AIChE

Reducing Risk through Explosion Safety and ATEX

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ORBITAL HSEQ Consultants

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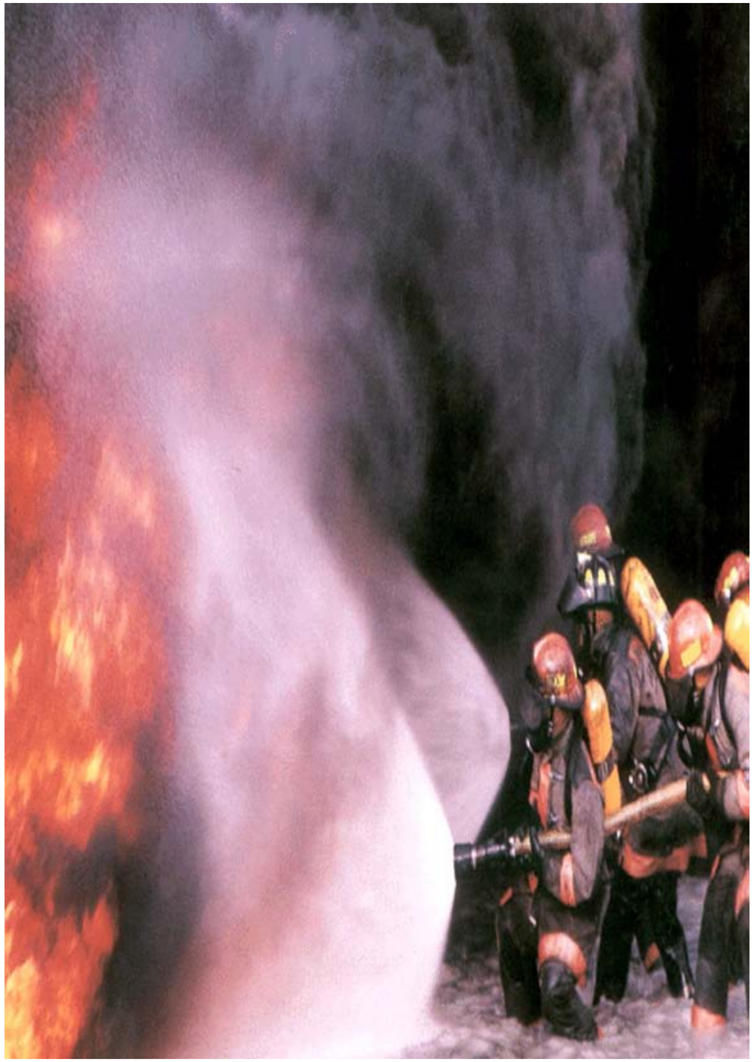
Agenda

- Introduction
- Explosion History
- Explosion Impact Analysis
- European Directives
- ATEX Directives
- Risk control and inherent safety



Introduction

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Lyn Fernie

- Chartered Engineer CEng, MIChemE, MIES, MIAQM
- Frank Lees Medal 2005
- Background in process engineering, product development, project engineering, EHS management, consultancy
- Vice President Aker Kvaerner Consultancy Services
  - Specialist EHS and asset optimisation consultancy
  - Centre of excellence within Aker Kvaerner
  - Consultancy support and training

Aker Kvaerner Consultancy Services - Profile

- Specialist consultancy with a focus in six key areas:

Process safety	EHS management systems
Environment	Land contamination management
Asset optimisation	Training

- Project-related services and services tailored for operating assets
- Centre of excellence within Aker Kvaerner
- Personnel located in Stockton, Warrington and Zoetermeer
- Highly qualified team drawn from a range of backgrounds, sectors and disciplines
- Key sectors - chemicals, refining, petrochemicals, nuclear, biofuels, oil and gas, water, pharmaceuticals, food and drink

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Clients

BASF The Chemical Company

Lucite International Going further

ConocoPhillips

Stockton-on-Tees Borough Council

DuPont

سابك sabic

HUNTSMAN

JM Johnson Matthey

bp

D1 Oils plc

Terra

Dow

DSM

basell Polyolefins

Chevron

UKAEA Restoring our Environment

Tessenderlo Group

Northumbrian Water

Air Products

Invista

Orbital HSEQ Consultants

gsk GlaxoSmithKline

vivergo fuels

Lubrizol

Scope of Services

Training

Process Safety

Asset Optimisation

Aker Kvaerner Consultancy Services

the Preferred Partner for

Environment

EHS Management Systems

Land Contamination Management

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ORBITAL Technologies BV

- QA Systems & Implementation
- Environmental Impact Assessments
- Safety & Risk Analyses
- Explosion (Impact) Analyses
- ATEX Implementation & Training
- Inherent Safety Implementation
- REACH implementation
- RBI/RCM Analyses
- RAM/LCC Analyses

Explosions

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Prerequisites for Fire / Explosion

- A fire requires:
  - A **Fuel** (e.g. an explosive gas such as hydrogen)
  - Enough **Oxidiser** to sustain combustion
  - A **Source of Ignition Energy** (e.g. a hot surface or an electrical spark)

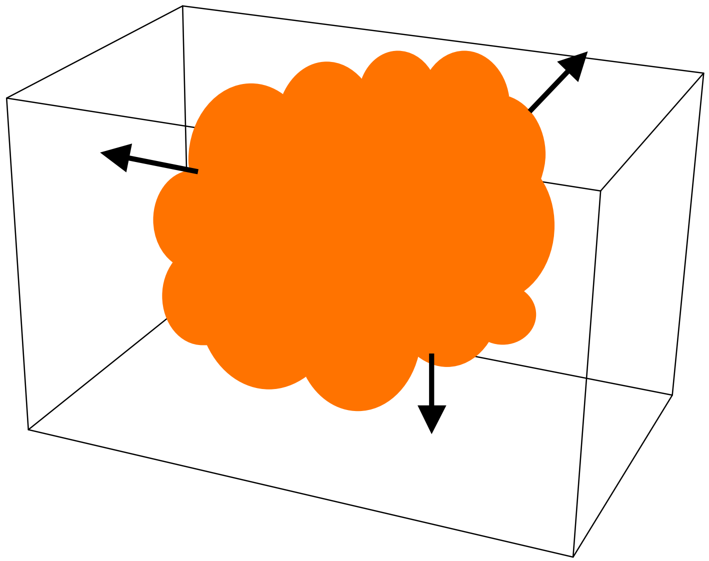
Explosion properties

For an explosion, two additional things are needed:

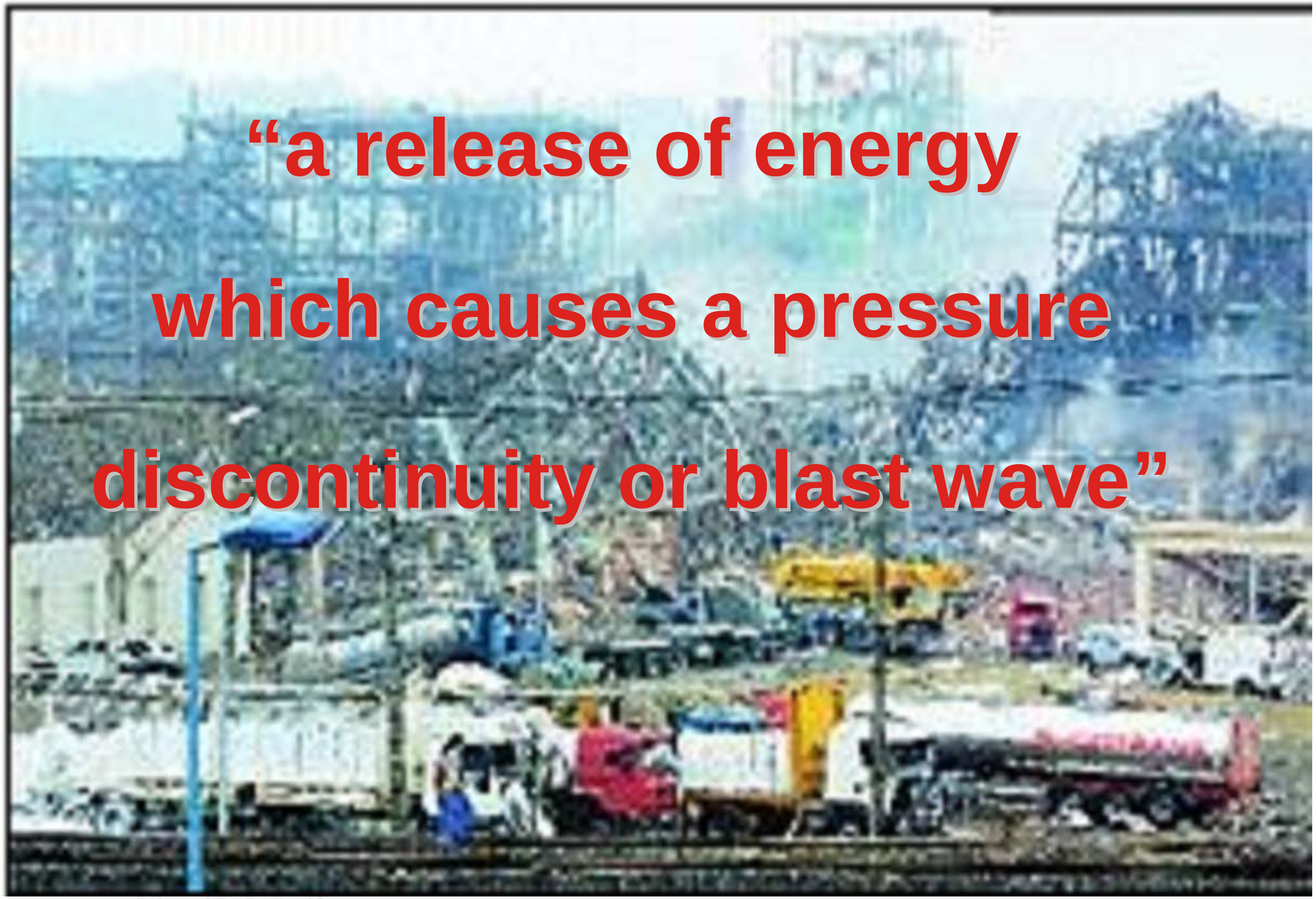
1. Something to mix the fuel and the oxidiser

   For example, the turbulence created in a leak of gas under pressure.

2. Containment or confinement - something that stops the gas expanding in 3 dimensions.



Definition of Explosion



History of accidents

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Dust Explosion in a flour mill

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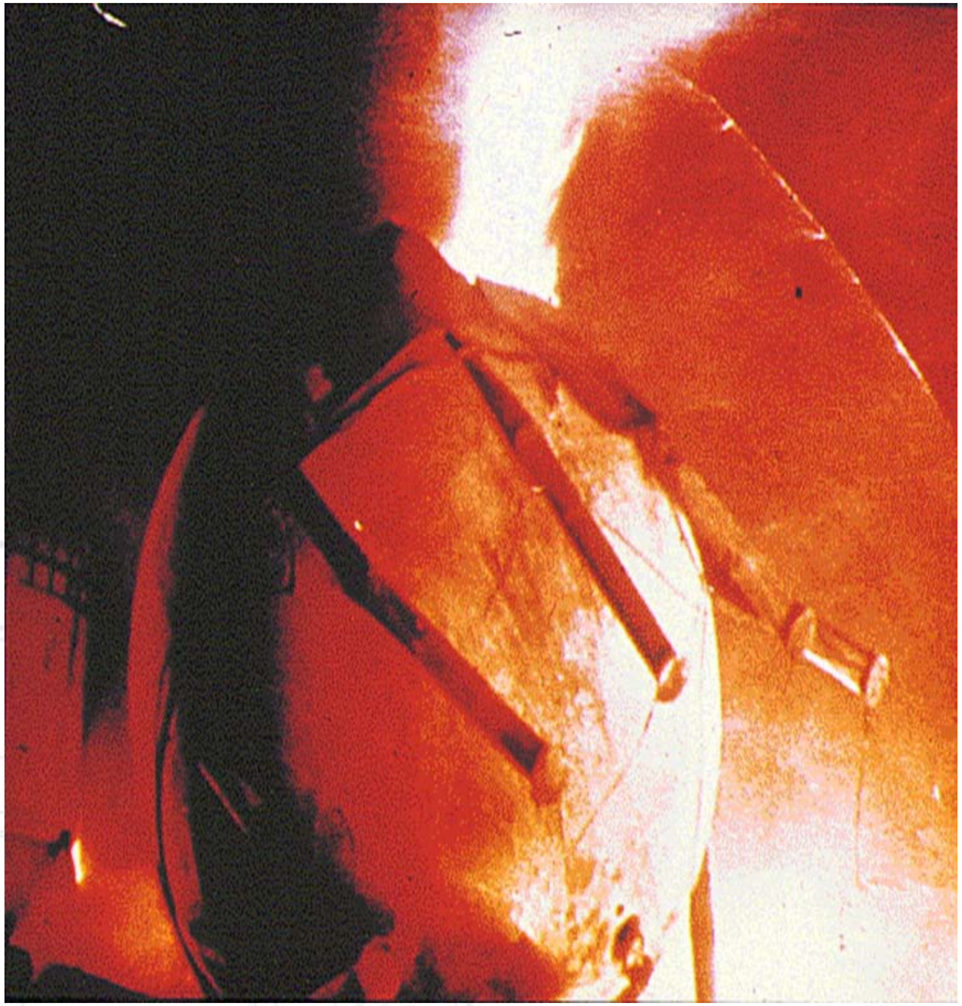
Refinery fire, Feyzin, France 1969



- Propane storage sphere
- 18 killed
- 81 injured

Cyclohexane explosion, Flixborough, UK, 1974

- Caprolactam production facility (nylon precursor)
- 28 killed
- 36 seriously injured

Explosion and fire, Piper Alpha, 1988

- Occidental Petroleum Ltd
- Oil and gas production
- 167 killed
- Total insured loss US$3.4 billion

Fire and Explosion, Castleford, UK, 1992

- Jet fire from still base on mononitrotoluene plant
- 5 killed
- 18 injured

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AZF Toulouse, France, 2001

- Explosion at fertiliser factory
- 29 killed
- 2500 seriously wounded
- 8000 light casualties
- Explosion heard 80 km away
- 40,000 public made homeless for a few days

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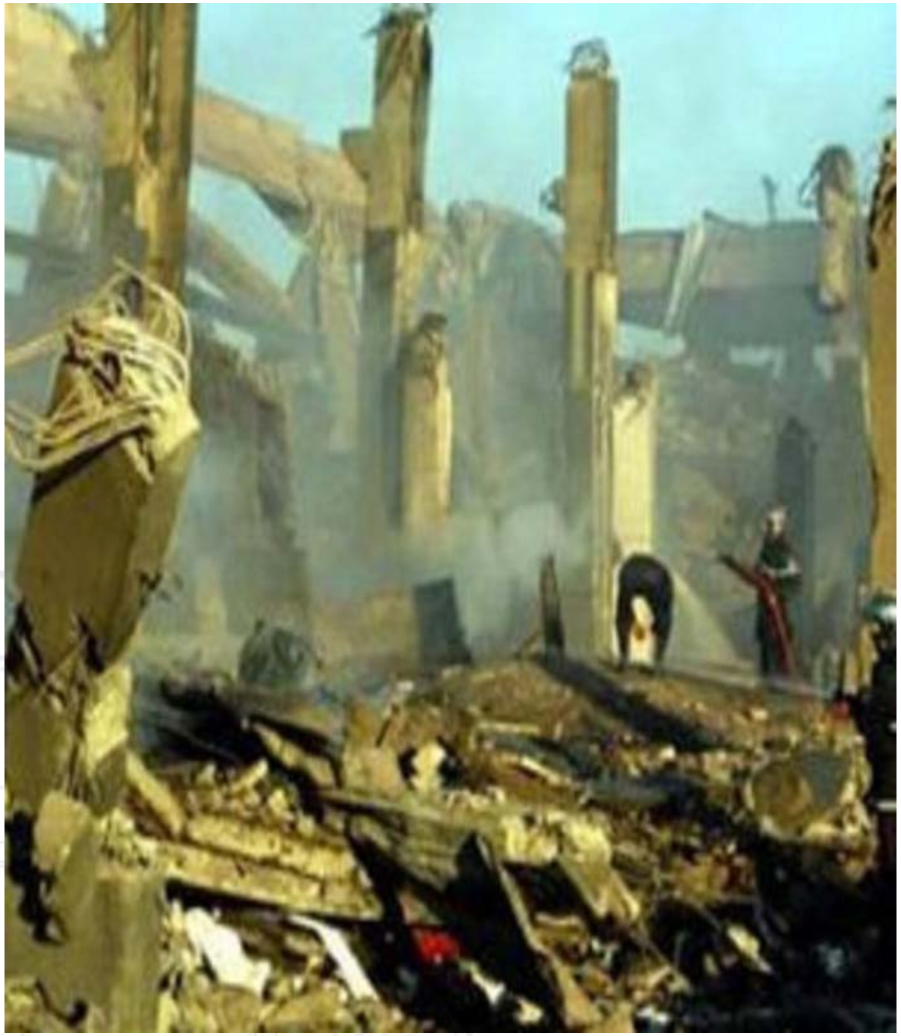
Skikda Refinery, Algeria, 2004



- An explosion during routine boiler maintenance operation due to insufficient purging
- 3 of 6 trains destroyed
- 27 killed along
- 74 injured
- New plant designs have eliminated the need for boilers

ICL Plastics, Glasgow, 2004

- Explosion at plastics factory
- Explosion caused by build-up of liquid petroleum gas that had leaked from pipes.
- 9 killed
- 40 injured

BP Texas City, USA, 2005

- Explosion and fire at refinery
- During start up tower and blowdown drum overfilled and liquid hydrocarbon released causing VCE
- 15 people killed
- over 170 injured
- Many in temporary buildings
- Offsite property damage

Engen, Durban, SA, November 2007

- Engen refinery
- Gasoline tank fire following lightning strike

Alon Refinery, Big Spring TX, 18 February 2008

- Explosion at refinery
- 5 injured

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Explosion Impact Analysis

Case studies

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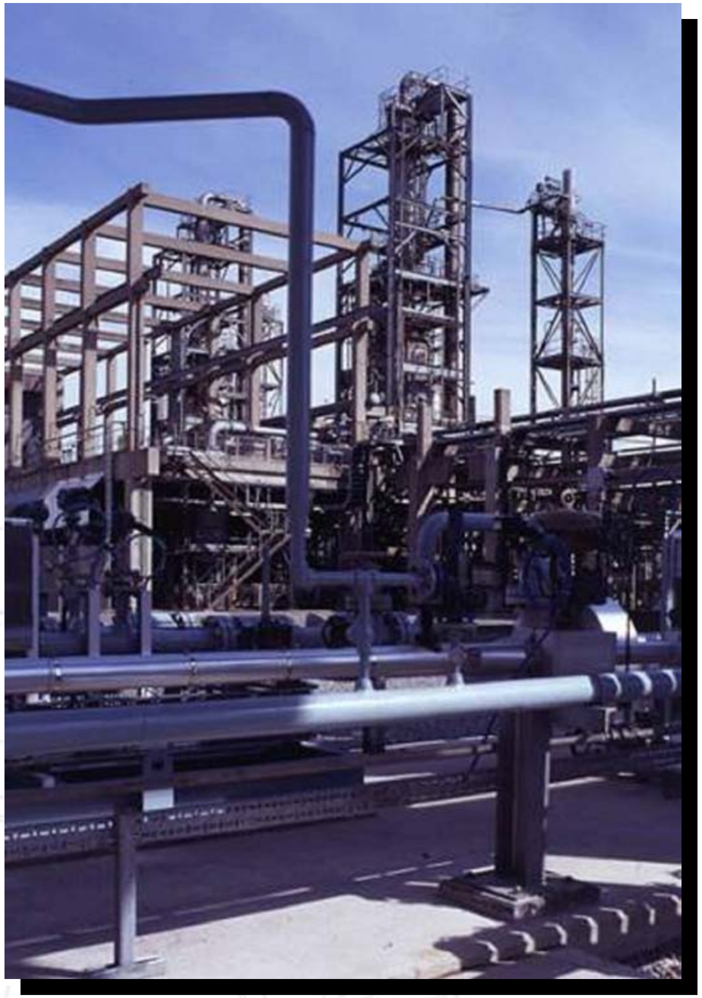
Explosion impact analysis

- Most people involved in explosions are killed within buildings……

Occupied building assessment – case 1

Products / materials

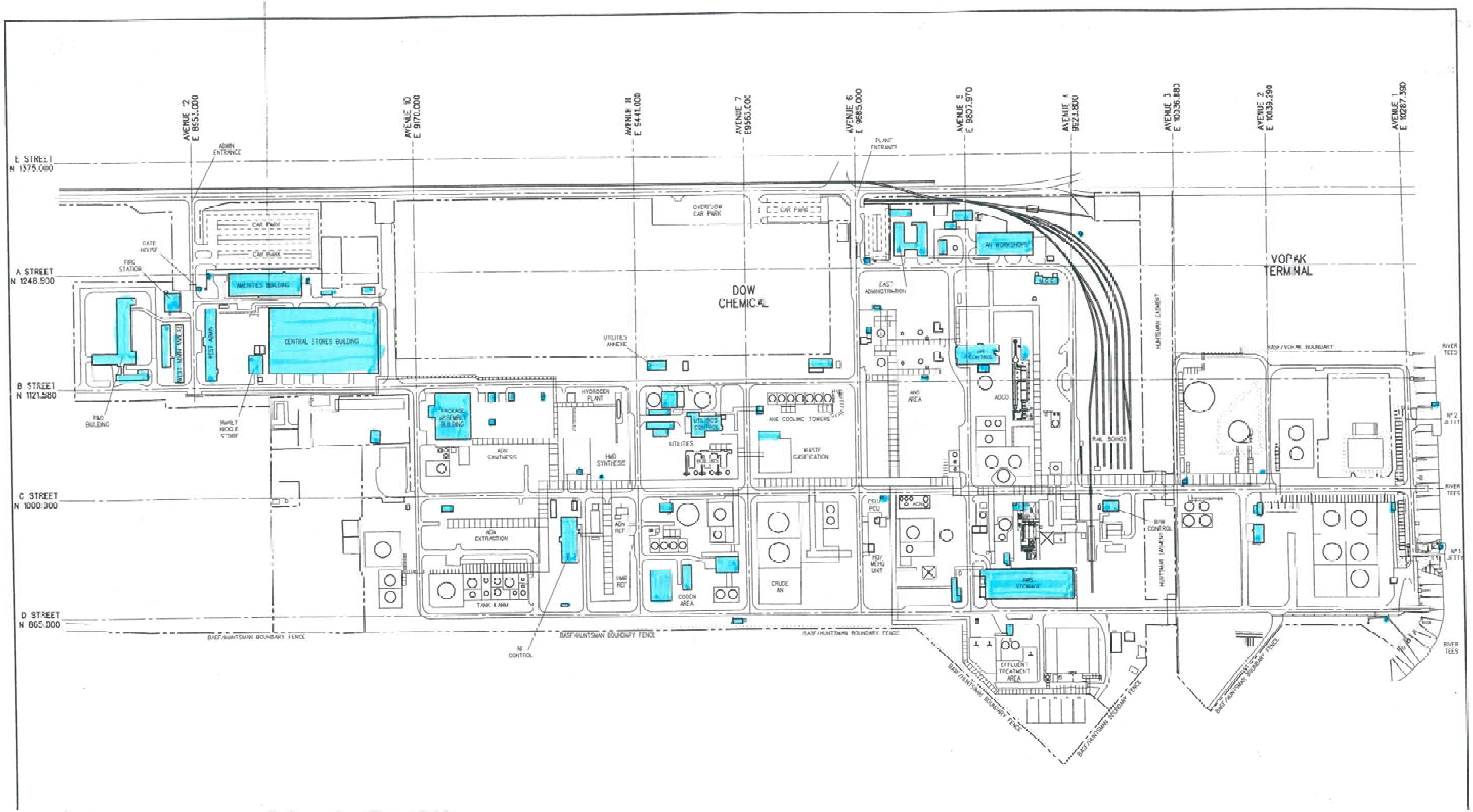


- Range of flammable and toxic liquids and gases used and produced on site
- 3 production units on site

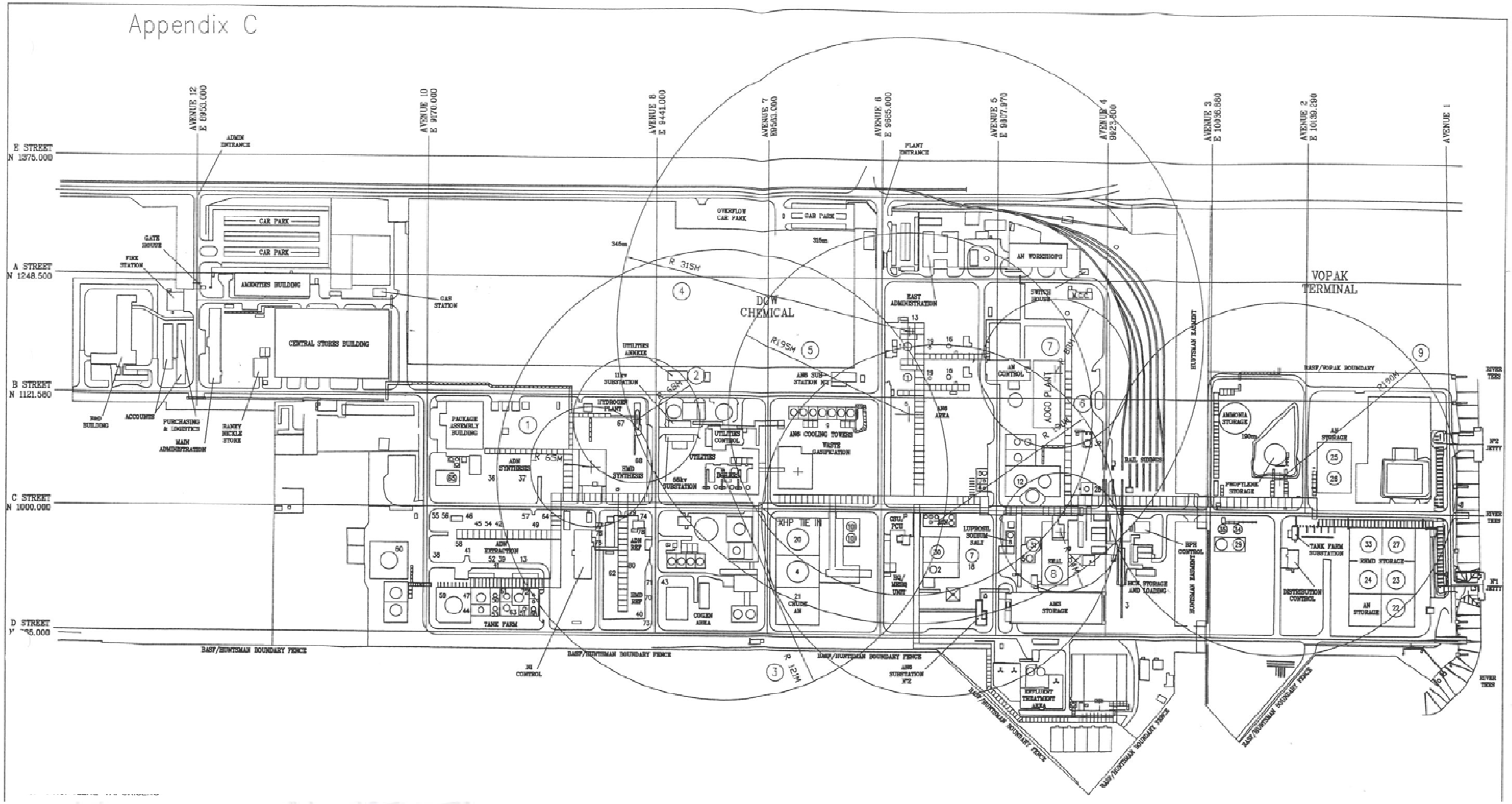
<u>Assessment</u>

- Step 1 identify occupied buildings
- Step 2 hazard based screening analysis for blast overpressures
- Step 3 detailed risk assessment where needed
- Step 4 remedial measures

Buildings on site



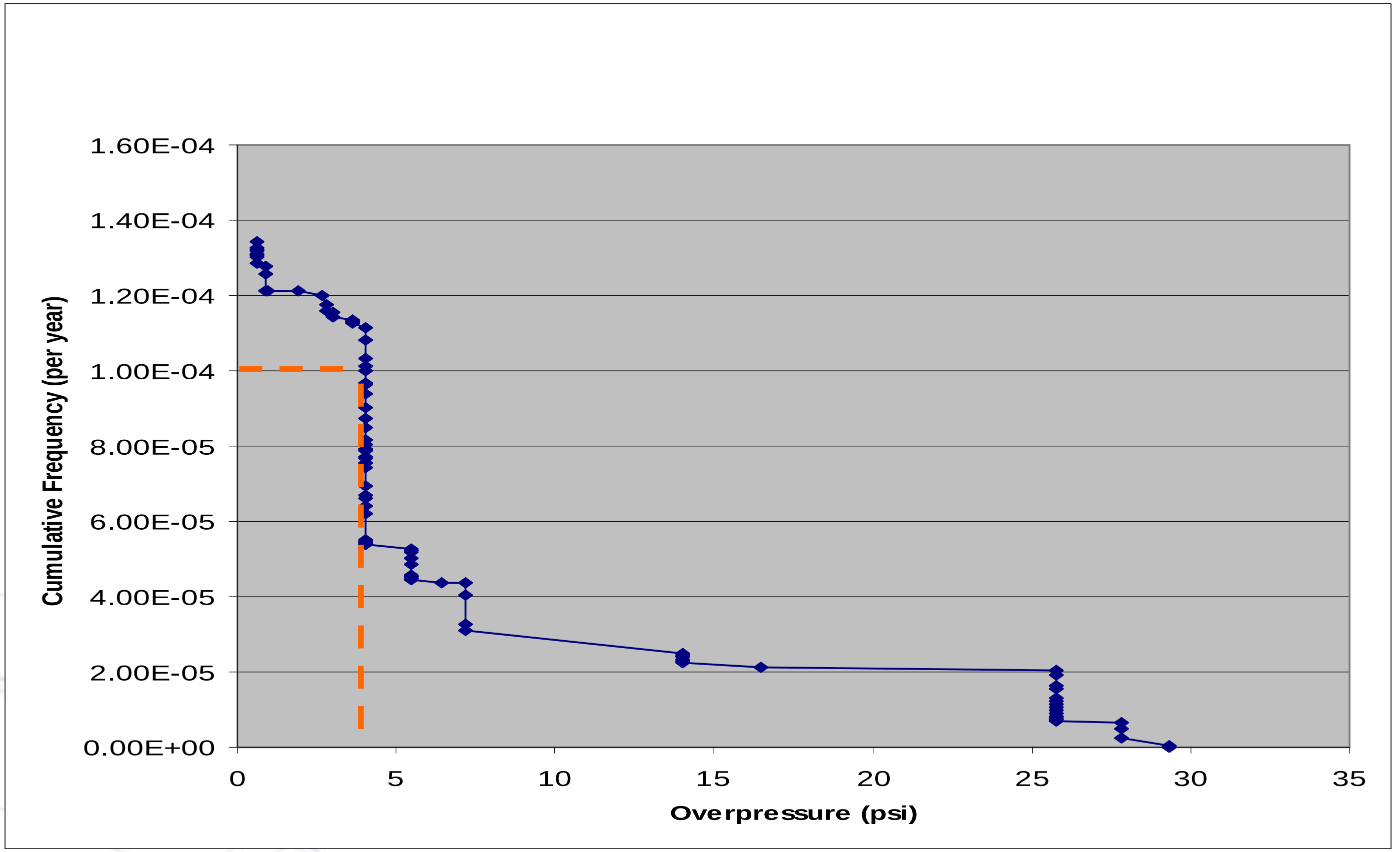
Blast circles



Detailed risk based assessment

- Cumulative frequency assessment
  - Cumulative frequency of all events with the potential to have an impact upon the building
  - Predict the overpressure level at the occupied building, which is likely to occur at a 1 in 10,000 year frequency
  - Use this overpressure level as design basis of the building

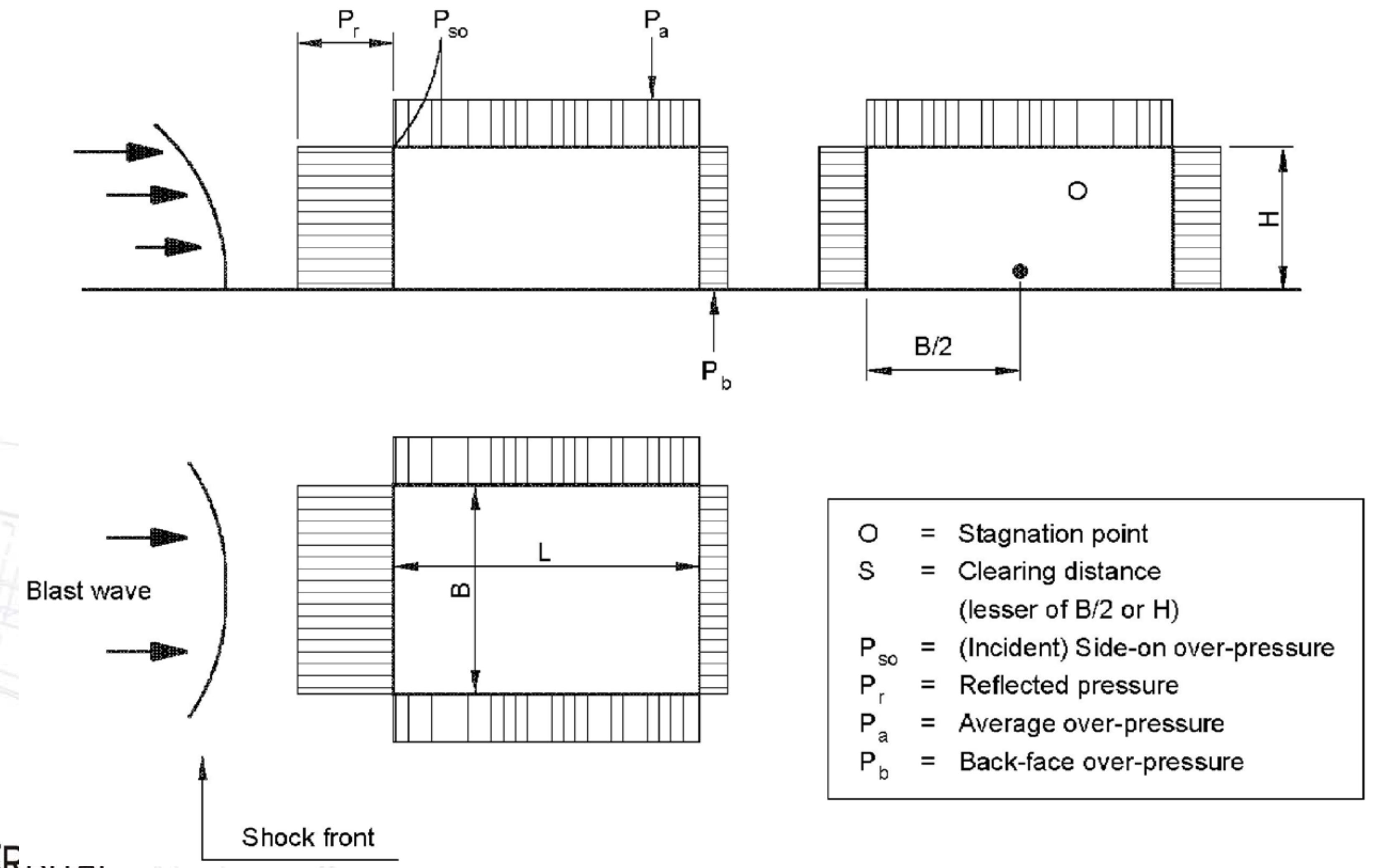
Cumulative frequency plot



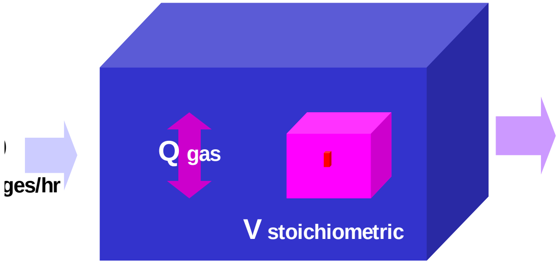
Gradient of curve changes significantly between the range 0-7 psi and 7-29 psi.

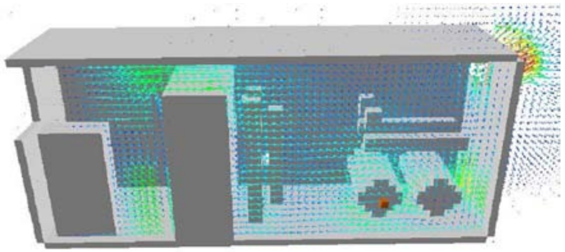
Indicates dominance of the high overpressure events from the vent recovery and pipe rack building due to the close proximity.

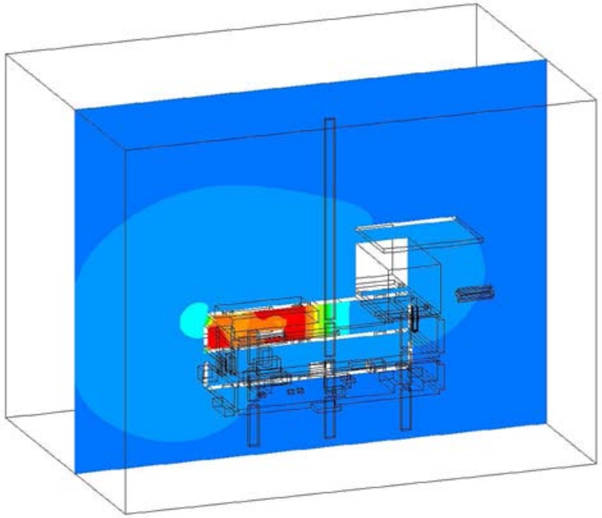
Temporary modular building – case 2

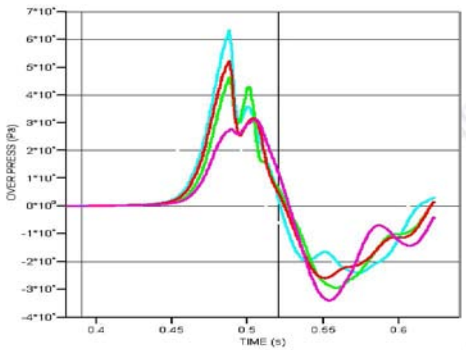


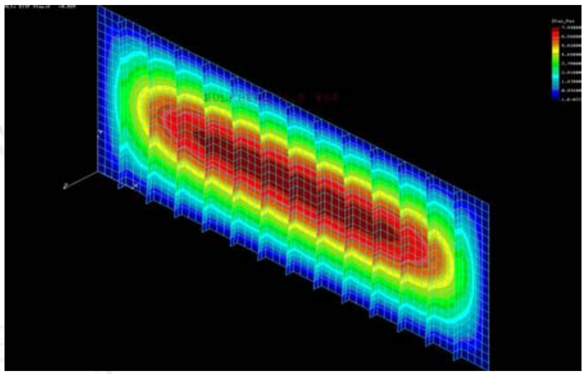
Integrated offshore assessment (CFD) – case 3











wintershall
BASF Group

NAM

bp

Chevron

BASF
The Chemical Company

VANDENBORRE
HYDROGEN SYSTEMS

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European Directives

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European Directives

96/82/EC
Seveso II

98/37/EC
89/655/EEC
Machinery
&
Work
Equipment

97/23/EC
PED

94/9/EC
99/92/EC
ATEX

BEVI

REACH

Risk Inventory & Evaluation

ATEX Directives

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General aims of ATEX

To ensure that equipment supplied for use in hazardous (explosive) areas is safe

Applies to manufacturers of equipment for use in hazardous areas

ATEX 95

To prevent people being killed or harmed by a fire or an explosion

Applies to operators of plants with hazardous (explosive) areas

ATEX 137

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ATEX Directives

- « New Approach »

- Applies to both MINES and SURFACE industries
- Deals with both gases and dusts
- Defines essential health and safety requirements

- Applies to electrical and non electrical equipment
- Deals with potential hazards
- Introduces a new marking
- Controls design and manufacturing
- Involves the responsibility of the manufacturer

ATEX 137 Implementation

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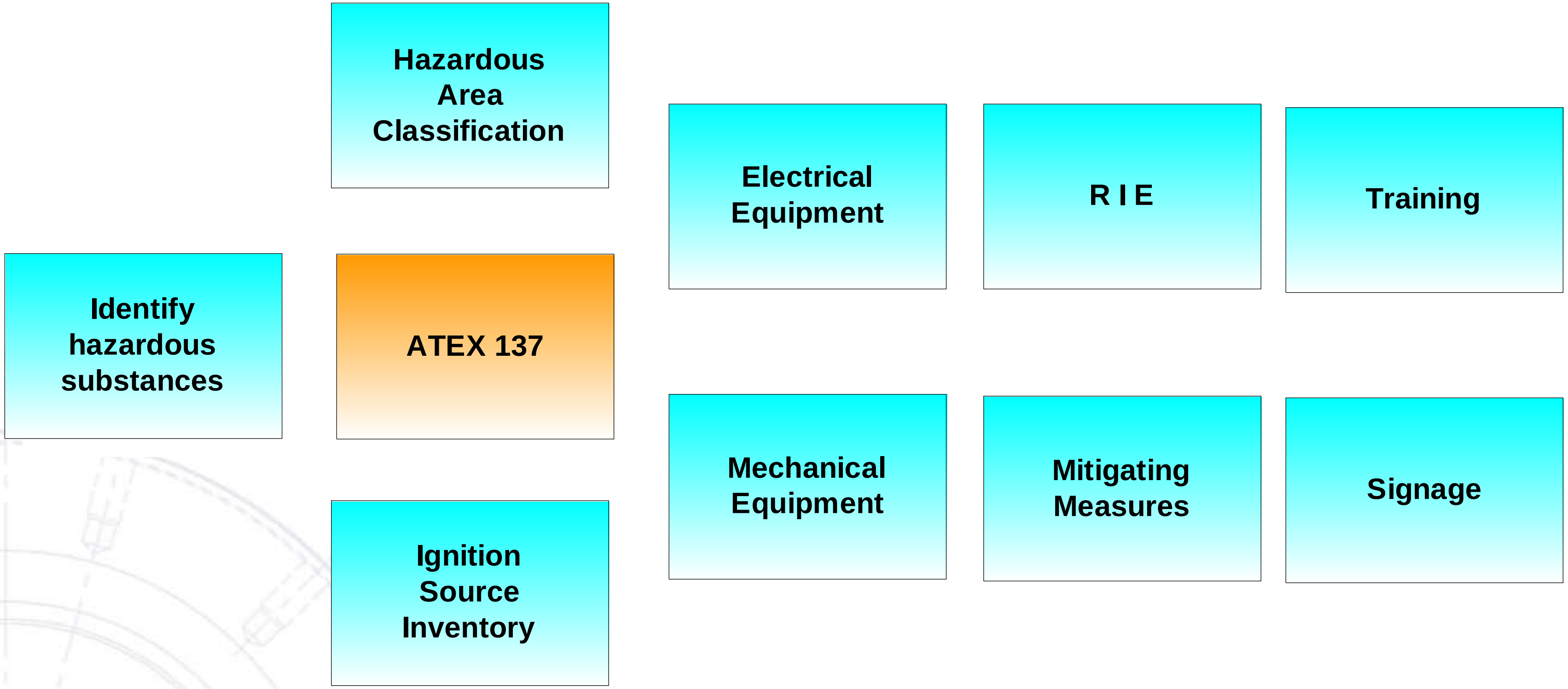
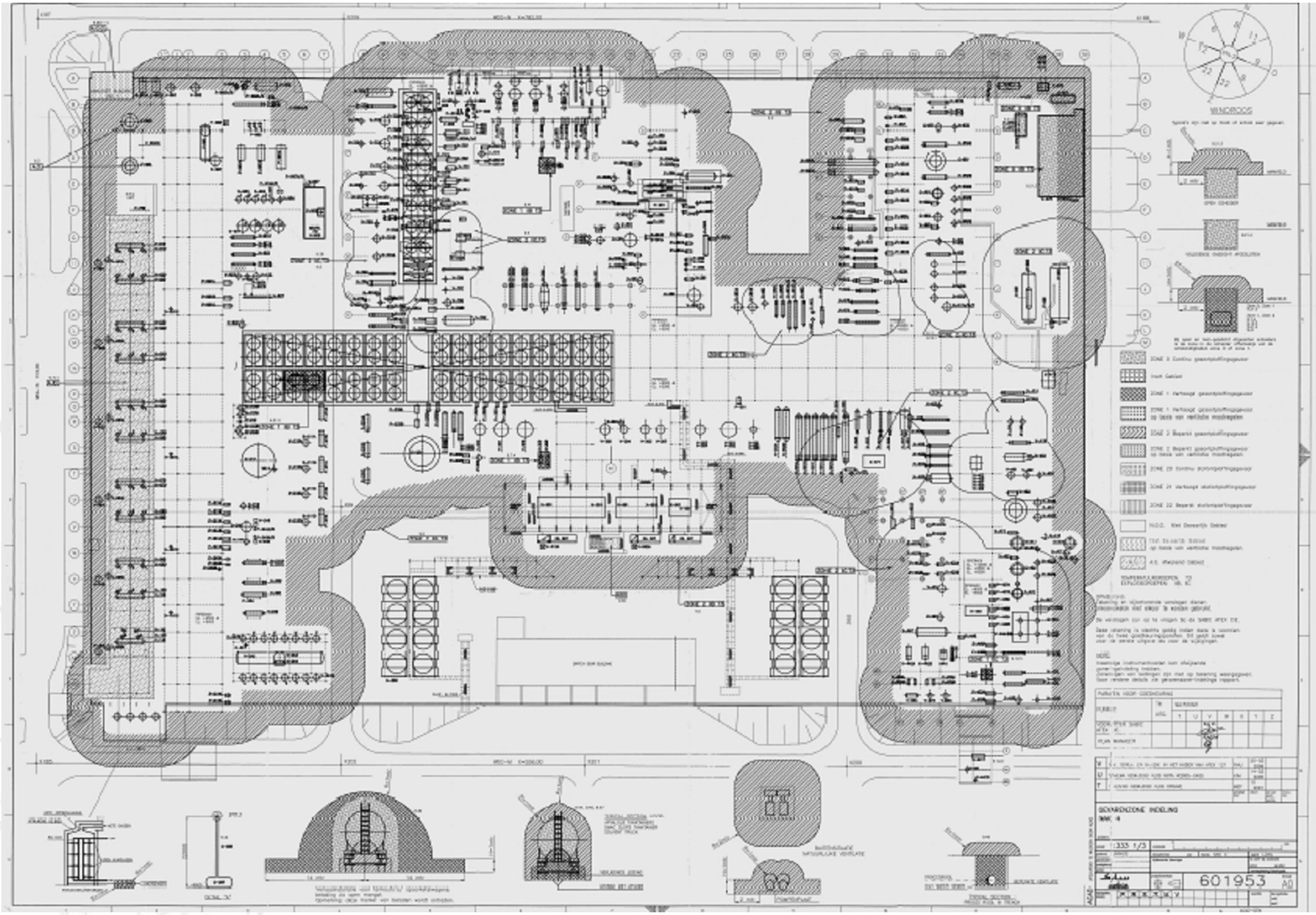
ATEX 137 scope



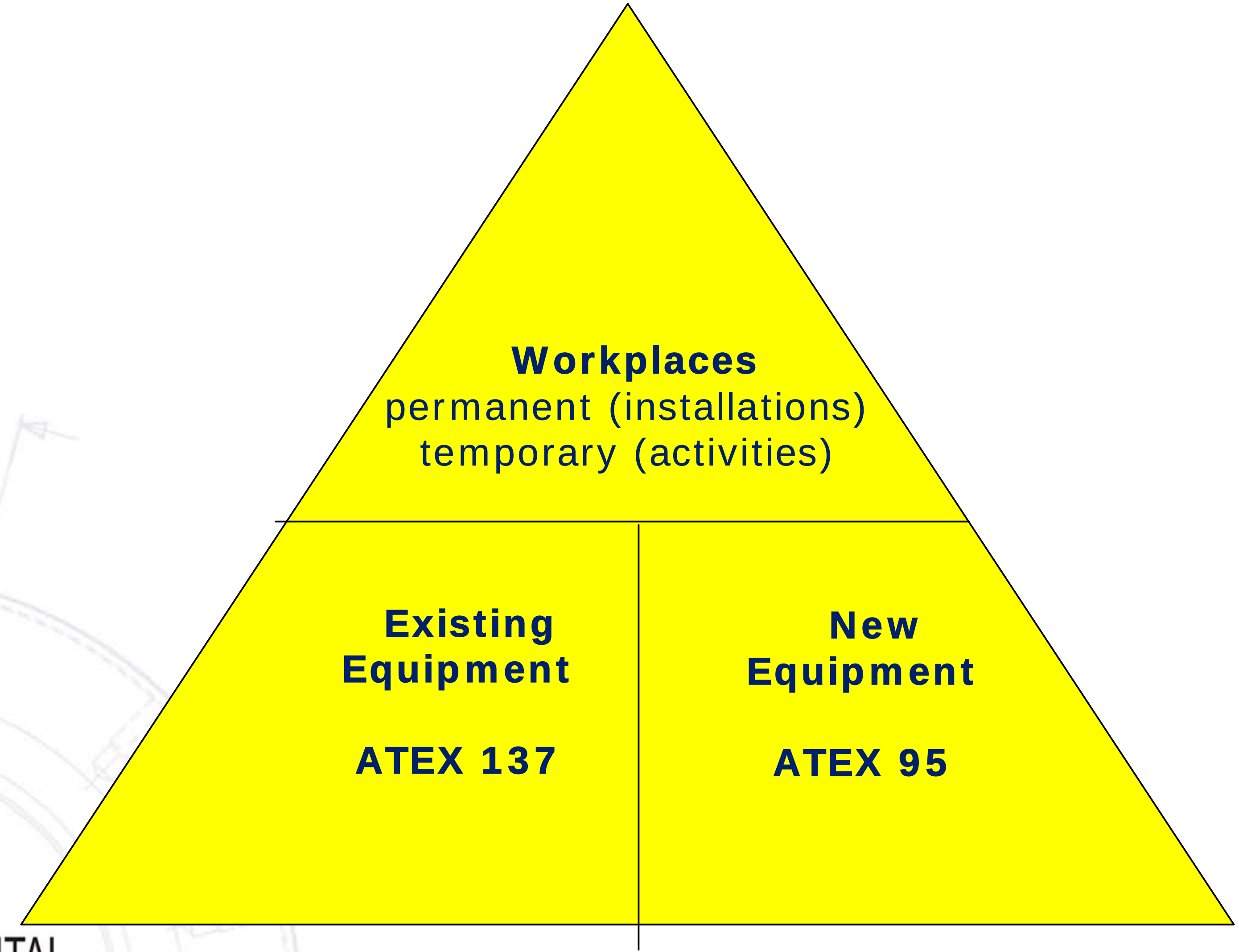
Hazardous area classification cracker



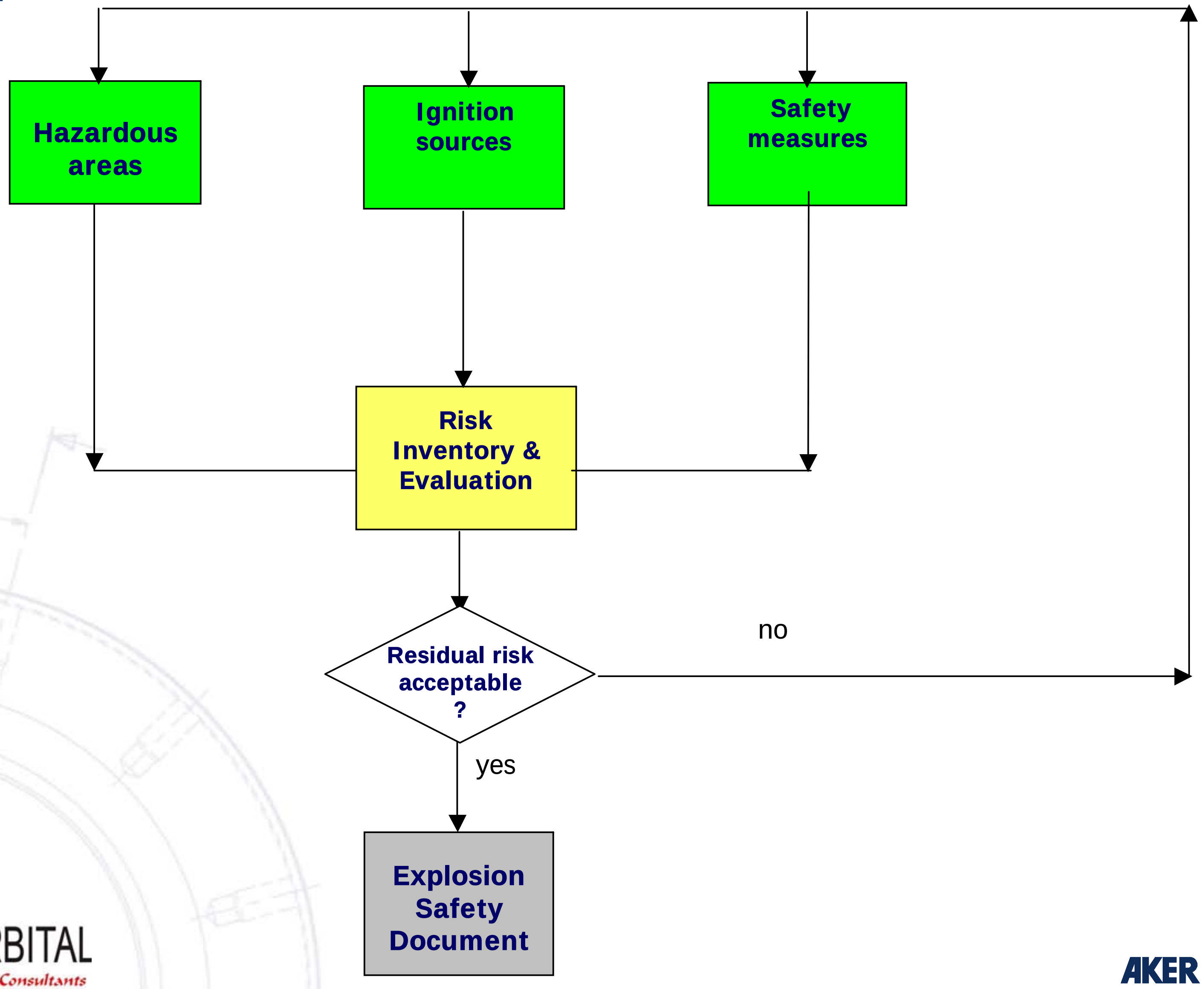
Ignition sources

- Hot surfaces
- Flames and hot gases
- Mechanically generated sparks
- Stray Electrical currents
- Static electricity
- Lightning
- Radio frequency (RF) Ignition
- Ultrasonic
- Adiabatic compression and shock waves
- Exothermic reactions (incl. self ignition of dusts)
- Non compliant equipment

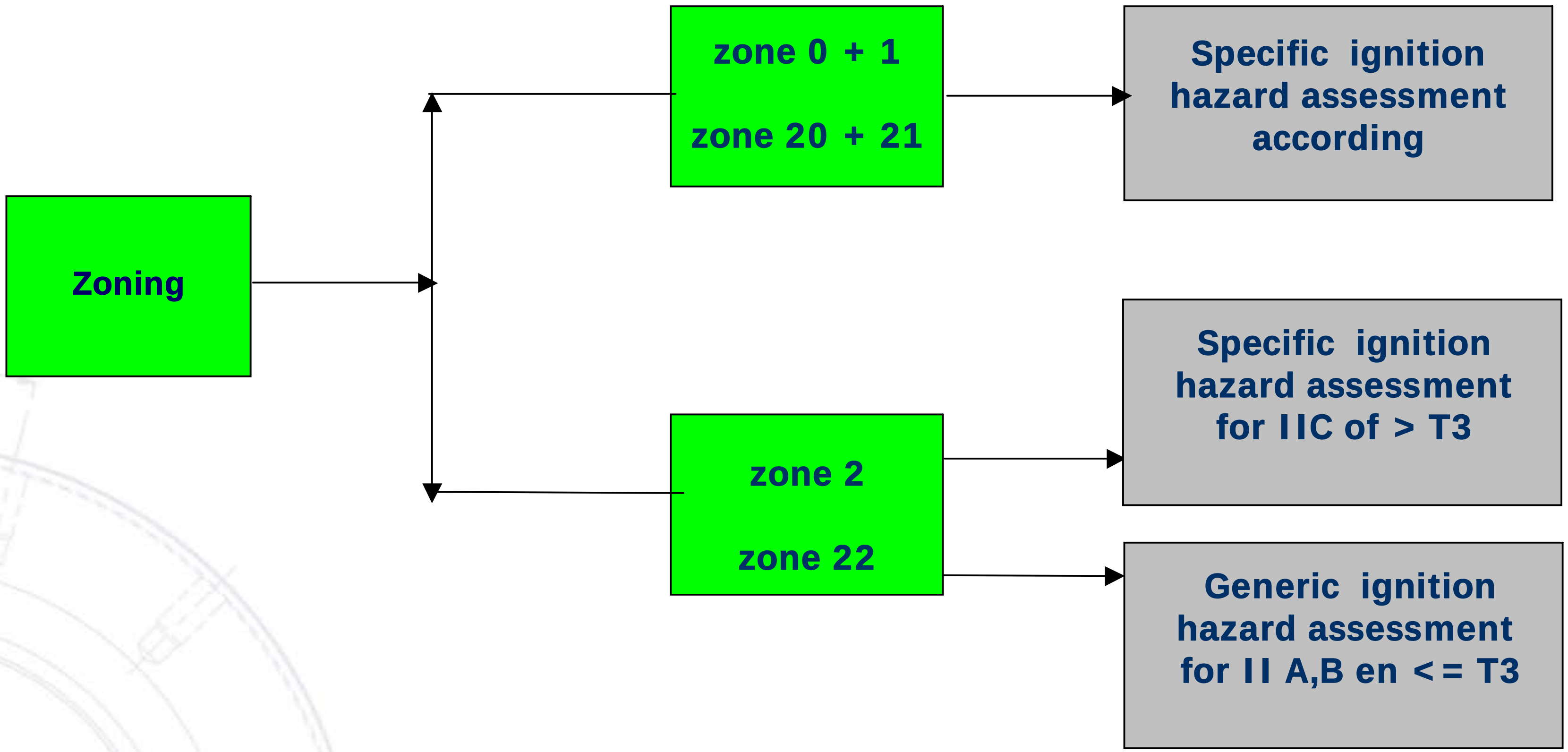
ATEX 137 Risk Inventory & Evaluation



Explosion Risk Evaluation



Mechanical equipment



Contents explosion safety document

- Documentation of **Explosion Risk Assessment**
- Description of work locations
- Description of production and operations
- Description of dangerous substances
- **Risk assessments / hazardous areas**
- Mitigating measures
  - Technical
  - Organizational
- Realization and control of mitigating measures
- Coordination of concurrent activities

Risk control

Remedial measures and inherent safety

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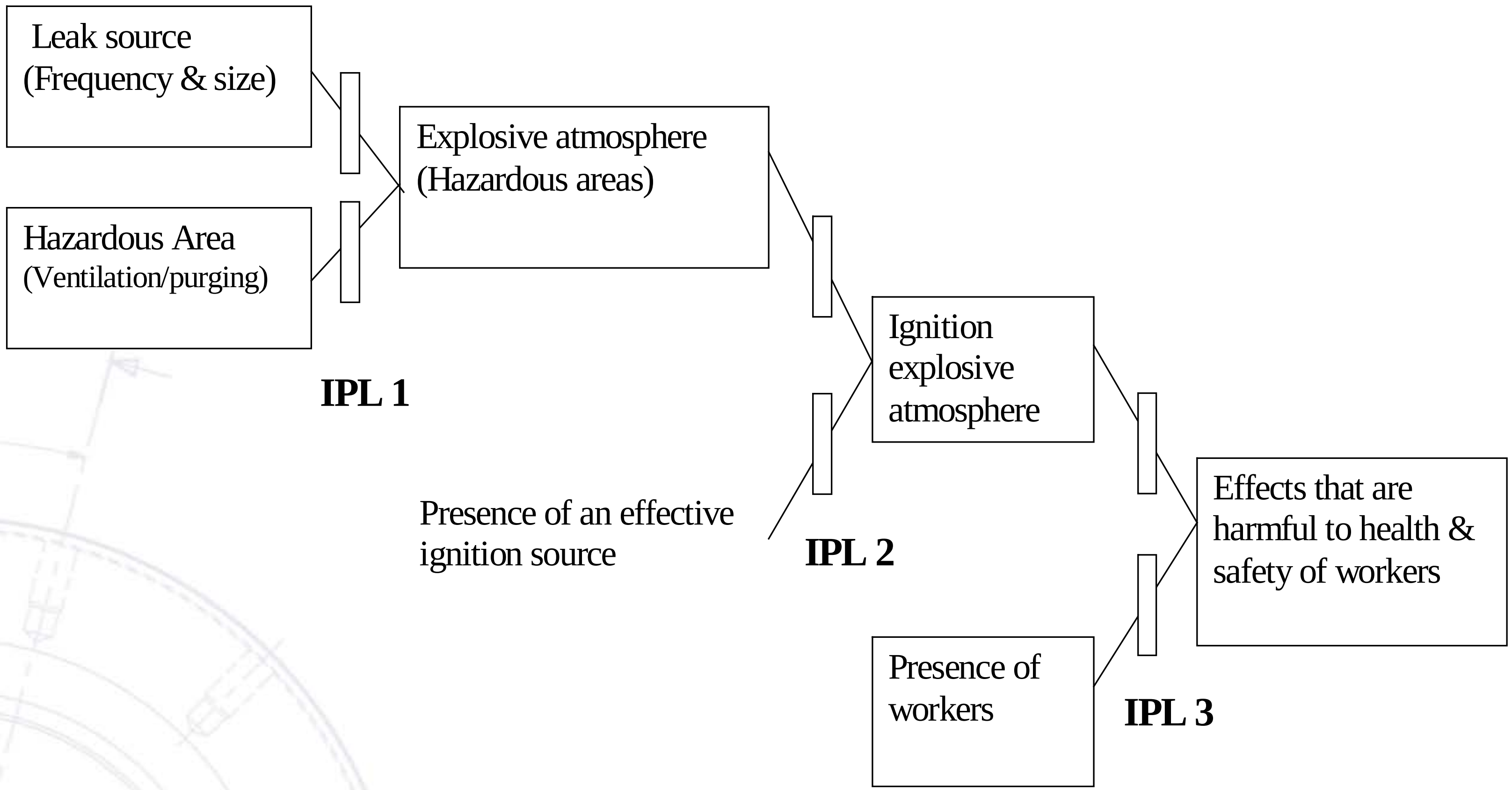
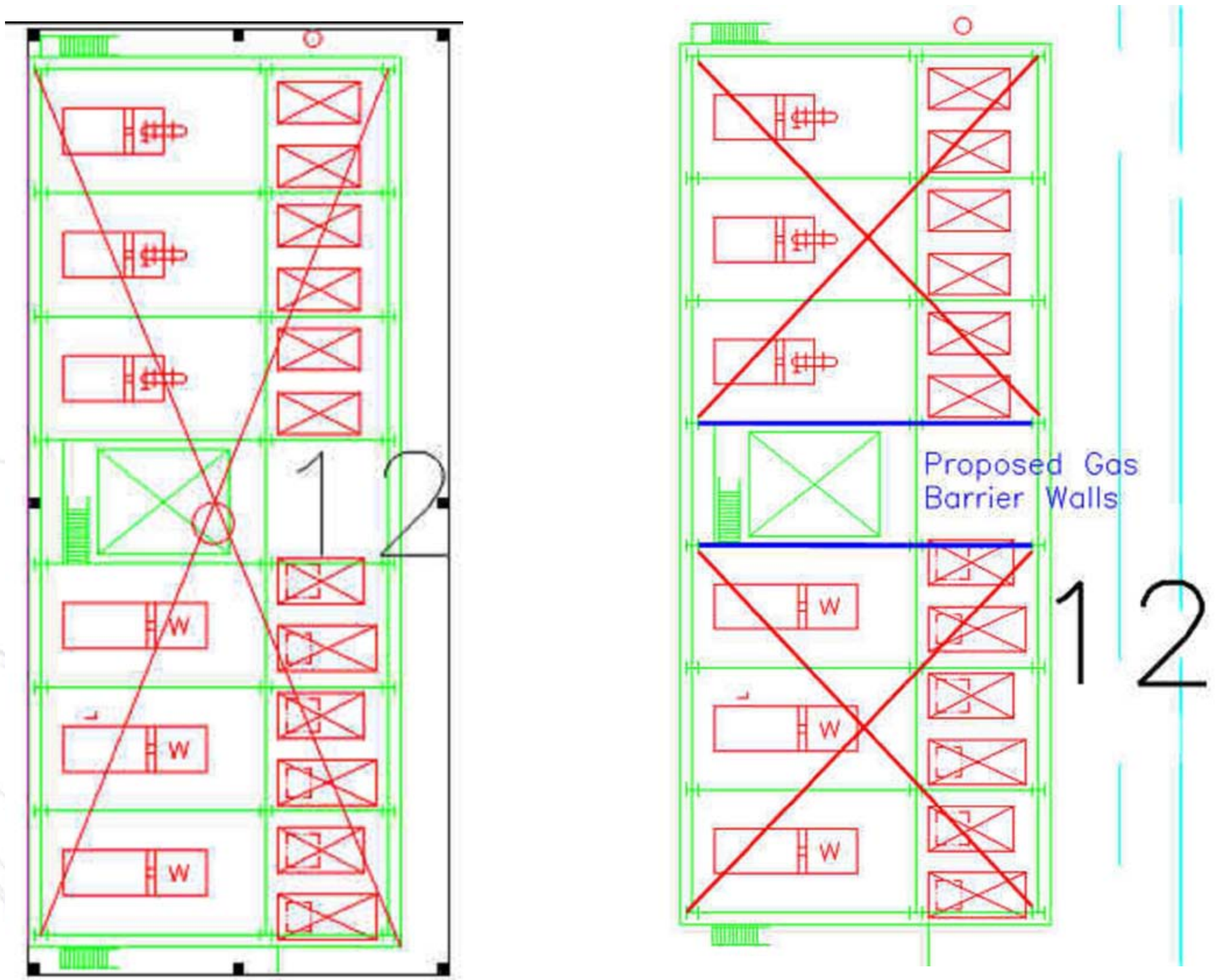
Layers of Protection



IPL = Independent Protection Layer

Example – gas barrier walls



Example – gas barrier walls

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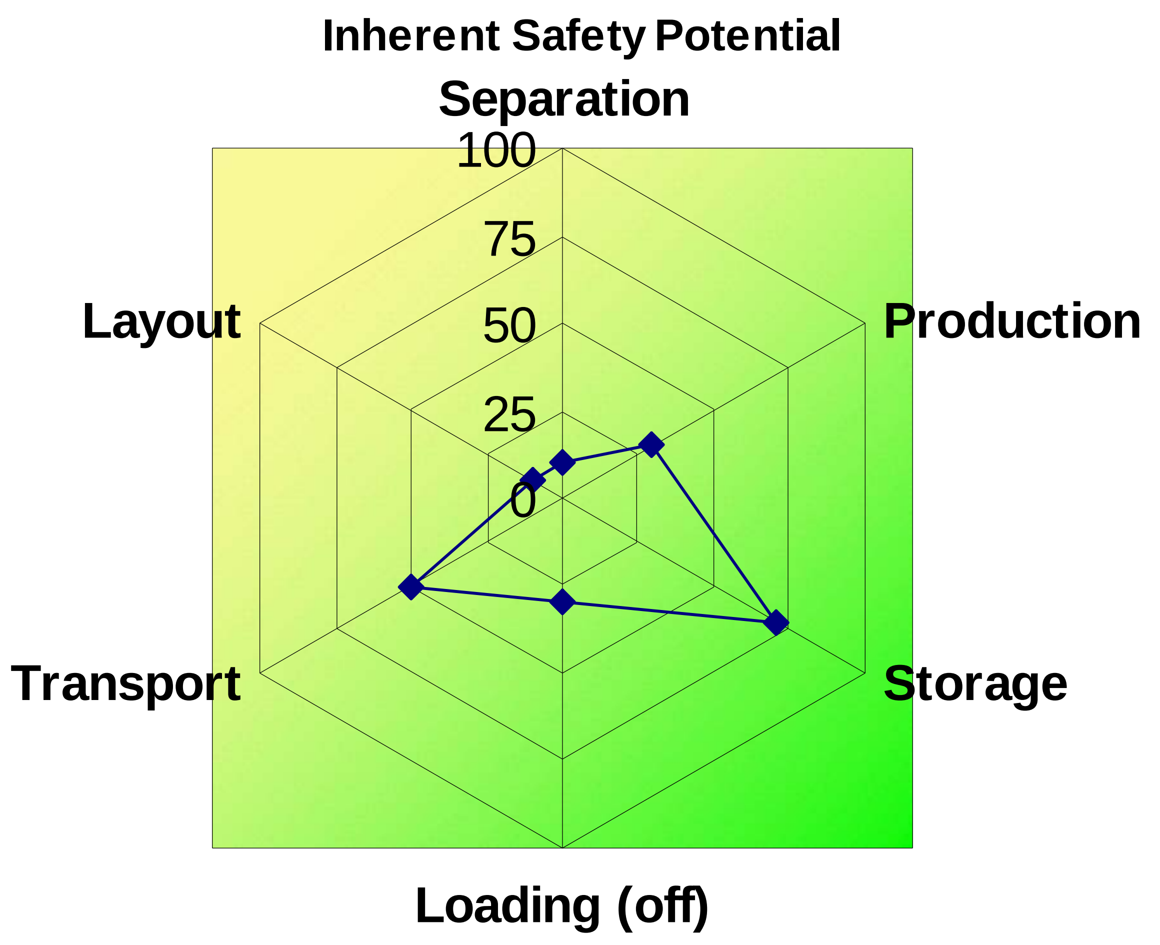
Inherent Safety Principles

- Substitution (dangerous substances)
- Intensification (reduction dangerous substances)
- Simplification (chemical routing)
- Improvement (process conditions)
- Lay out (reduction effects)

Inherent Safety



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Questions

Next LDM 8th April

Annual Colloquium 12th June

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