# Principles of Inherent Safe Design

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Flixborough 1974

# Presentation outline

- What is inherent safety?
- Inherent safety implementation techniques
- Conflicts in inherent safety
- Human factors and inherent safety issues

# Definition

Inherent safety:

An approach to process design and operation which builds in safety, health and environmental considerations at the start

# Definition

Inherent safety:

What you don’t have can’t leak!

Trevor Kletz 1978

# Definition

Inherent safety:

A low level of danger, even if something goes wrong

Wikipedia….

# Inherently safer design

In reality no design can be inherently safe

However you can have an inherently safer design

# Inherently safer guidewords

| Guideword | description |
|---|---|
| **Substitute** | Replace a substance with a less hazardous material or processing route with one that does not involve hazardous material. Replace a hazardous procedure with one that is less hazardous. |
| **Minimise** | Use smaller quantities of hazardous materials when the use of such materials cannot be avoided - also called intensification. Perform a hazardous procedure as few times as possible when the procedure is unavoidable**.** |
| **Moderate** | Use hazardous materials in their least hazardous forms or identify processing options that involve less severe processing conditions - also called attenuation or limitation of effects. |
| **Simplify** | Design processes, processing equipment and procedures to eliminate opportunities for errors by eliminating excessive use of add-on (engineered) safety features and protective devices - also called error tolerance. Less equipment of any kind means that there is less to go wrong. |

# Other options – not inherent safety

- Reduce consequential harm
  - risk to people is dependent on their presence in the harm zone
  - risk to environment is dependent on the sensitivity of species within the harm zone
  - risk to asset is not location specific

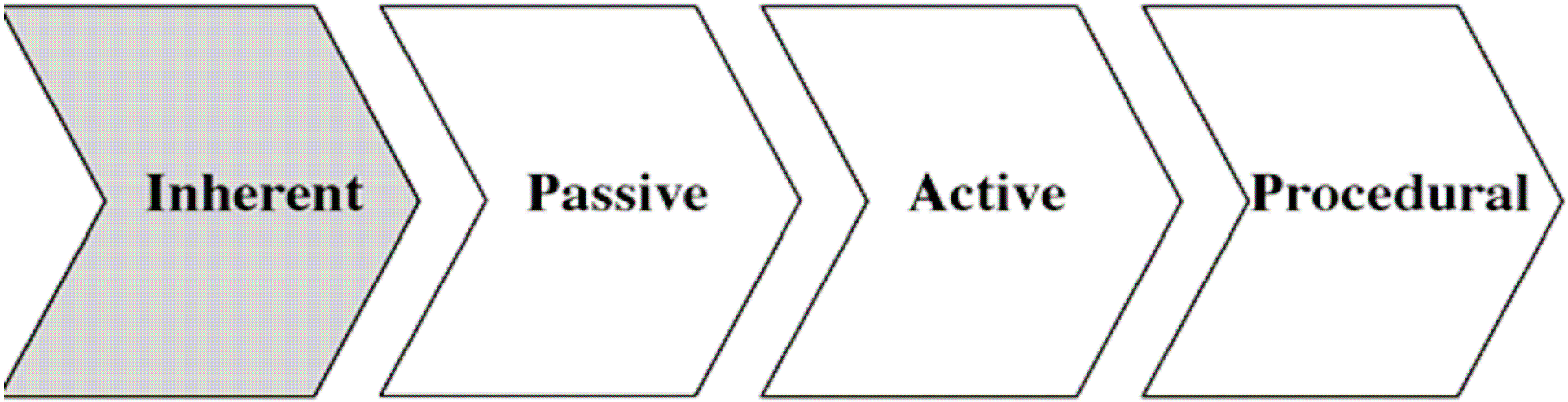
# Other options – not inherent safety

- Locate process in region with no ‘harm consequences’
  - is it justified to release hazardous material into an area which has
    - low population numbers
    - no special environmental features?
  - in the UK severity of harm is based on
    - people – number of fatalities and injuries estimated
    - environment – potential for a ‘ major accident to the environment’ (MATTE) which is relative to the special features nearby

# Other ‘obvious’ options

- Design piping for maximum pressure and temperature under fault conditions rather than installing pressure and temperature trips
- Minimise pipe route lengths to limit quantity available to leak
- Use all welded lines
- Select materials of construction for the worst case conditions they could see, not the ‘normal’ conditions
- Design support structures for the worst credible external events such as wind, flood, earthquake, fire

# Layers of process safety



# Layers of process safety - inherent

Ideally this means eliminating the hazard from the design

# Layers of process safety - passive

This is building the protection into the design so it cannot be (easily) changed

- Reduce frequency and / or consequence of hazard
  - e.g. design conditions should mean that process cannot move outside of the safe envelope under any circumstances – however external factors such as external damage exist
  - future design / process changes could invalidate protection

# Layers of process safety - active

These layers are intended to prevent, control or mitigate a potentially hazardous scenario: e.g.

- Prevent: high level trip isolates flow into a tank before it can overfill and lose containment
- Control: a restrictive orifice plate limits the rate of loss of containment if a line fails
- Mitigate: heat activated links open deluge valves to spray water in case of fire

# Layers of process safety - procedural

These are systems which are intended to manage risk

- Safety / process management system (SMS) / (PMS)
  - company policy
  - site rules
  - operating procedures
  - training / refresher training
  - maintenance and inspection regimes
  - test procedures and schedules
  - emergency response plans (on- and off- site)

# Tolerability of risk - ALARP

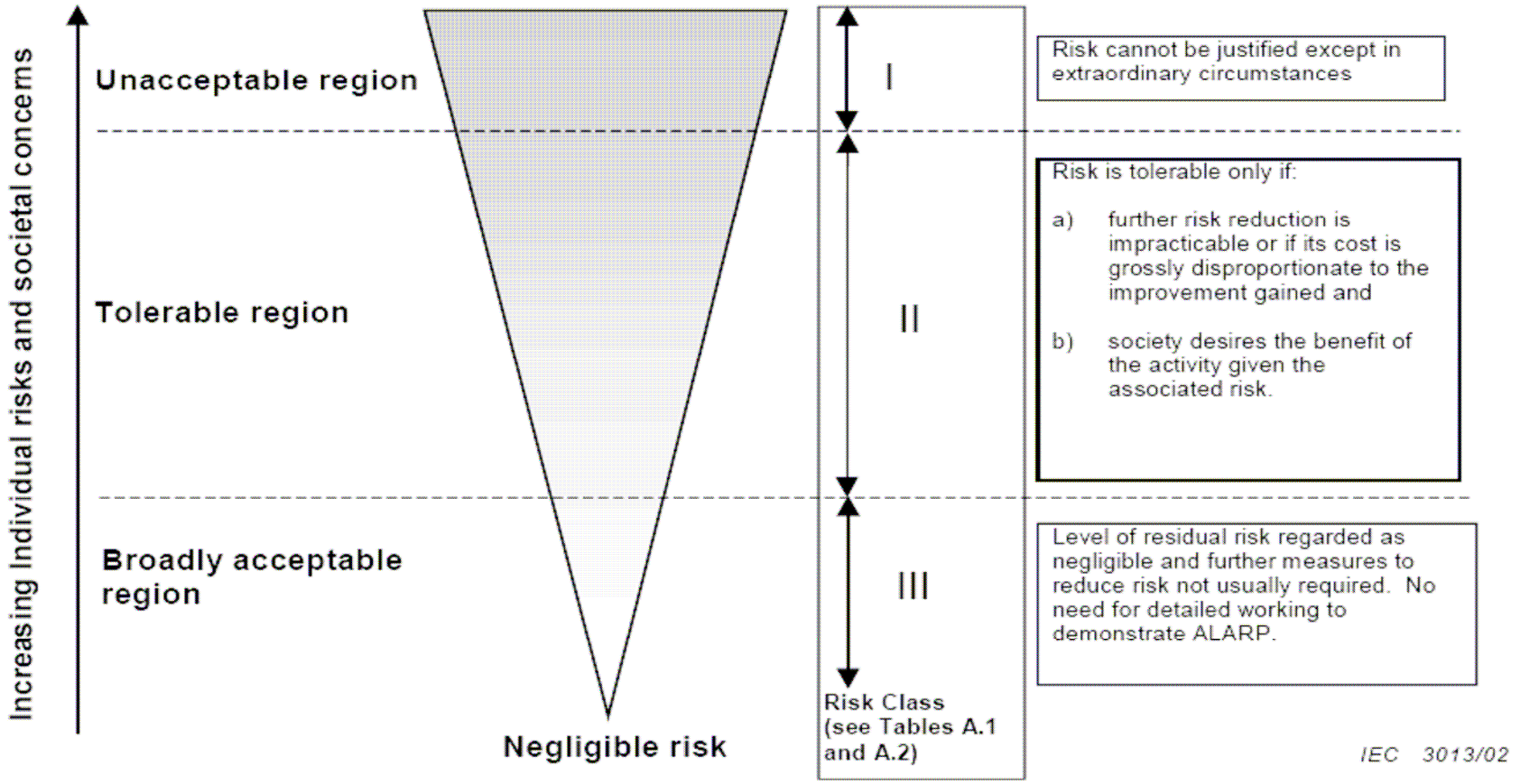



**Figure A.1 – Tolerable risk and ALARP**



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# Inherent safety implementation techniques

- Constructive questioning for example:
  - Is it necessary?
  - Why do it that way?
  - Why that material?
  - Why so much?
  - How can we make it simpler?

# Inherent safety implementation techniques

- Alternatives for lower impact?
- Alternatives to minimise inventories?
- Alternatives for benign process conditions?
- Ultimate fate of all substances?
- Designed for minimum purges?
- Designed for minimum effluent & waste disposal?
- Designed to minimise consequences of releases?
- Impact of increased SH&E standards on costs?

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# Conflicts in inherent safety

Inherent Safety is not always obvious

- Cost implications
- Flexibility
- Personal choice
- Balance of demands
- Judgement
- Information available
- etc etc

# Conflicts in inherent safety

Inherent safety design depends on extent of understanding:

- Experience – of people
- Experience – of process
- Industry knowledge
- History of incidents
- Data availability (e.g. MSDS, compatibility, etc)
- New / novel / innovative – then what??

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# Human factors and inherent safety issues

- Task design / workload
- Motivation
- Complexity
- Time available in which to make a decision
- Procedures design – ease of reference, correct, detailed
- Communications
- Organisational structure
- Management attitude – 'production is more important than safety'
- Non-compliance with standards accepted as normal
- Poor training / inexperience
- Lack of self belief (in ability to make correct decision)
- Poor design (too many alarms arising – so ignores them – no distinction of 'important alarms)
- Colour blind
- Too busy / distracted
- Poor environment (too hot / cold / cramped / poor lighting / layout not conductive to seeing fault warning)
- Misleading information
- Alarm fault ( e.g. alarm often in spuriously, so ignored)
- Stress / fatigue / boredom

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