Challenges and Opportunities of Occupied Building Risk Assessments

TECHNICALLY SUPERIOR
RISK MANAGEMENT

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Overview

01	Introduction
02	Historical context
03	Overview of OBRA methodologies
04	Case study highlighting important assumptions and decision-making moments in an OBRA

What is an Occupied Building Risk Assessment?

A structured methodology used to evaluate the risks to workers in buildings

Why Conduct an Occupied Building Risk Assessment?

- Safeguard workers by assessing their onsite risk while in buildings
- Key considerations:
  - Building location
  - Building design / protection
- Historical events highlight risks to occupants of buildings near process areas
- Key examples include Flixborough and BP Texas City

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 an ignition source
- 28 worker fatalities and 36 injuries
- 18 fatalities in the collapsed control room

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)
- 15 worker fatalities and 180 injuries
- Majority of fatalities were personnel in trailers near vent stack

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

Building Siting Guiding Principles:

1) Locate personnel away from process areas
2) Minimise the use of buildings close to process areas
3) Manage occupancy within those buildings close to process areas
4) Buildings intended for occupancy should be designed, constructed, modified and maintained to protect against hazards
5) Manage the building occupancy as part of facility operation

Key Building Hazards

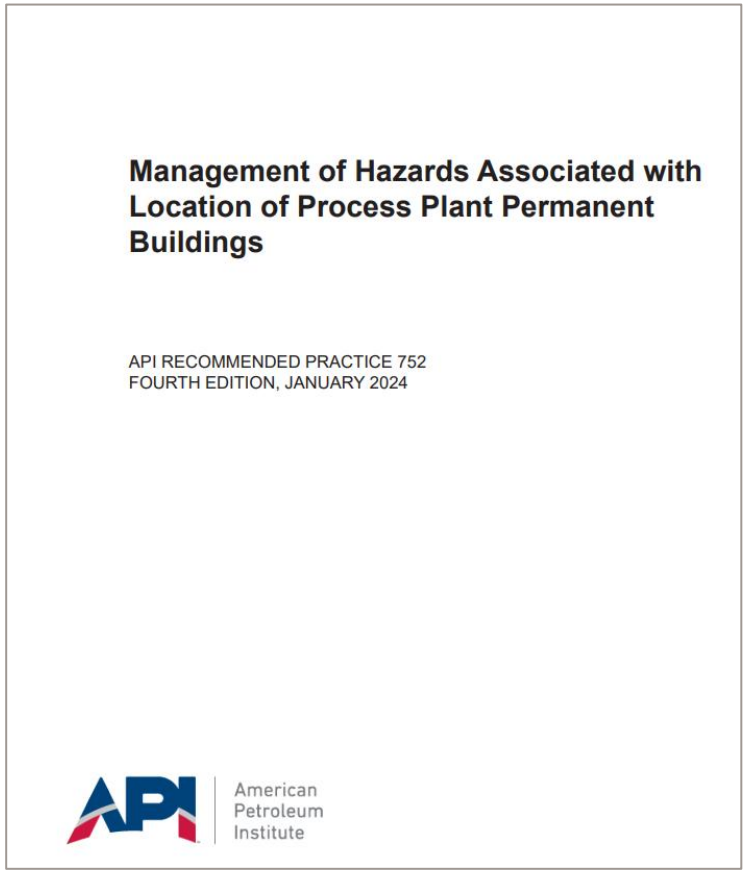
TOXIC

EXPLOSION

FIRES

Industry Guidance

- CCPS: Guidelines for evaluation process plant buildings for external explosion, fires and toxic releases (2012)
- API RP 752: Location of Process Plant Buildings (2024)
- API RP 753: Location of Process Plant Portable Buildings (2024)



API Assessment Approaches

1) Spacing Tables

2) Consequence Based

3) Risk Based

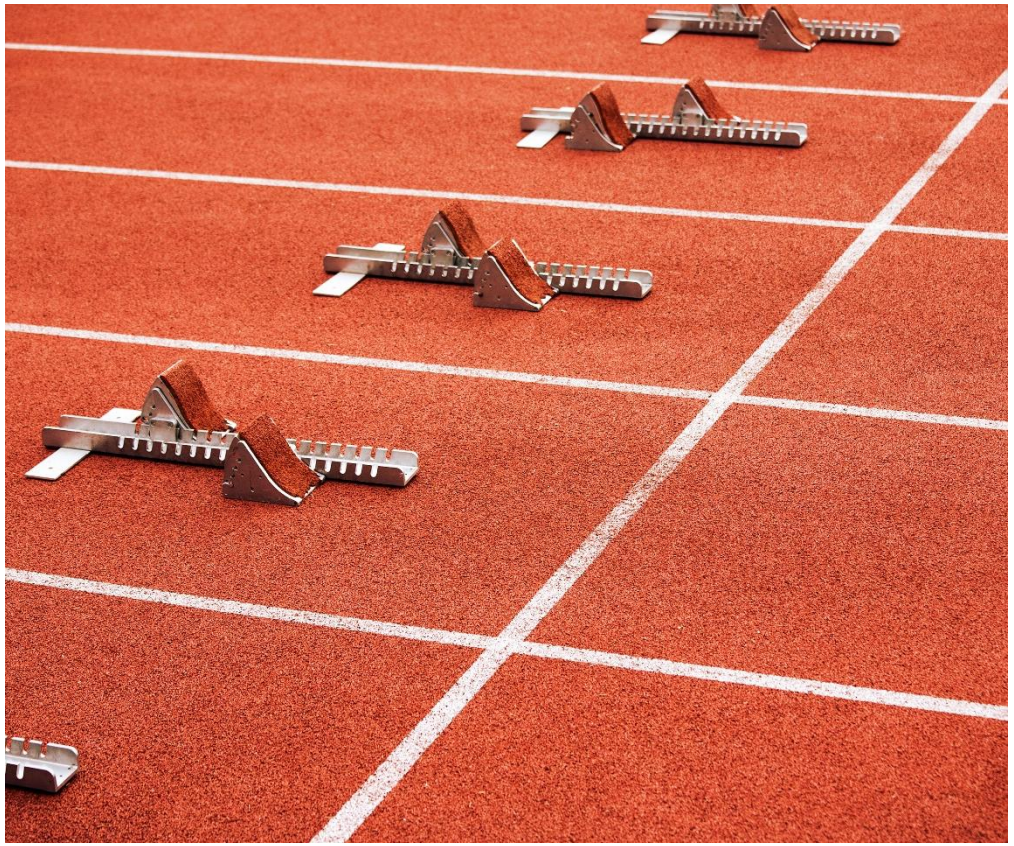
Consequence Based Approach

- Determine buildings to be included in assessment scope
- Identify process hazards with potential to impact buildings and define the maximum credible events (MCEs)
- Evaluate consequence of MCEs and the building response to determined level of impact
- Compare impact with building evaluation criteria
- Develop and implement mitigation options where the criteria is not met

Risk Based Approach

- Determine buildings to be included in assessment scope
- Identify all process hazards with potential to impact buildings
- Evaluate consequence of identified hazards and the building response to determined level of impact
- Evaluate the event frequency and fatality probability to determine risk
- Compare impact with building risk evaluation criteria
- Develop and implement mitigation options where the criteria is not met

Risk-Based OBRA Starting Point



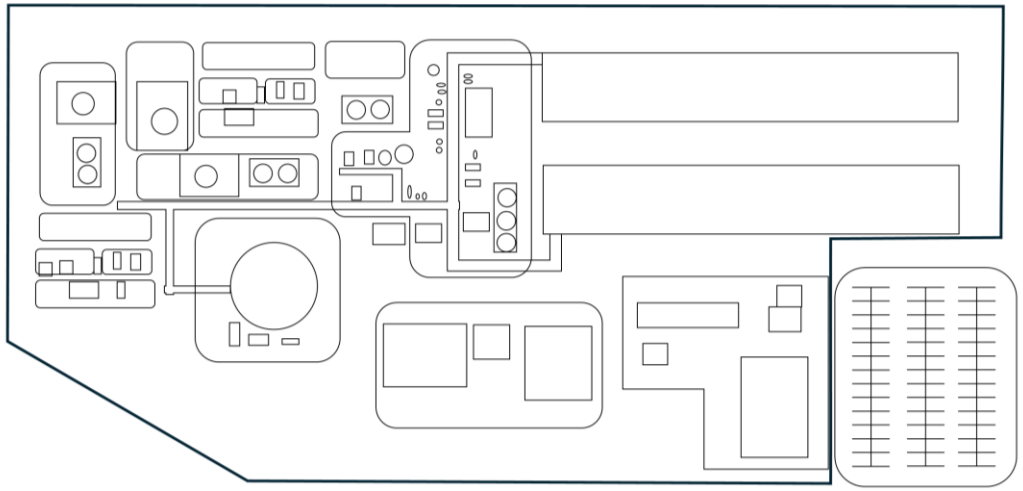
- Two starting points are:
  - Consequence modelling
  - Quantitative risk assessment (QRA)
- Consequence modelling allows for initial screening of hazards
- QRA streamlines OBRA allowing you to build upon the hazard identification, consequence models and frequency data from the QRA
- Larger sites increasingly leverage QRA for efficient OBRA studies

Case Study: Ammonia Production Facility

- Scope: to assess individual and societal risk to onsite workers through an OBRA
- Hazards include:
  - Toxic releases (ammonia)
  - Vapour cloud explosions (VCEs)
  - Fires
- Risk based approach following API RP 752 / 753
- Already had a QRA model

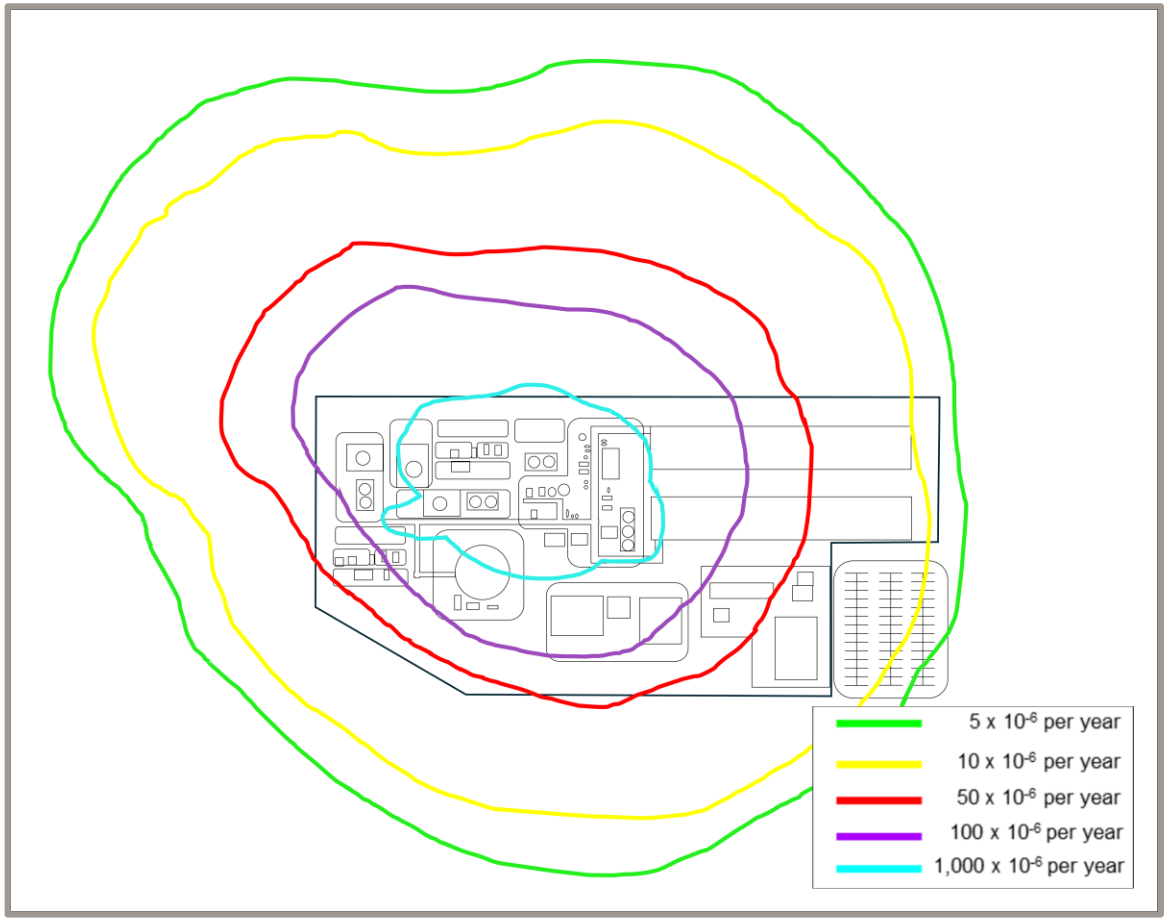
Case Study: Methodology

- Step 1 – The QRA
- Step 2 – Compile list of occupied buildings
- Step 3 – Building impact assessment
- Step 4 – Assess the risk for the building occupants
- Step 5 – Propose mitigation strategies.



Step 1: QRA

- Site wide QRA completed using DNV Safeti software
- Scope of QRA was offsite risk
- Completed a gap assessment of hazards identified to determine if any onsite only hazards were excluded
- Any identified onsite hazards added to the QRA model



Location Specific Individual Risk (LSIR) of Fatality Contours

Step 2: Define Occupied Buildings

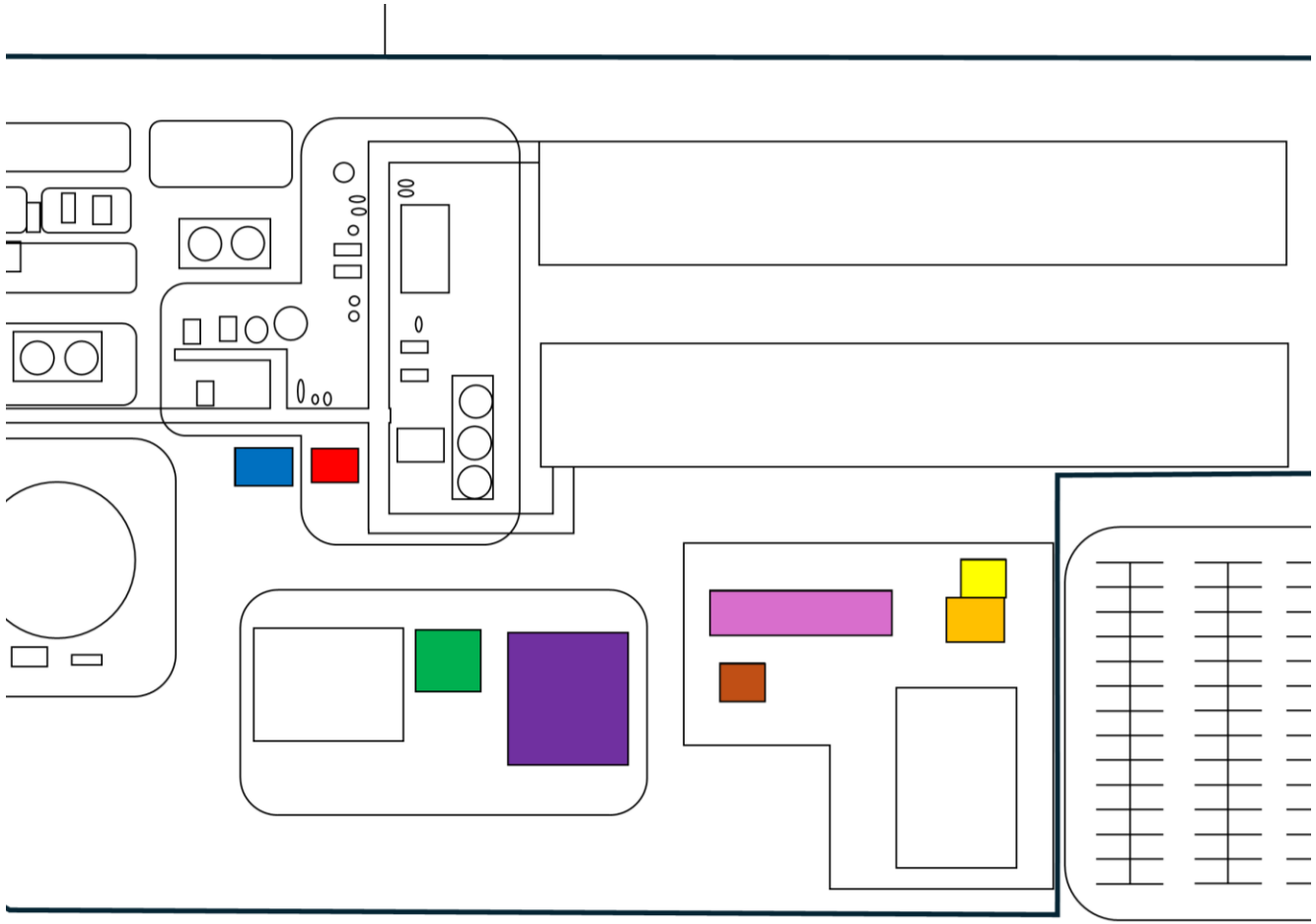
- API RP 752 has the following guidance:

  "A building is intended for occupancy if it has personnel assigned to it or if it is used for a recurring group (i.e. more than one person) personnel function."

- Questions to ask:
  - Are there desks in the building?
  - Is it used for a recurring group function?
  - Do you have designated contractor laydown areas or temporary buildings?
  - Does it have processing equipment inside?

Case Study: Occupied Buildings

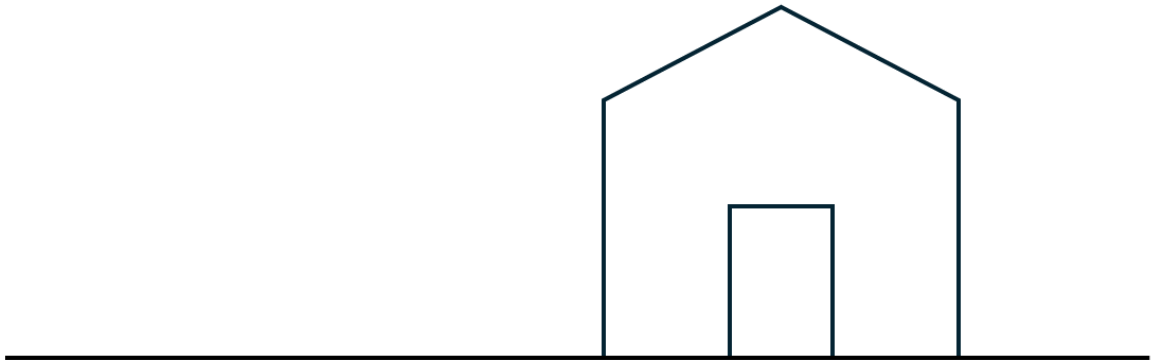
- Engineering Office
- Control Room
- Canteen
- Workshop
- Administration Offices
- Laboratory
- Security
- Training Rooms



Evaluation of each building's response to impacting process hazard

Toxic Building Impact

- Estimate the rate of ingress of toxic vapours into each buildings as a cloud passes around a building
- Defined by the Ventilation Rate (air changes per hour)
- Emergency response: shelter-in-place or evacuate
- Toxic impact estimated for each building considering:
  - Building type (e.g. office, warehouse, toxic gas refuge, etc.)
  - Forced ventilation (e.g. HVAC) or natural



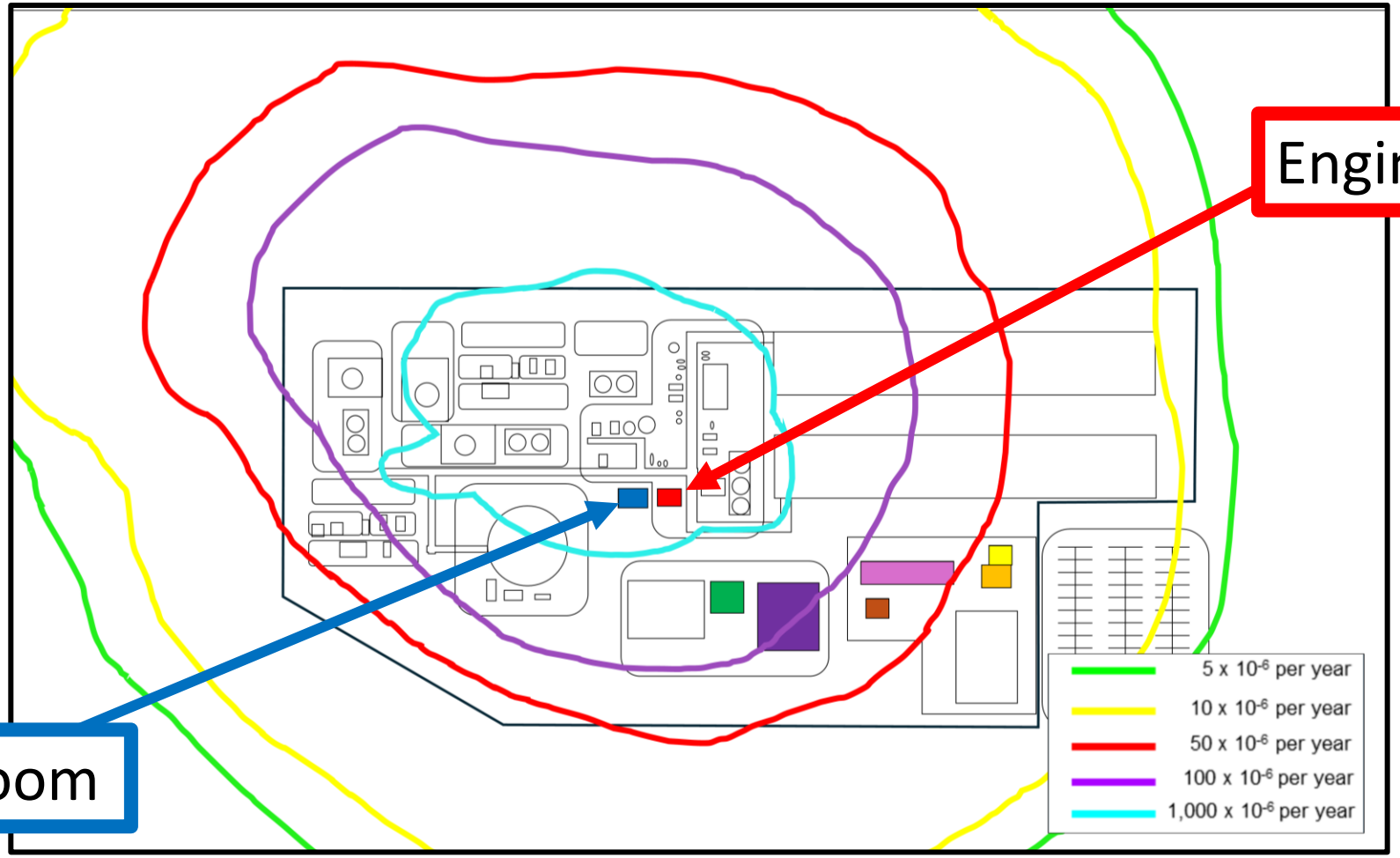
Other Building Impacts

- Building considerations for explosions:
  - Building frame
  - Construction materials
  - Windows
  - Number of stories
- Building considerations for fires:
  - Building construction materials
  - Safe evacuation

Step 4: Risk Assessment

- Location Specific Individual Risk (LSIR)
- Building Individual Risk per Annum (IRPA)
- Societal Risk

Location Specific Individual Risk



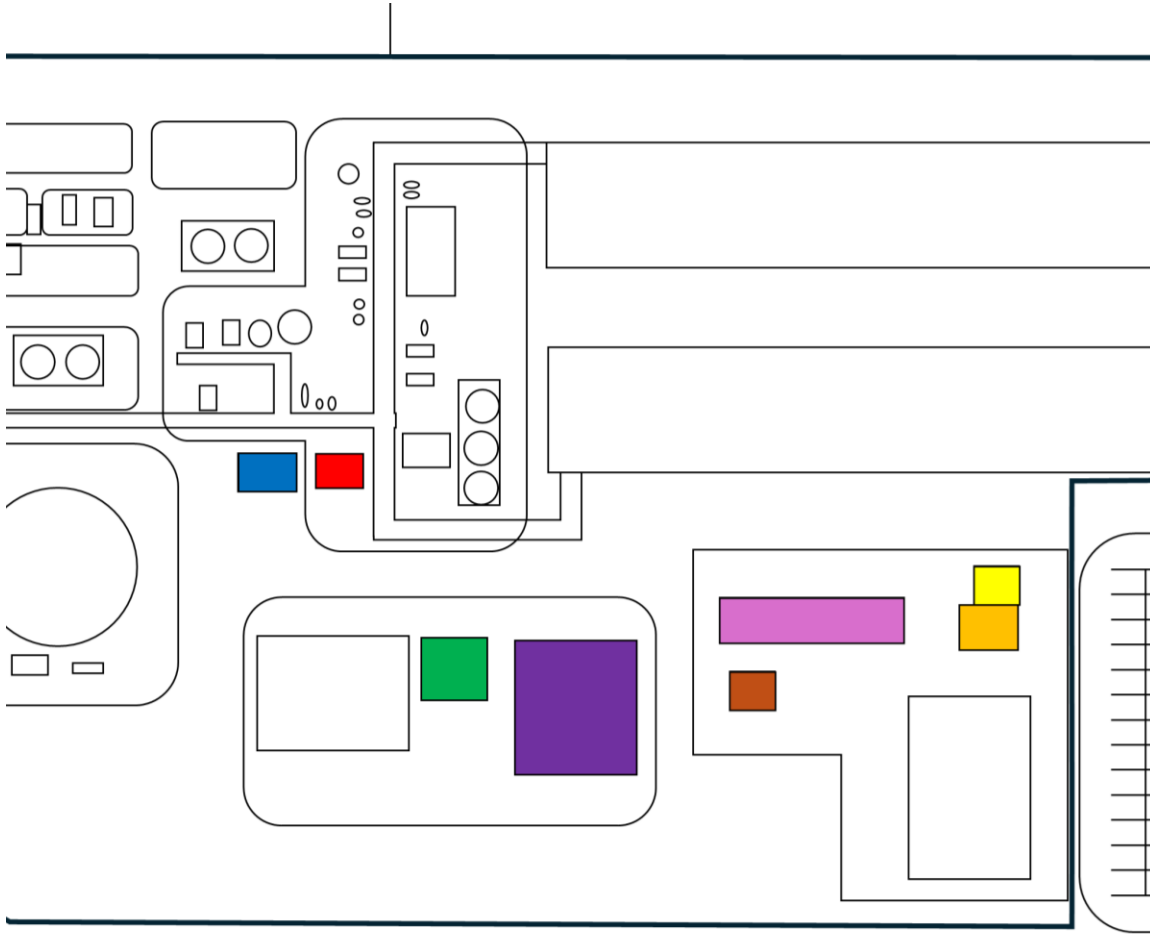
Building Individual Risk per Annum (IRPA)

- Individual risk to building occupants, calculated for a nominated worker group
- Includes the worker's occupancy, how often they are in the building
- Risk criteria based on UK HSE:

Unacceptable region	IRPA ≥ 1,000 x 10^{-6} / yr
Tolerable if risk reduced SFAIRP	1 x 10^{-6} / yr < IRPA < 1,000 x 10^{-6} / yr
Broadly acceptable region	IRPA ≤ 1 x 10^{-6} / yr

Case Study: IRPA Results

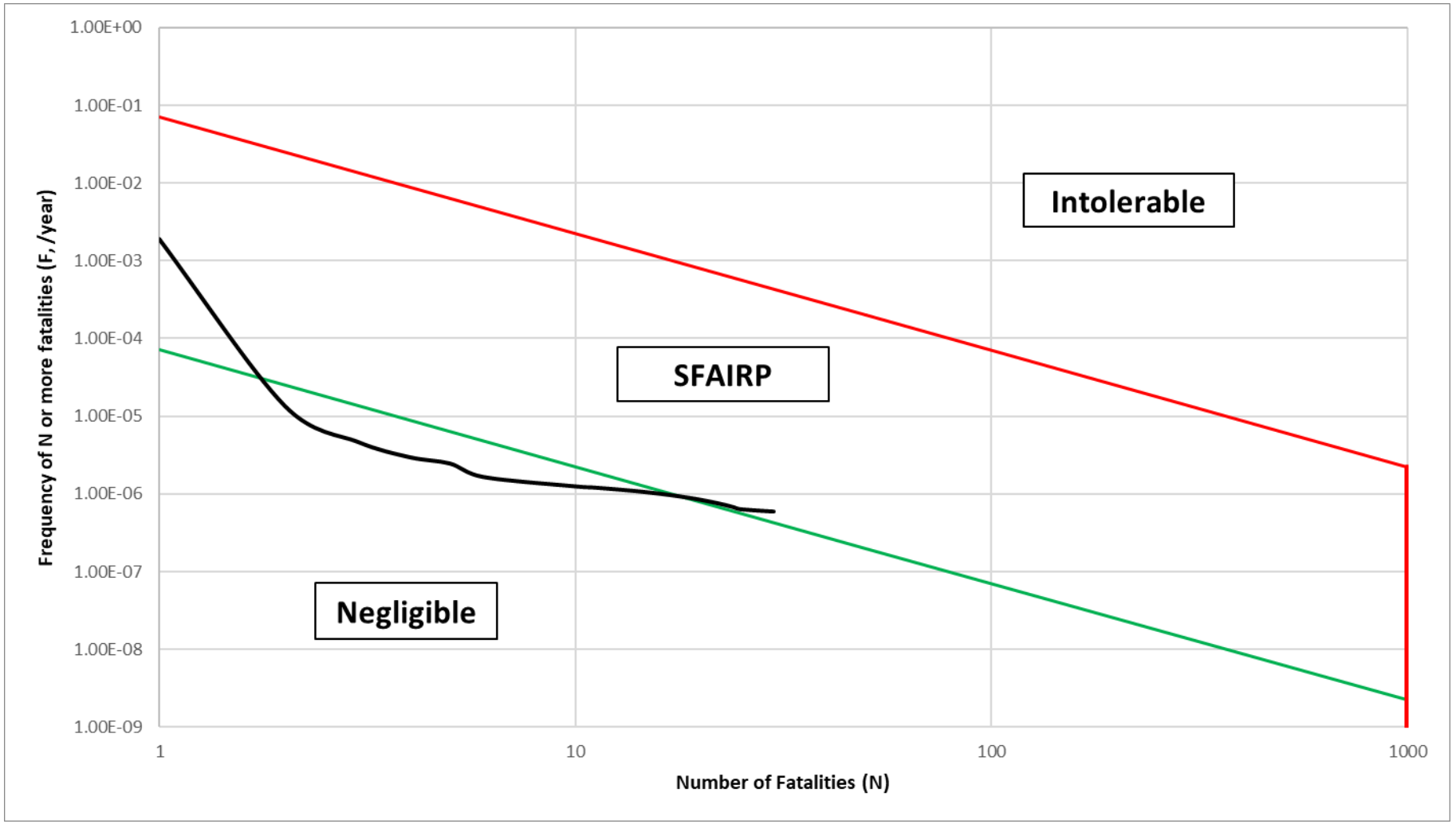
Building	IRPA (x 10^{-6} / yr)
Engineering Office	710
Control Room	420
Canteen	120
Workshop	54
Administration Offices	30
Laboratory	40
Security	22
Training Rooms	10



Societal Risk

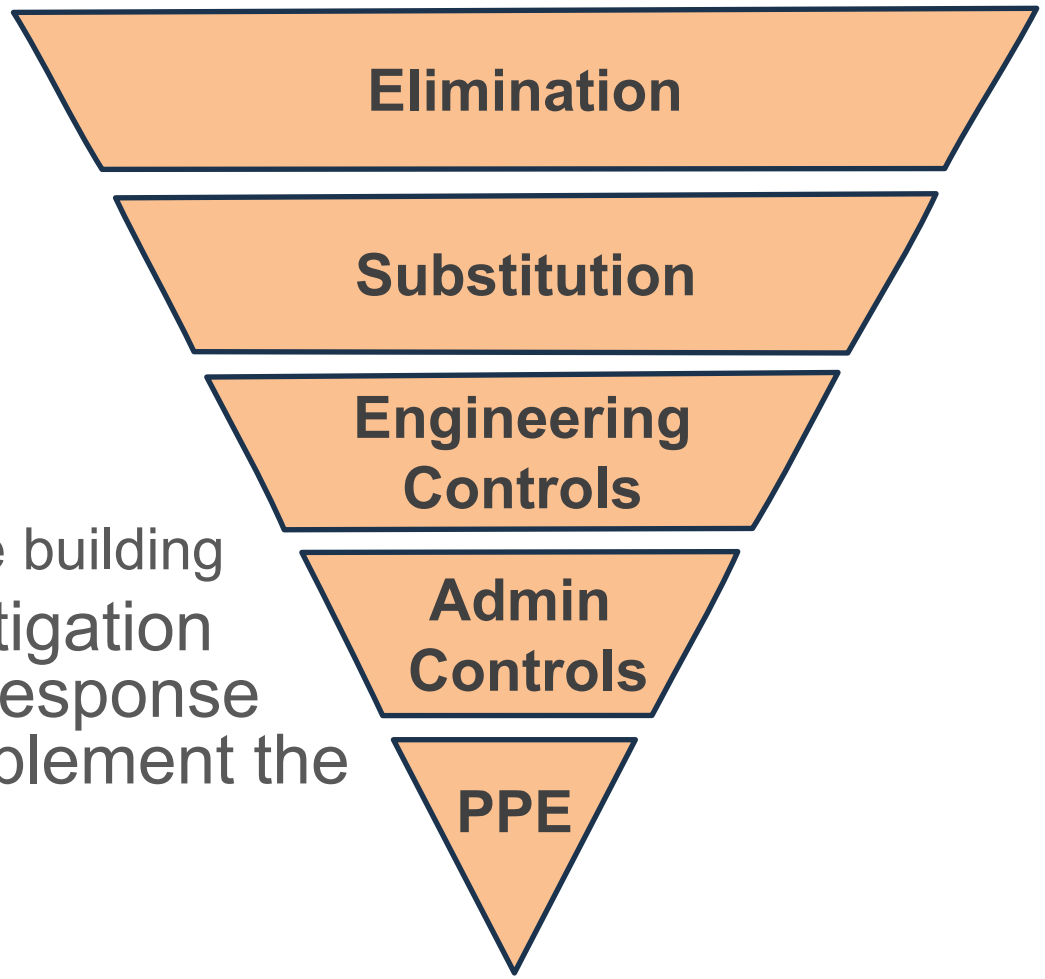
- The measure of the risk of a multiple fatality event occurring
- Society has a greater intolerance for larger events
- "F-N Curve" is used to quantify the societal risk
- The F-N Curve plots the cumulative frequency (F) of events involving "N or more" fatalities.
- The F-N Curve is plotted against societal risk criteria that define three regions as follows:
  - Intolerable – The risk is considered unacceptable and must be reduced immediately
  - SFAIRP – The risk is considered tolerable if the risk has been reduced So Far As Is Reasonably Practicable (SFAIRP)
  - Negligible – The risk is considered tolerable but must be managed.

Building F-N Curve



Step 5: Risk Mitigation Strategies

- High risk buildings:
  - Engineering Office
  - Canteen
- Key hazard: toxic releases
- Proposed mitigation strategies:
  - Relocate buildings or people
  - Reduce building ventilation rates
  - Provide a means of safe escape from the building
- API latest updates emphasise risk mitigation strategies – for example emergency response planning and building egress - to supplement the risk calculations.



Questions?