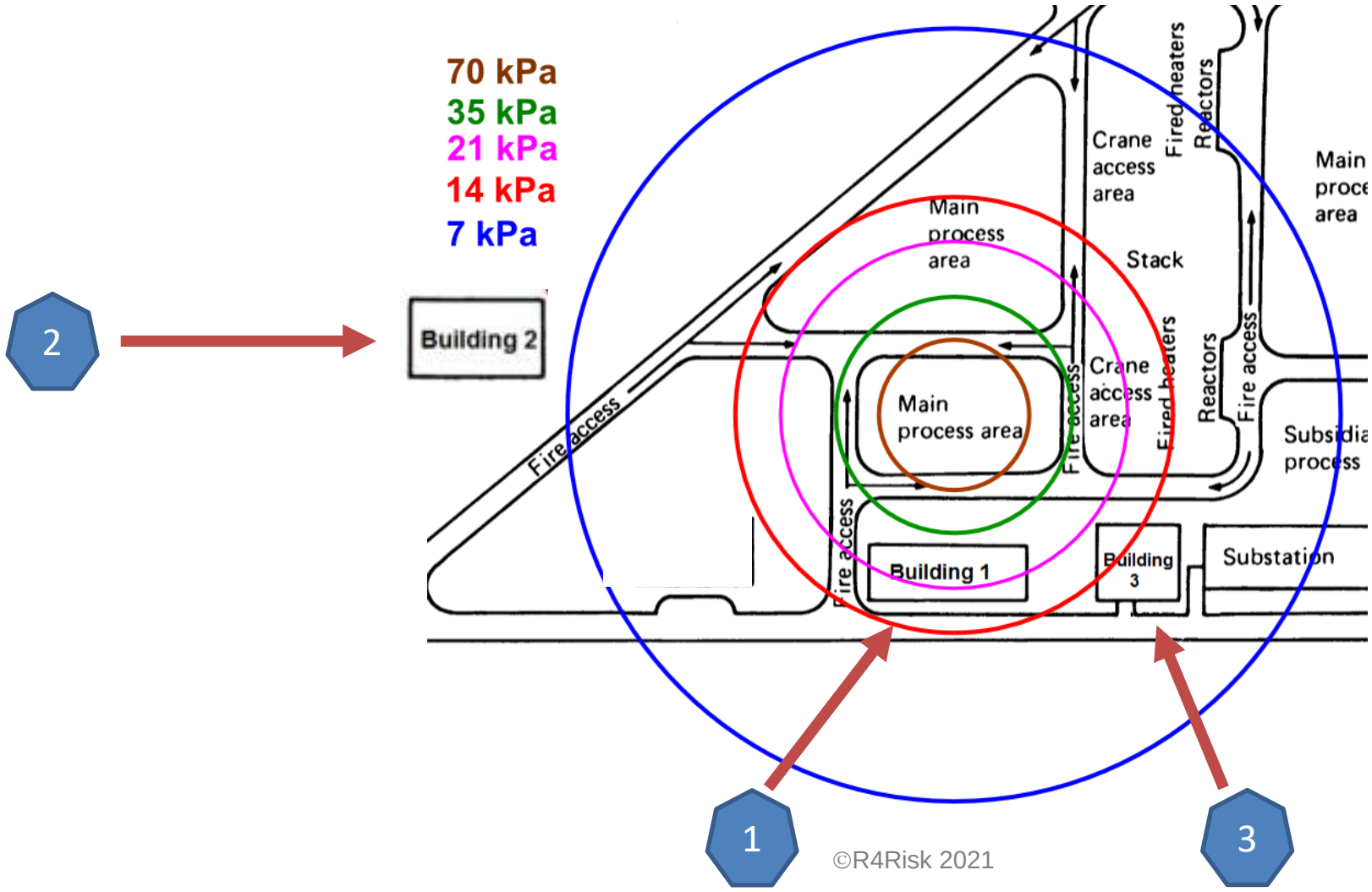
Consequence-Based or Risk-based

- 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

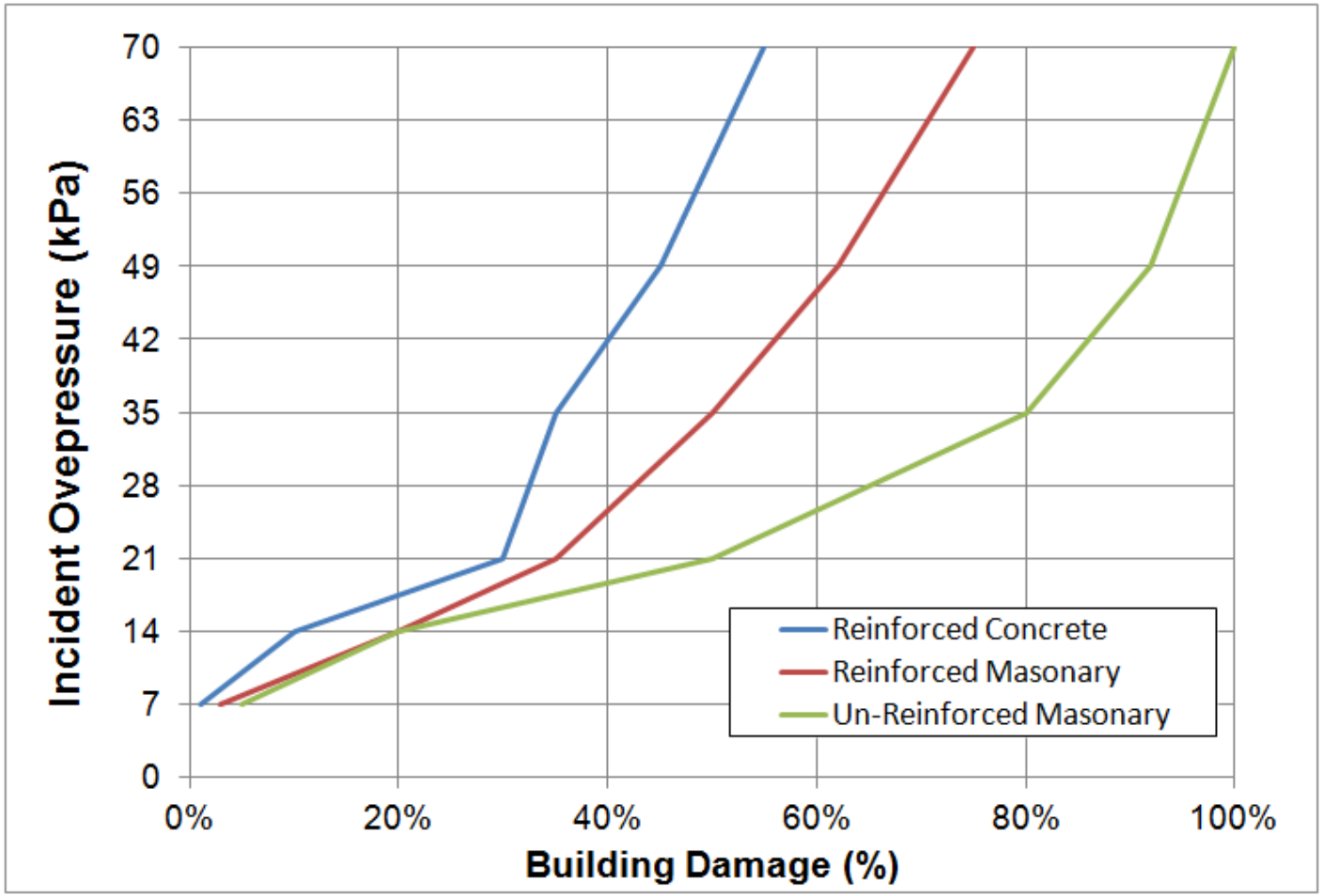
Evaluation of Existing Building Siting

- Identify VCE scenarios within plant
- Assess potential for VCEs to impact existing buildings
- Determine blast loads experienced by building
- Results compared with siting evaluation criteria

Evaluating Location Based on Blast



Building Damage Curves



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

Evaluating Location Based on Blast

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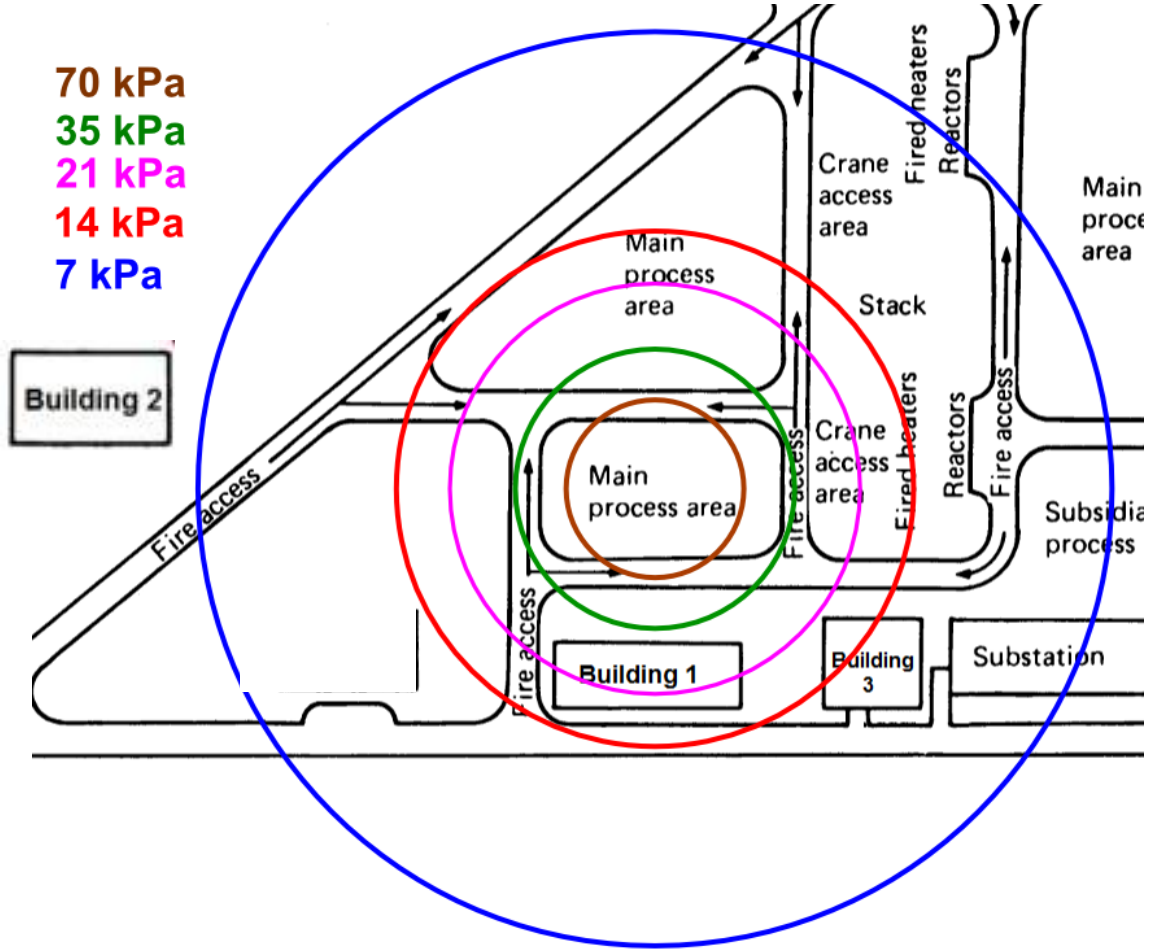
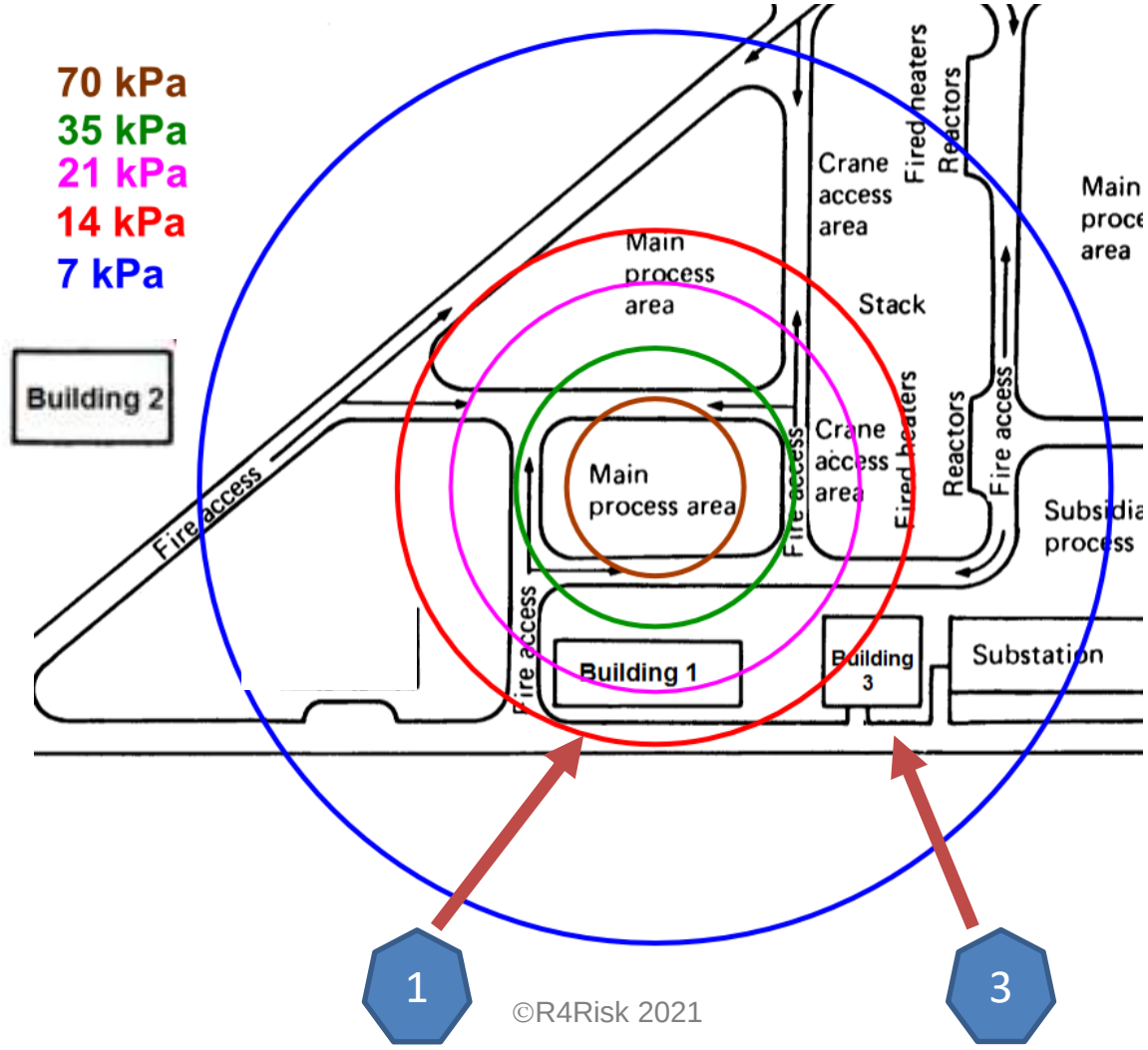


Evaluating Location Based on Blast



Mitigation Options

- Hierarchy of Mitigation Measures
  - Passive
  - Active
  - Procedural
- Typical option used
  - Reduce consequence of release
    - However this maybe difficult to do as process is normally fixed
  - Strengthening of building
    - Requires detailed structural analysis
  - Relocation of personnel to alternate locations
    - Non-essential v. Essential
  - Abandon the building

Conclusions

- Use industry developed guidance for locating buildings in process areas
  - Existing buildings should be checked
  - Ensure siting evaluation is undertaken for portable buildings
- Manage building occupancy as part of facility's operation through the MOC process
- Use experts to apply building siting evaluation

Upcoming Events

Webinars

- Linking Risk Assessments to Process Safety Management (May 26 2021)
- After the Bowties – The Story Continues (29 June 2021)
- Fire Safety Studies (29 July 2021)

Online Live Training

- Introduction to LOPA (19 – 20 May 2021)
- Risk Assessment Leader (25 – 28 May 2021)
- Introduction to Process Safety (22 – 23 June 2021)

For more information and registration, visit www.r4risk.com.au or contact solutions@r4risk.com.au

Q&A Session