

An aerial view of an industrial facility, likely a chemical plant or refinery. A large smokestack on the left is emitting a thick plume of white smoke that drifts across the scene. In the background, there are several large circular storage tanks and other industrial structures. A white tanker truck is parked on the right side of the image. The entire scene is overlaid with a semi-transparent blue and green gradient.

DIY OBRA

Do-it-yourself Occupied building risk assessment

Pier-Jan Hettema

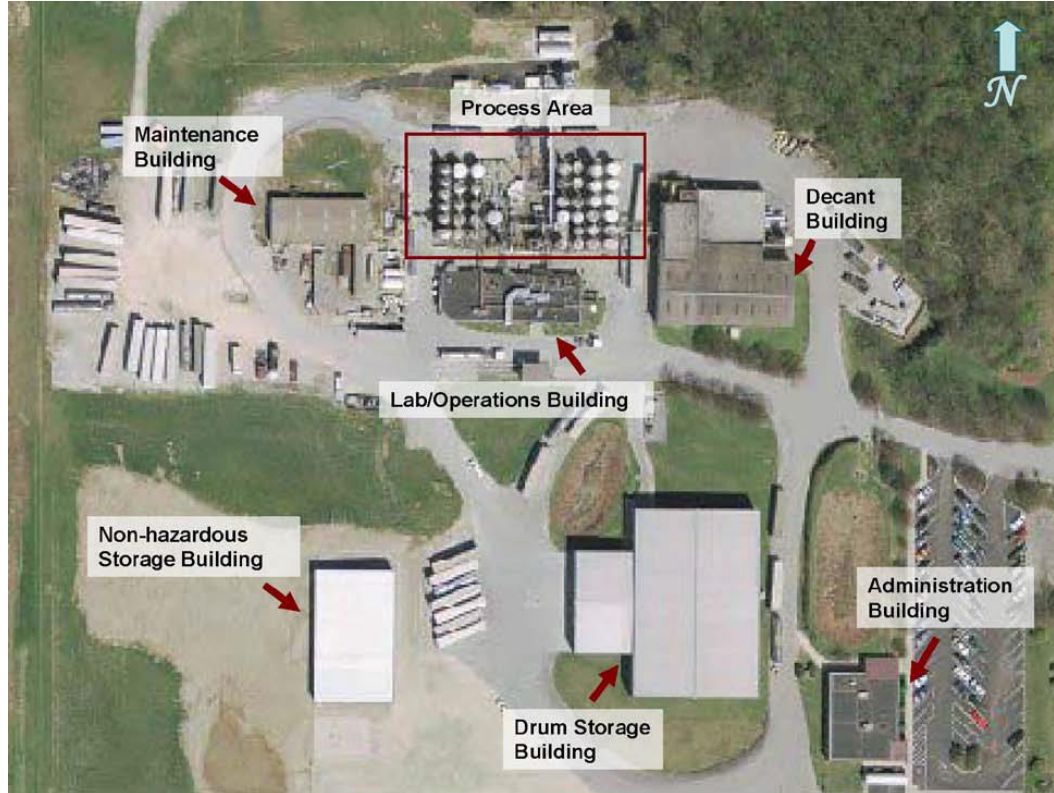
Global Senior Process Safety Expert

DSM Global Safety Health & Security

14 September 2022, Antwerp BE, EPSC congress



WHAT WOULD YOU DO DIFFERENT IN THE SITE LAYOUT OF THIS PLANT?





**VEOLIA TECHNICAL
SOLUTIONS LLC**

**PLANT AFTER VAPOR
CLOUD EXPLOSION**

(PICTURES FROM CSB)

Occupied Building Safety

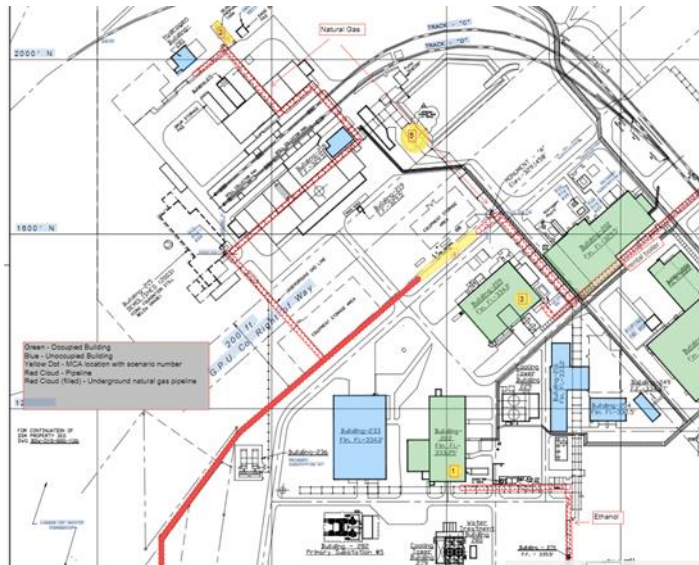
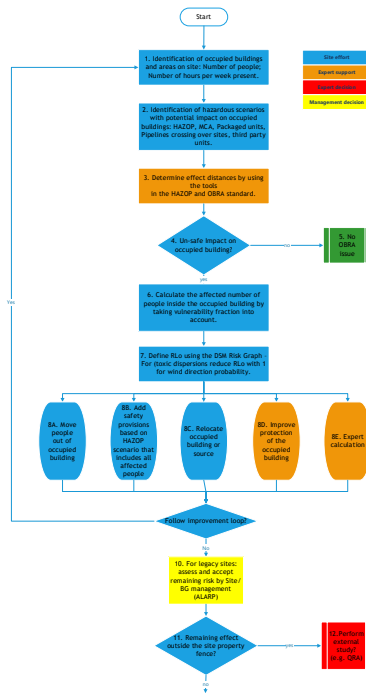
Protect people in buildings
against potential
consequences of major
process-related incidents



“Wrong dosing, runaway”

OBRA FLOWCHART

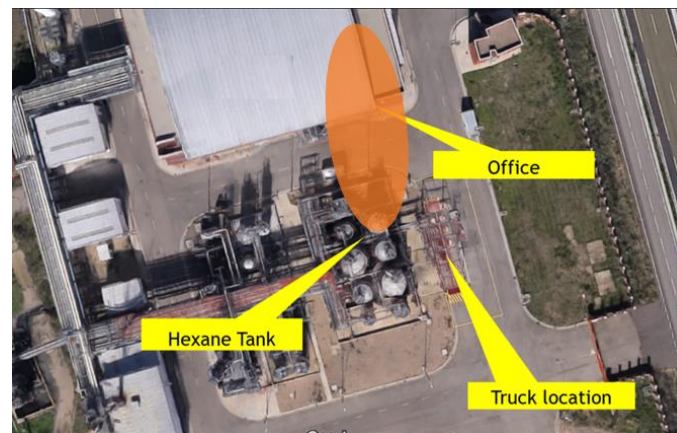
- Occupied buildings
- Hazards
- Effect calculations
- People affected
- Risk determination
- Measures
- Risk reduction



DETERMINE THE EFFECT DISTANCES BY USING TOOLS

- Expert software (e.g. PHAST, SafeSite, Effects)
- CHEF (or RAST) Excel tool -Available via CCPS and EPSC

VAPOR DISPERSION INPUT INFORMATION				JET MIXING		SIMPLE VAPOR DISPERSION	
STEP 1 - Select Location, Type of Release, Concentration and Distance of Interest Release Location: <input type="text"/> Type of Release: <input type="text"/> Use Averaging Time Correction for Flammable Releases: <input type="checkbox"/>				For 3 meters Wind Speed, Class B Atmospheric Stability, and Ponder Vapor Density: $\rho = \text{atmospheric pressure} \times \text{Equation 3-10}$ Discharge Velocity Equation 3-5: $U = 1.27 \sqrt{Q} / \pi \times d^2$		Release Location: <input type="text"/> Release Concentration: <input type="text"/> Distance of Interest: <input type="text"/>	
STEP 2 - Enter Chemical Properties (See Select Chemical Name from File List) Chemical Name: <input type="text"/> Molecular Weight: <input type="text"/> Normal Boiling Point: <input type="text"/>				Distance Correction for Initial Concentration Vapor from Liquid Evaporation, Equipment Failure, or Low Vapor Pressure: <input type="text"/> Vapor from Gas Release: <input type="text"/>		Test for Plume versus Puff Model at Dispersion Conditions: Plume or Puff: <input type="text"/>	
STEP 3 - Enter Process Information Process Name: <input type="text"/> Release Rate: <input type="text"/> Release Temperature: <input type="text"/> Total Release Quantity: <input type="text"/> Liquid or Two-Phase Release Velocity: <input type="text"/> Initial Vapor Velocity: <input type="text"/> Vapor Pressure at Release: <input type="text"/>				Correction for Release Elevation Effective Release Elevation Equation 3-24: $H_{eff} = H + (1/16) \times (U/U_{ref})^2 \times (1/16) \times (1/16)$ H: <input type="text"/> U: <input type="text"/> U _{ref} : <input type="text"/>		Estimated Exposure Duration - Continuous Dispersion: Exposure Duration: <input type="text"/>	
STEP 4 - Enter Equipment and Plant Layout Information Equipment and Plant Layout Inputs: <input type="text"/> Diameter of Hole or Discharge Piping: <input type="text"/> Release Elevation: <input type="text"/> Release Direction: <input type="text"/> Enclosed Process Area Volume: <input type="text"/> Enclosed Process Area Ventilation Rate: <input type="text"/>				Iteration for Release within Enclosed Space Check Limit for Total Release Due to Enclosed Volume Equation 3-3: $C_{max} = 1.0 \times 10^{-6} \times (Q/U) \times (1/16) \times (1/16) \times (1/16)$ C _{max} : <input type="text"/> Q: <input type="text"/> U: <input type="text"/>		Maximum Ground Level Concentration from Elevated Contin Maximum Ground Level Concentration: <input type="text"/>	



DEFINE AFFECTED NUMBER OF PEOPLE

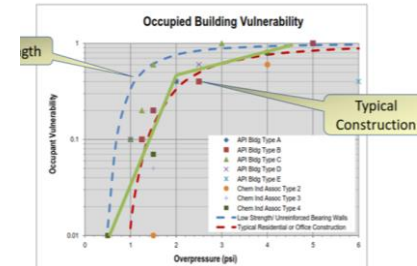
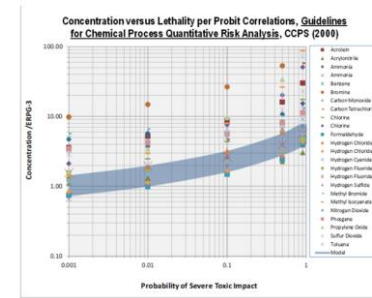
People affected = Occupancy x vulnerability factor

Define vulnerability factor for
toxic concentration in a building

- ERPG-3 = 0%
- 5 times ERPG-3 = 100%

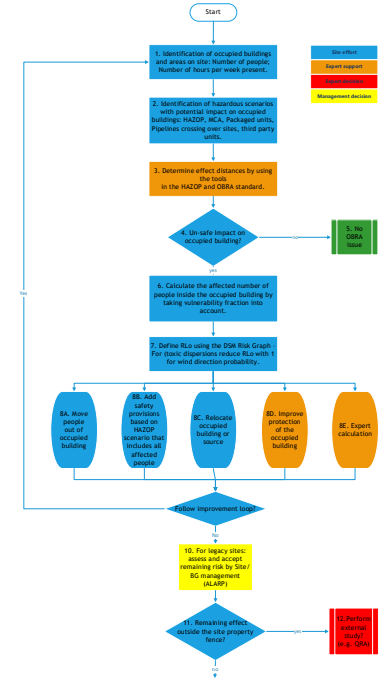
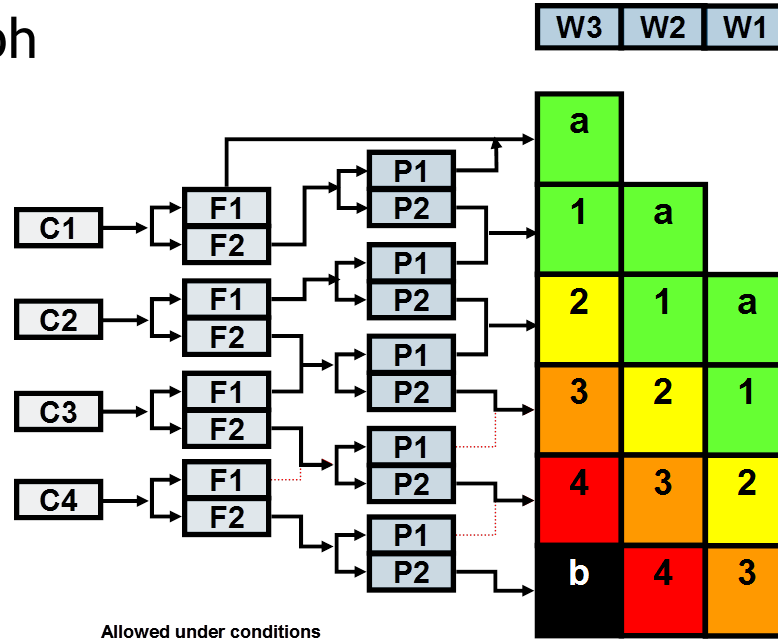
Define vulnerability factor for
explosion pressure @ building

- 30 mbar = 0 %
- 300 mbar = 100%



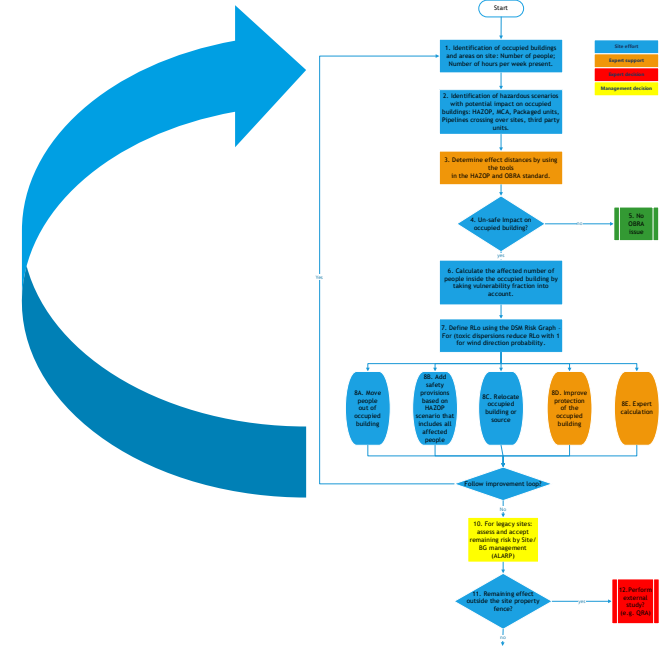
DEFINE THE RISK

DSM RiskGraph



OBRA MEASURES FOR RISK MITIGATION

- A. Move people out of occupied buildings
- B. Improve/increase the safeguarding to mitigate the risk
- C. Relocate the occupied building or source of the hazard
- D. Modify occupied buildings



FLIXBOROUGH, UK - 1974

OBRA RELATED INCIDENT

- Explosion equivalent to 15 Tonnes TNT
- 1,800 buildings within 1 mile radius damaged
- All 18 people in control room killed
- 500+ would have been killed during a weekday



WHERE IS MY REACTOR BUILDING?



BRIGHT SCIENCE. BRIGHTER LIVING.™

