

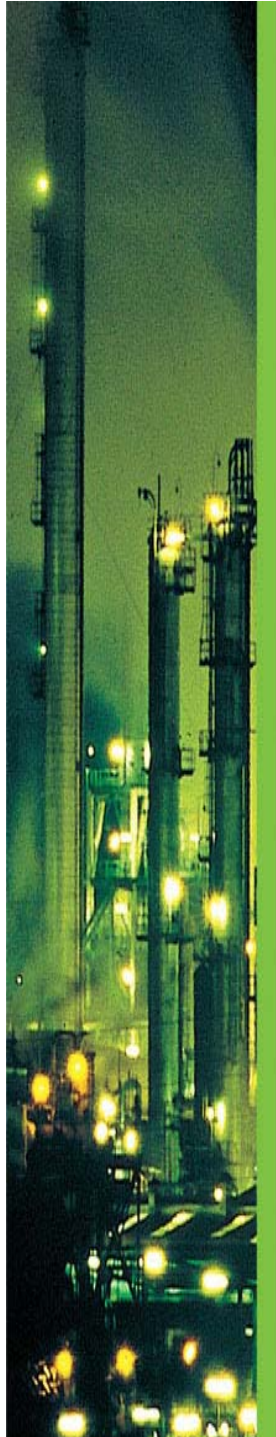
*PRISM Seminar 2003*  
*4-5 Sept. 2003, Athens, Greece*



**ARAMIS**

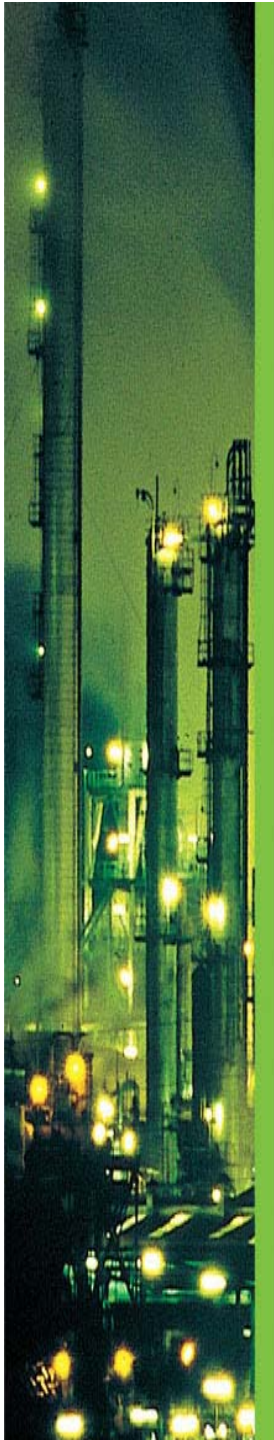
***Safety barriers***

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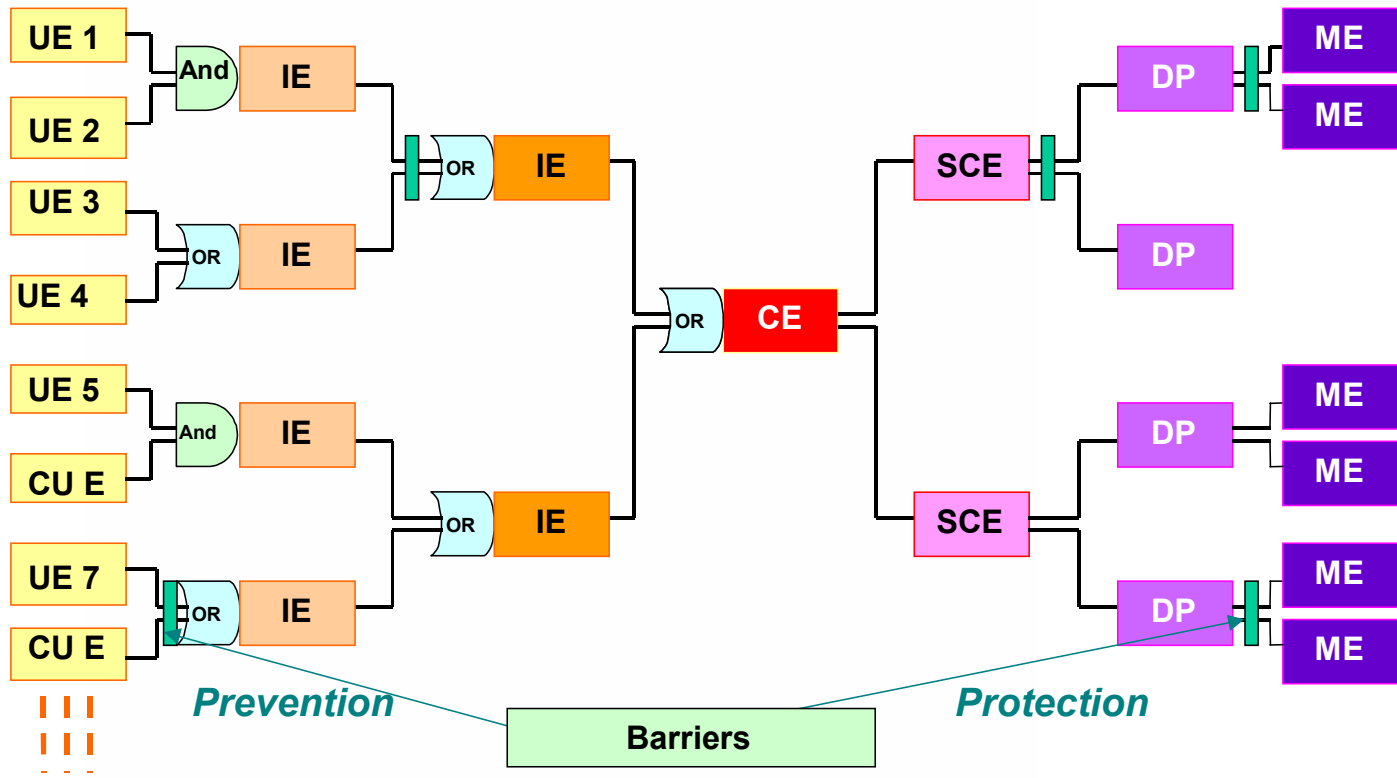


## *Chemical industries*

- Risks are regulated in Seveso II Directive
- Potential accidents occur as
  - Loss of Containment (LOC)
  - Loss of Physical Integrity (LPI)
- Modelling with Accident Scenarios
  - Bow-tie
  - Safety Barriers
- Risk: Probabilities & Consequences

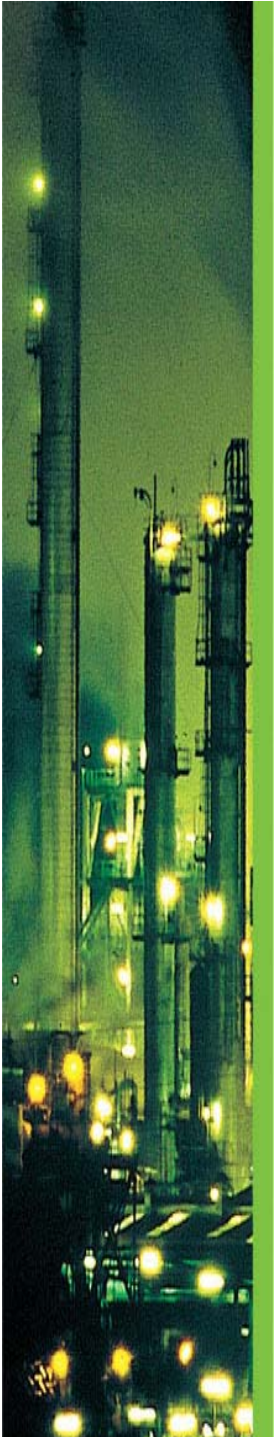


# Bow-tie & Barriers



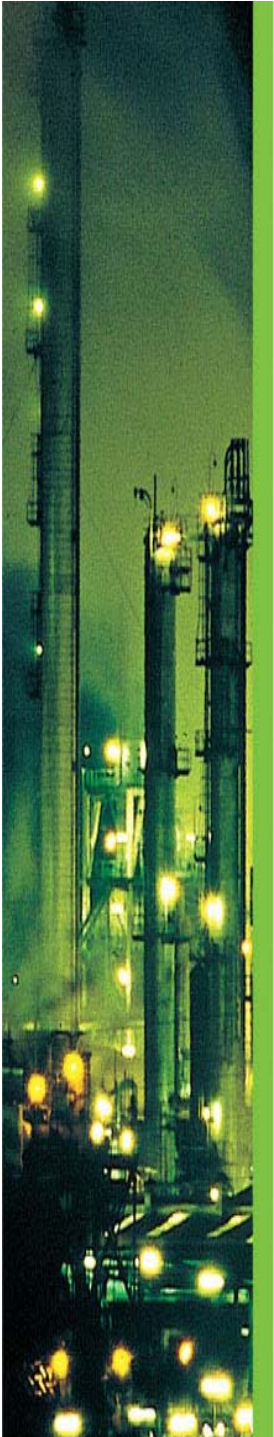
**Fault Tree**

**Event tree**



## *Approach*

- Safety function =
  - technical, organisational or combined function
  - that reduces probability or consequences
  - via safety barriers
- Action verbs
  - To prevent
  - To limit (to protect)
  - To mitigate



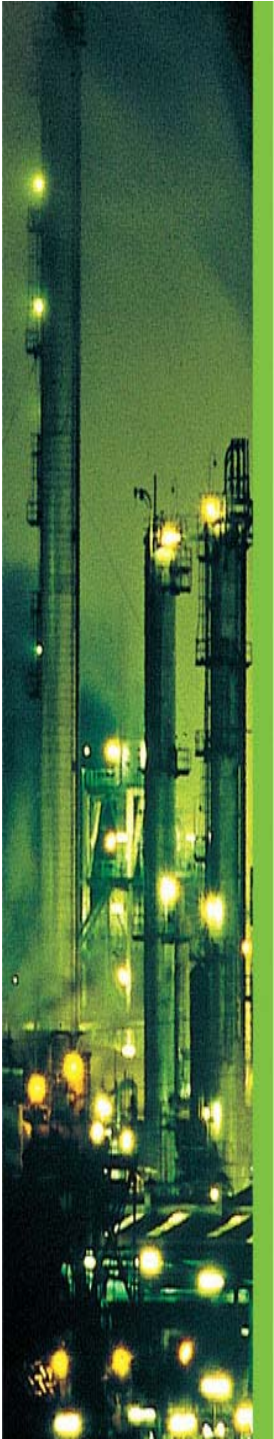
# Barriers

- Categories of barriers
  - Passive barriers
    - vessel wall, dykes
  - Active barriers
    - interlock systems, relief valve
  - Procedural barriers
    - work permit
- Functioning: permanent or activated
- Activated: detection - diagnosis – action

## *Probability of LoC/LPI*

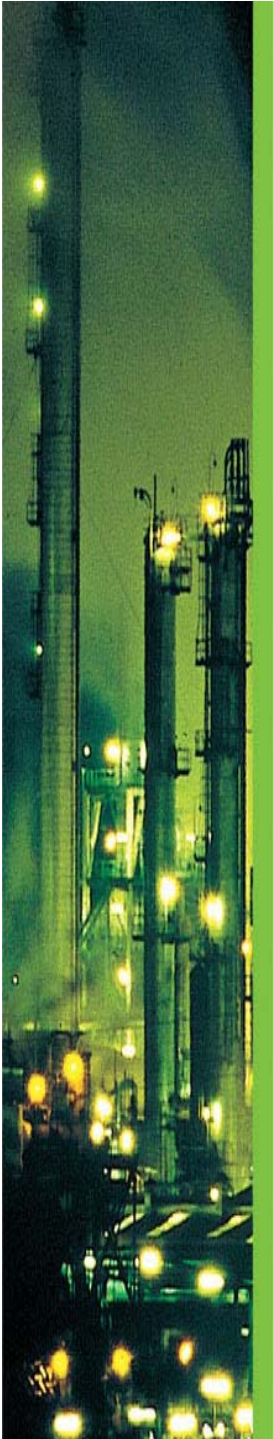
Safety barriers decreases probability

- of technical component failures and human error rates
- by adding control functions (AND-gates)
- of conditional probabilities (in the consequence event trees)

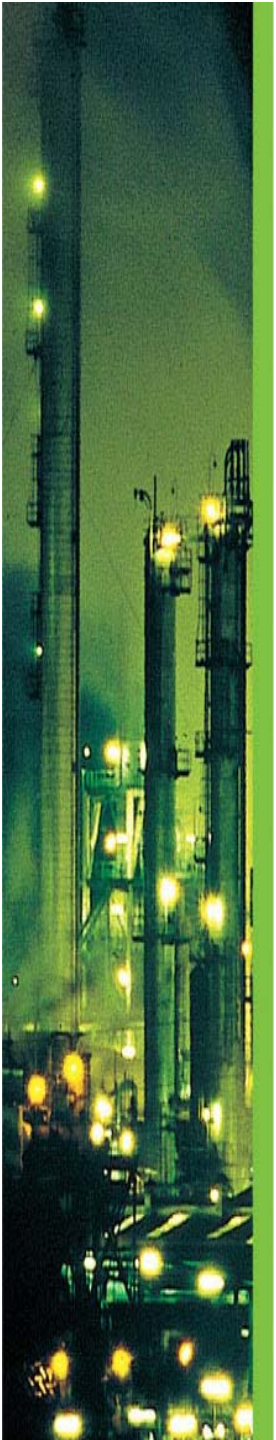
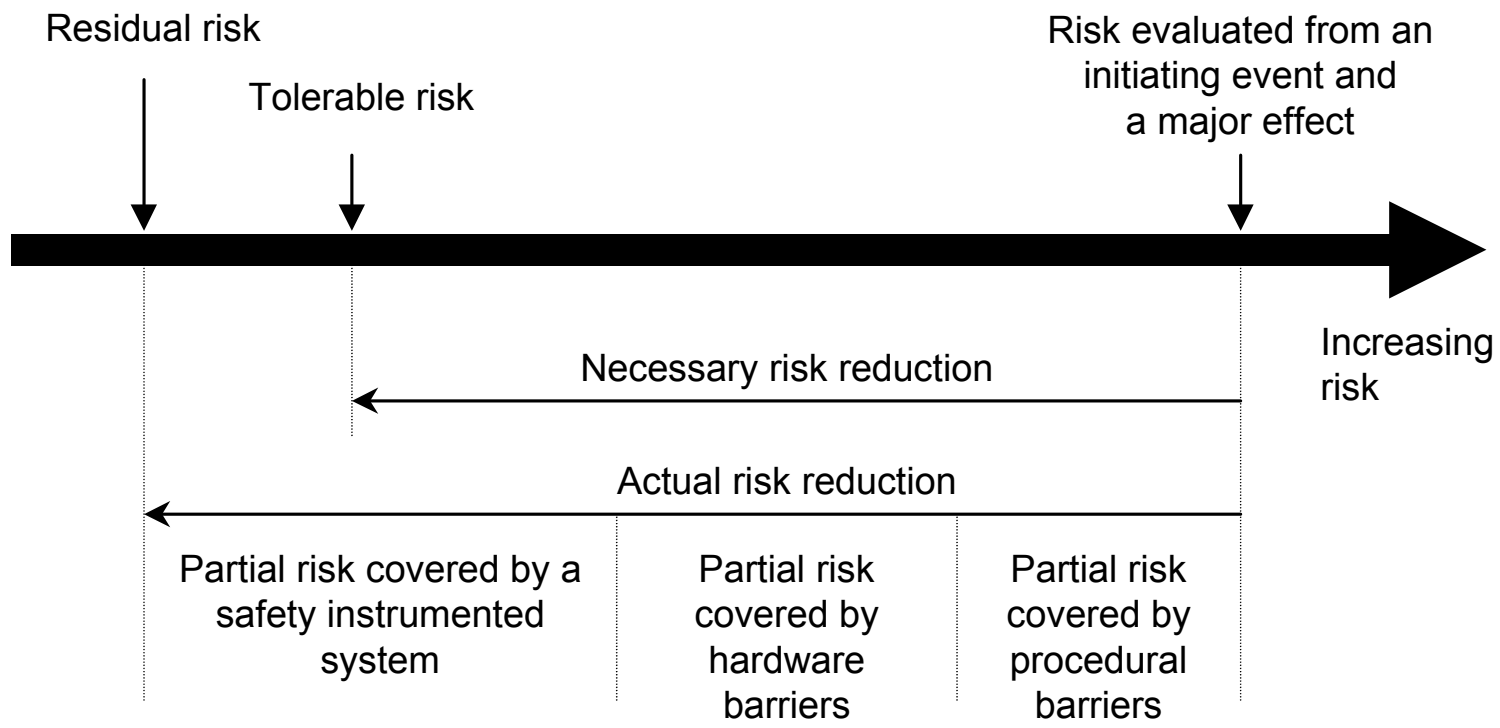


# Design & Redesign

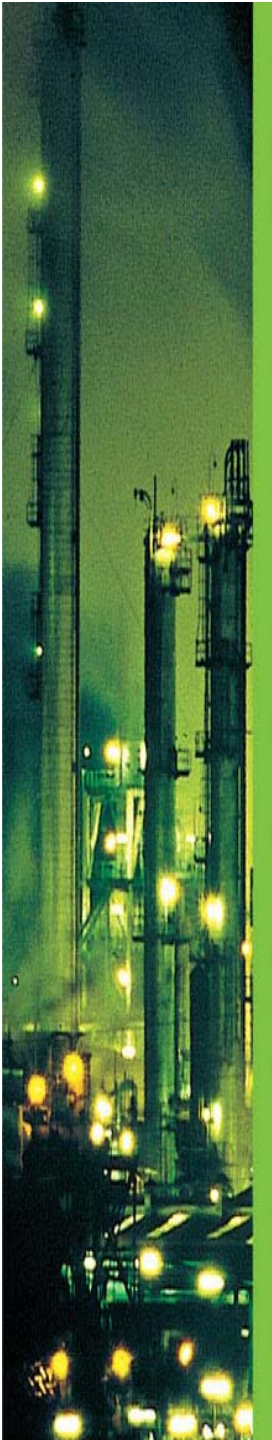
- Management strategies
  - Inherently safer design
  - Safety barriers
  - SIL (safety integrity level) choice
  - Independent Layers of Protection
- Safety management implications



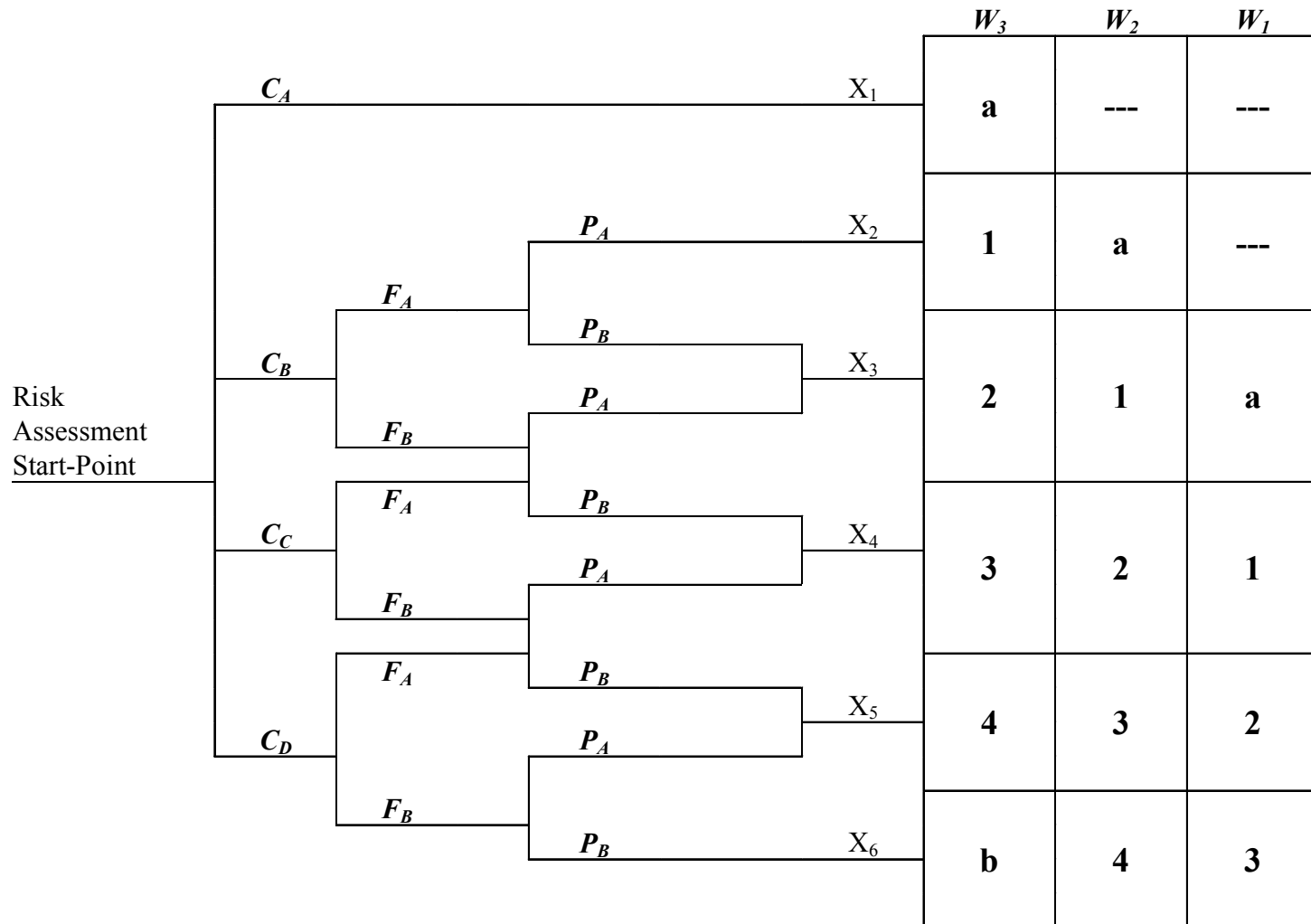
# Risk reduction process

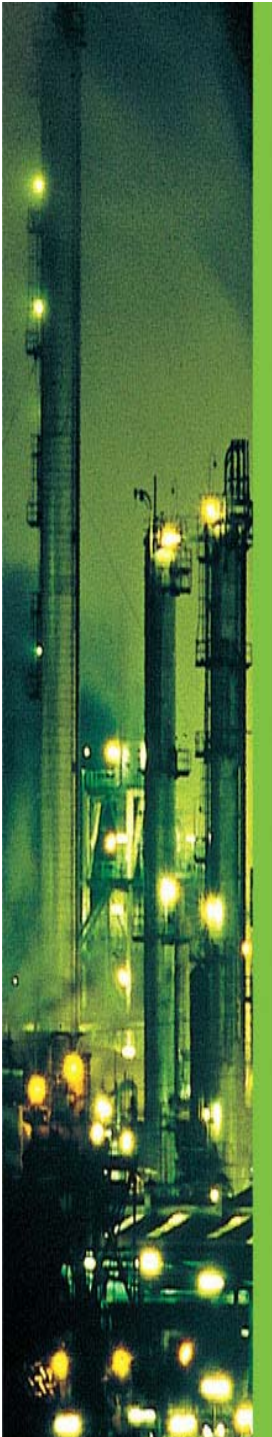






# Setting a risk reduction objective





## Class of confidence per barrier

- Active barriers
  - Derived from SIL principles (IEC 61508-61511)

Safe Failure Fraction (SFF)	Tolerant to :		
	0 failure	1 failure	2 failures
... ▲ 60 %	SIL 1	SIL 2	SIL 3
60 ▲ 90 %	SIL 2	SIL 3	SIL 4
90 ▲ 99 %	SIL 3	SIL 4	SIL 4
99 % ▲ ...	SIL 3	SIL 4	SIL 4

## Class of confidence per barrier

- Passive barriers
  - Derived from generic PFD values

Generic passive safety barrier	PFD from Literature and Industry (no dimension)	Level of Confidence in the barrier
Dike	$10^{-2} - 10^{-3}$	2
Underground drainage system	$10^{-2} - 10^{-3}$	2
Open vent (atmospheric vessel)	$10^{-2} - 10^{-3}$	2
Fire-proofed wall / blast wall / bunker	$10^{-2} - 10^{-3}$	2
Flame / detonation arrestors	$10^{-1} - 10^{-3}$	1

- Procedural barriers / human actions
  - Derived from indicative PFD values

## *Important assumptions*

- A barrier performance is characterised by:
  - its effectiveness,
  - its response time,
  - its class of confidence
- Definition of barrier independence
- Assuring a barrier contextual performance
  - Safety organisation should assure barriers are managed and maintained in time
  - Link to the organisational model

