Risk Based Decision Making and ALARP

How low is low enough?

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Purpose of Presentation

- An introduction to making risk based decisions and reducing risks As Low As Reasonably Practicable (ALARP).
  - When is individual risk low enough?
  - When is societal risk low enough?
  - What approaches are available to help decide?
- Hopefully it is useful!

Basic Risk Management

IDENTIFY

Are people, environment, assets or reputation exposed to potential harm?
What could go wrong?

ASSESS

What are the causes and consequences?
How likely is it?
How bad will it be?
What is the risk and is it tolerable?

CONTROL

Can the causes be eliminated?
Is there a better way?
How can it be prevented?
How effective are the controls?

RECOVER

Can the potential consequences be limited?
What recovery measures are needed?
Are recovery capabilities suitable and sufficient?

ALARP basic principle

Whilst reduction of risk will always be desirable, the achievement of the reduction may be unwarranted

ALARP may be summarised as:

> A measure to reduce risk must be undertaken unless it can be demonstrated (by the duty holder) that the sacrifice involved in implementing the preventative measure(s) is grossly disproportionate to that risk.

Why have quantitative risk criteria?

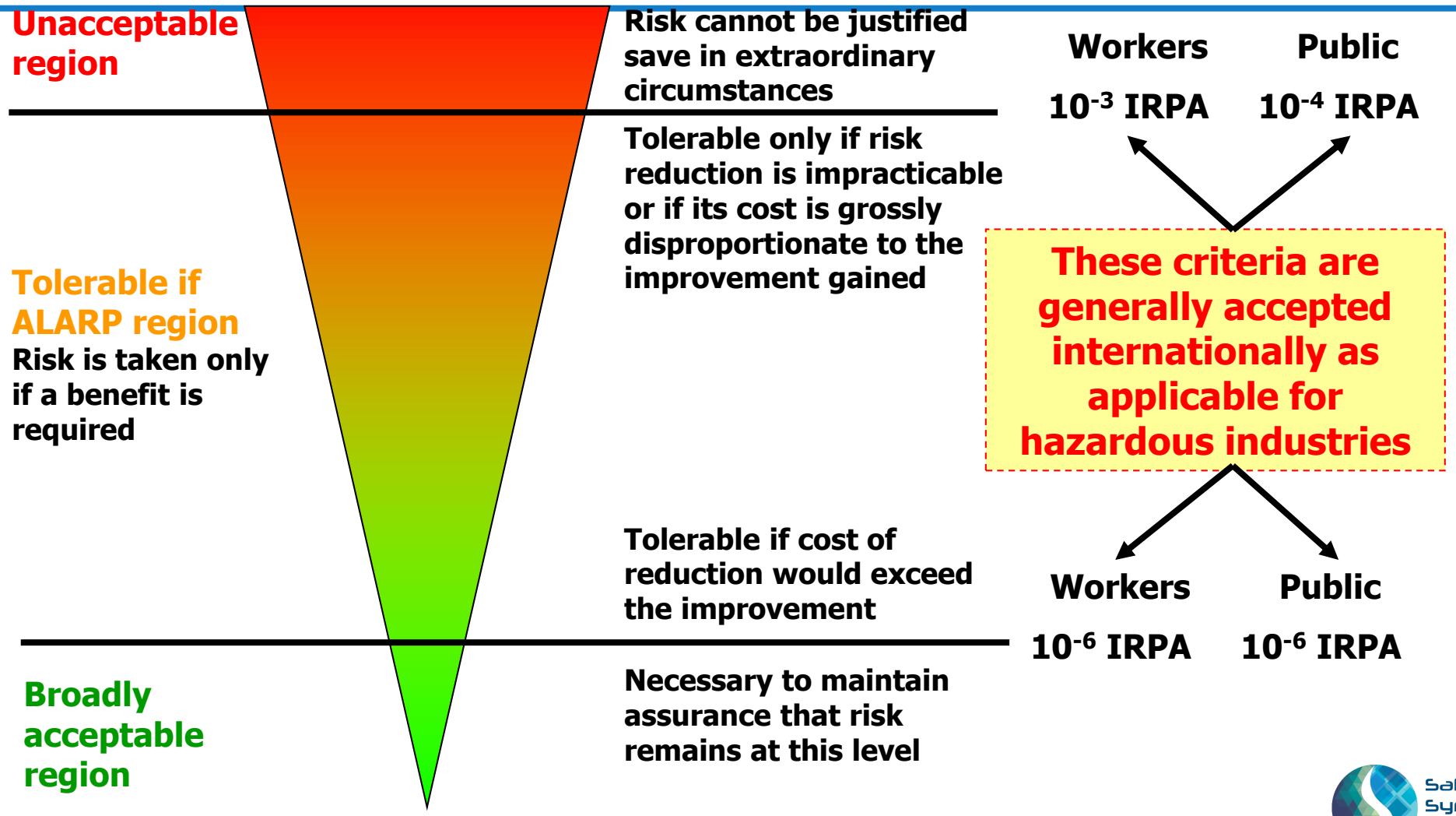
- Individual risk: to ensure individual workers or members of public are not exposed to excessive risks

But what is excessive?

- Societal risk: to limit the risk of multiple fatalities arising in a single event

But when is too big too often?

Tolerability of risk framework & individual risk criteria



How big is 10^{-3} per year?

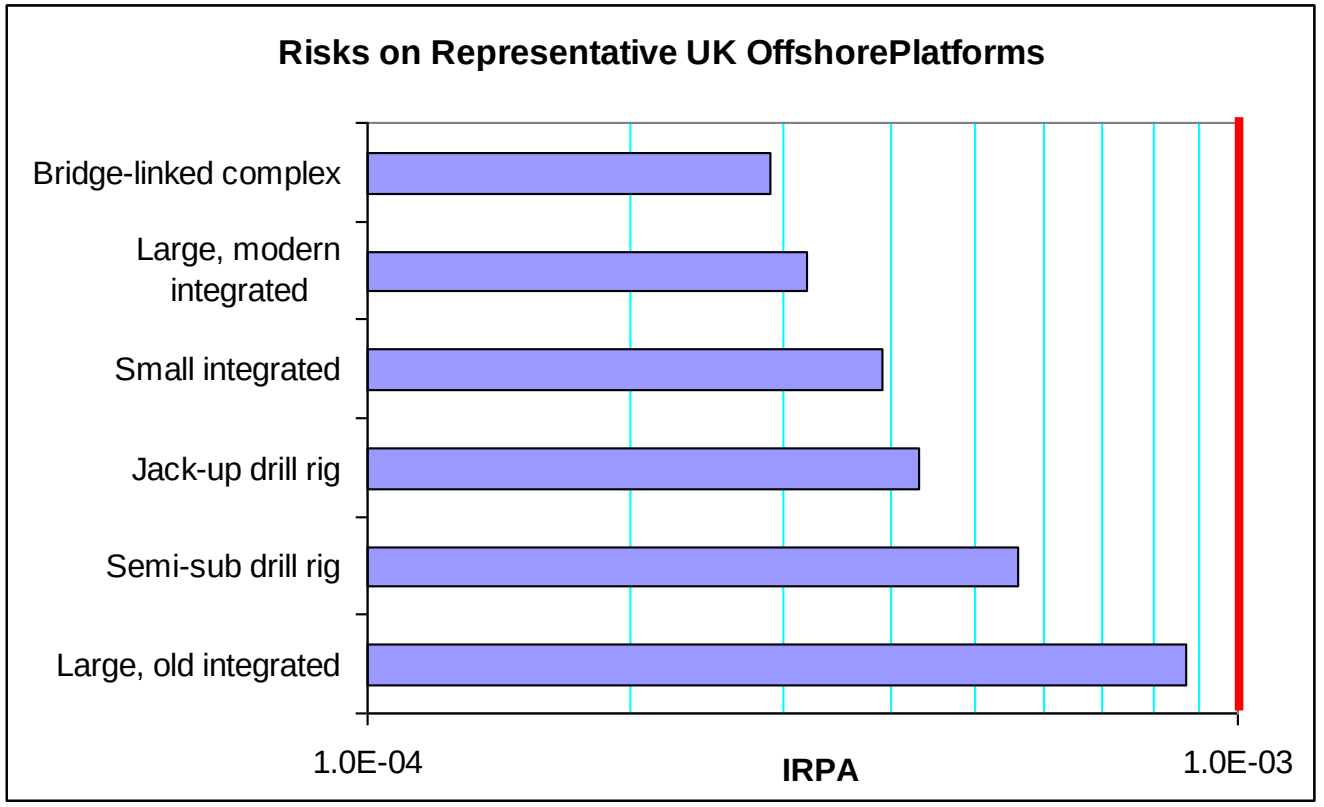
First established in UK, 10^{-3} per year was explicitly related to risk borne by high risk groups in mining, quarrying, demolition and deep sea fishing

Activity	Risk	How much activity in 1 year = 1E-3?
Hang-gliding	1 in 116,000 flights	116 flights
Surgical anaesthesia	1 in 185,000 operations	185 operations
Scuba diving	1 in 200,000 dives	200 dives
Rock climbing	1 in 320,000 climbs	320 climbs

An IRPA of 10^{-3} is really quite risky

What are typical risk levels in practice?

- 10^{-3} is rather lenient for installations, e.g. very few offshore installations reach this

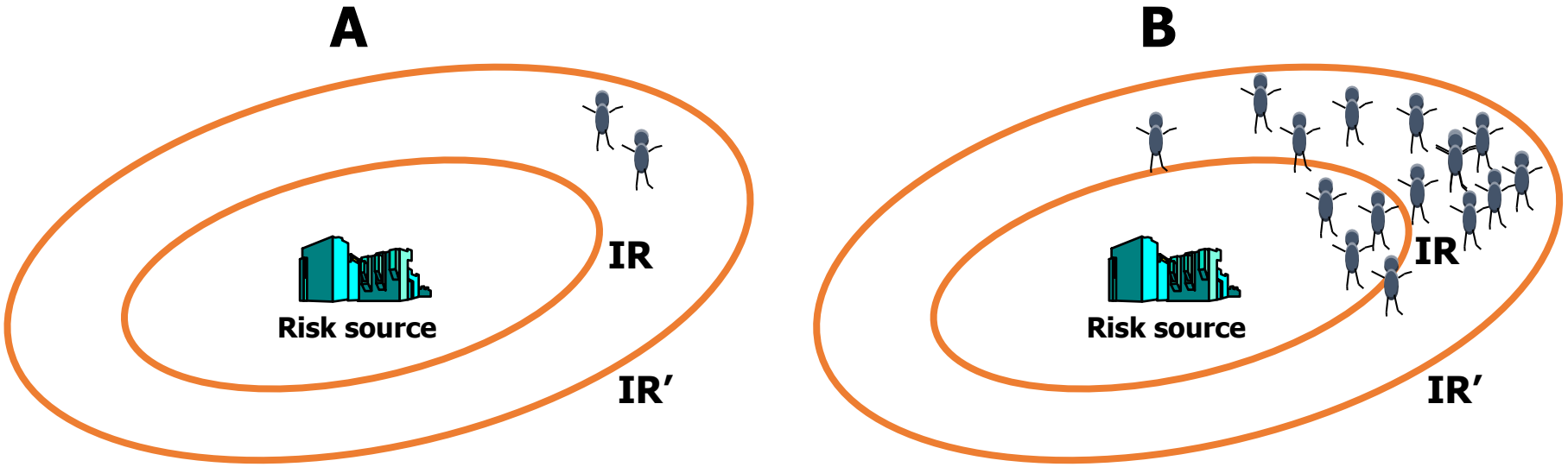


- Risk levels are rarely ever insignificant, i.e. $<10^{-6}$ /y
- Singapore QRA guidelines give IR of $5x10^{-5}$ /y (on-site) and $5x10^{-6}$ /y (off-site)

Individual risk - summary

- Maximum tolerable IRPA criteria of 10^{-3} for workers & 10^{-4} for public are in common international use
- But are rather lenient for most facilities - new designs often set more stringent criteria – 10 or more times lower

Societal risk



$$IR_A = IR_B$$
$$SR_A < SR_B$$

A and B have equal individuals risk levels (IR and IR') but B has larger societal risk (SR) because more people exposed

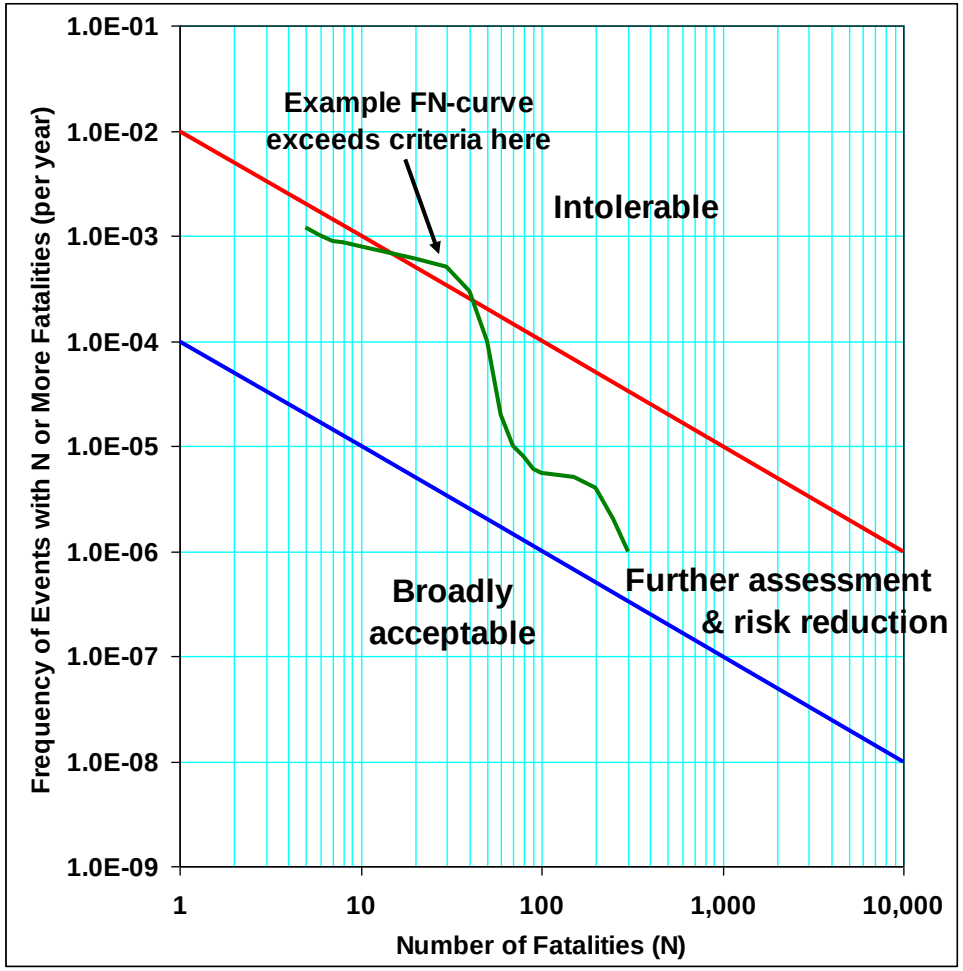
If IR levels are acceptable, when is SR not acceptable?

Why have societal risk criteria?

- Use to limit risk of major accidents (rare high-consequence events)
- Help target risk reduction measures, e.g.
  - Restrictions on concurrent activities
  - Restrictions on land use
  - Enhanced engineered safeguards
  - Improved building siting
  - Improved building protection

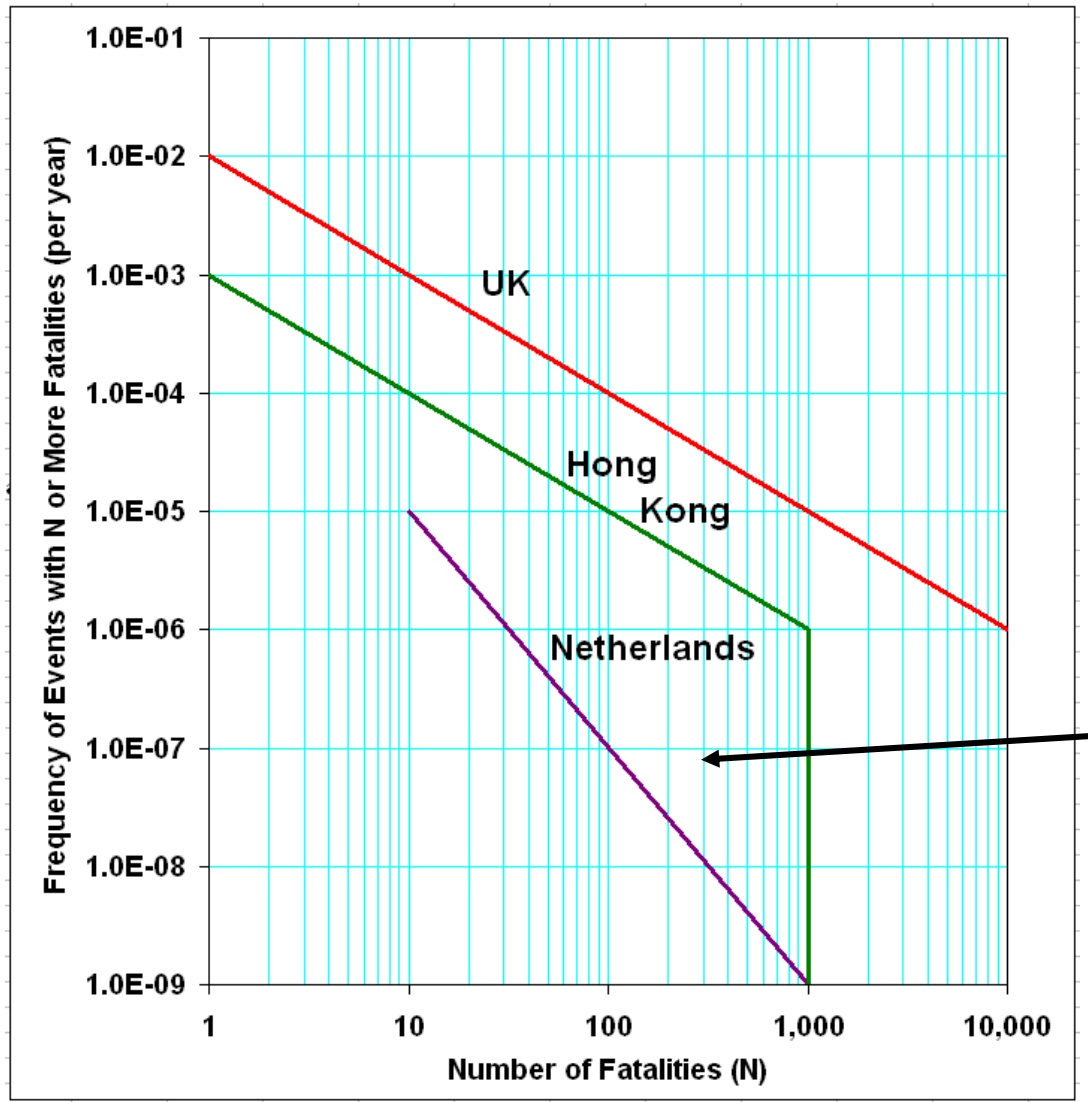
Societal risk framework

Most common form is FN-diagram



But where are these lines?

Unlike IR, variation in regulatory SR criteria is very wide



Variation of over 100 in upper tolerability lines

Steep slope builds in multiple fatality aversion

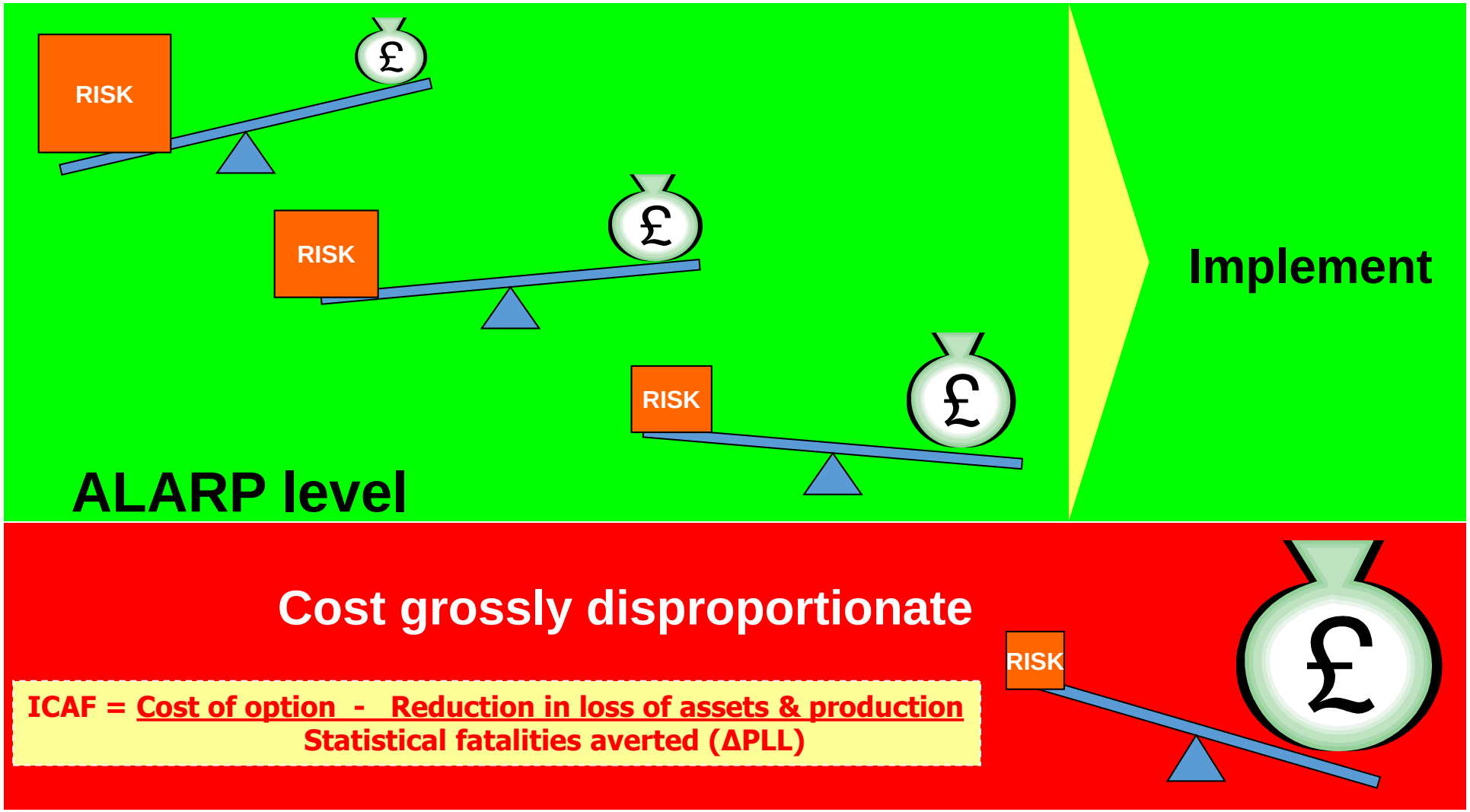
Societal risk - summary

- A single multiple fatality accident at industrial facility can seriously threaten future of operator
- In absence of regulatory criteria, choice of criteria largely comes down to company's values
- FN-curves not without drawbacks but helpful when used in context
- Criteria must be workable in practice:
  - Too severe or loose = limited usefulness
  - Based on current good industry practice

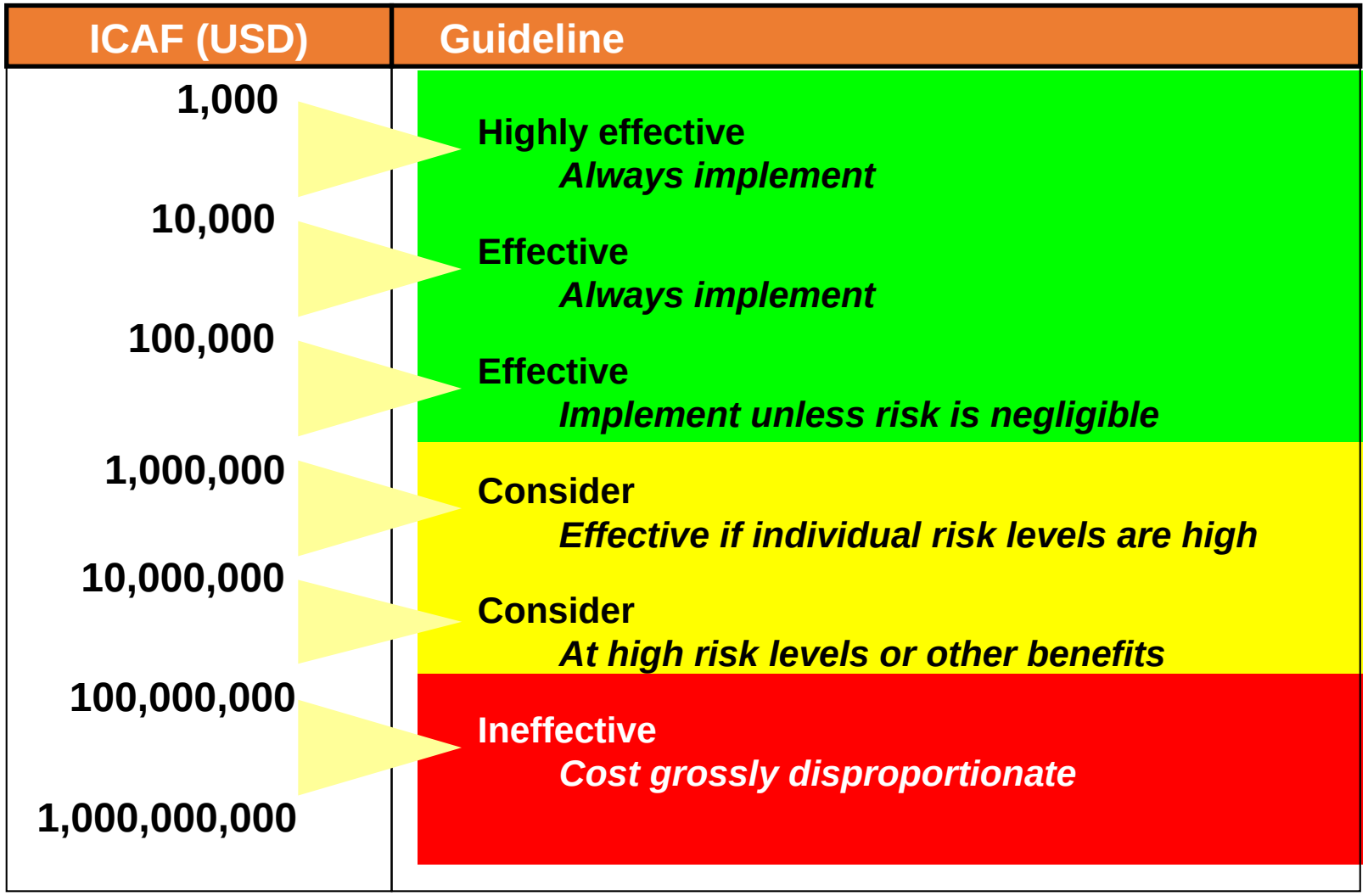
But if risk is in ALARP zone then risk is ALARP, right?

- Wrong! Have only taken first step
- Need to consider introducing further risk reduction measures to drive remaining, or “residual”, risk downwards to ALARP level
- ALARP level is reached when time, trouble and cost of further reduction measures become unreasonably disproportionate to additional risk reduction obtained

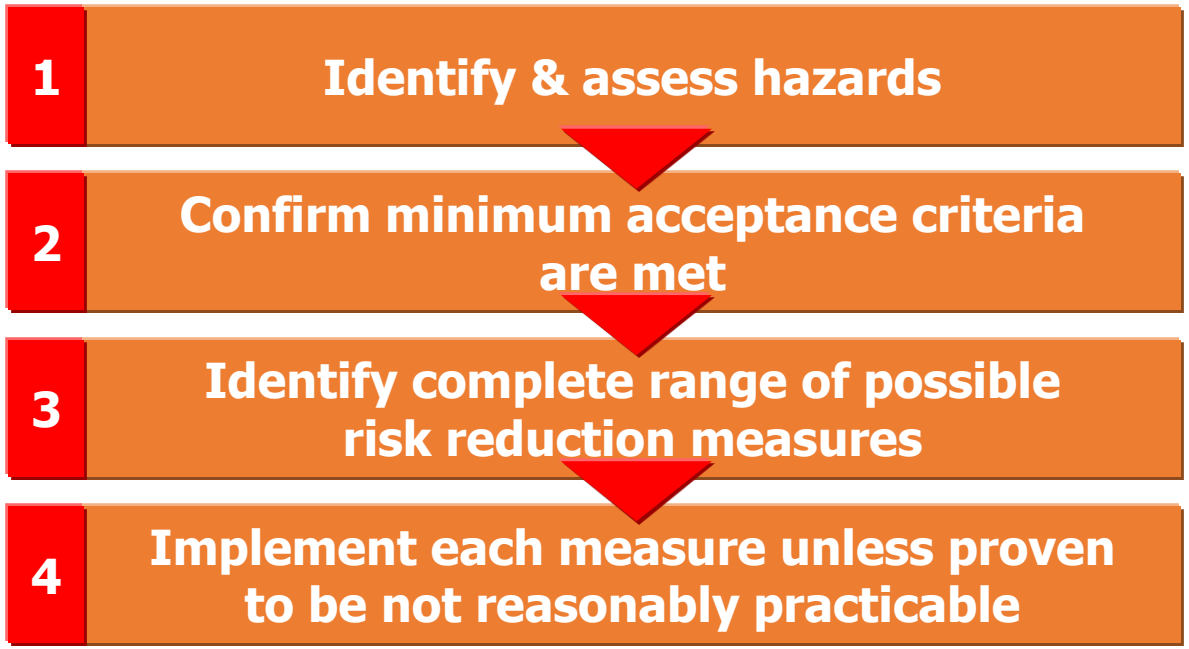
Balancing cost and risk reduction



Cost of averting a fatality - illustrative

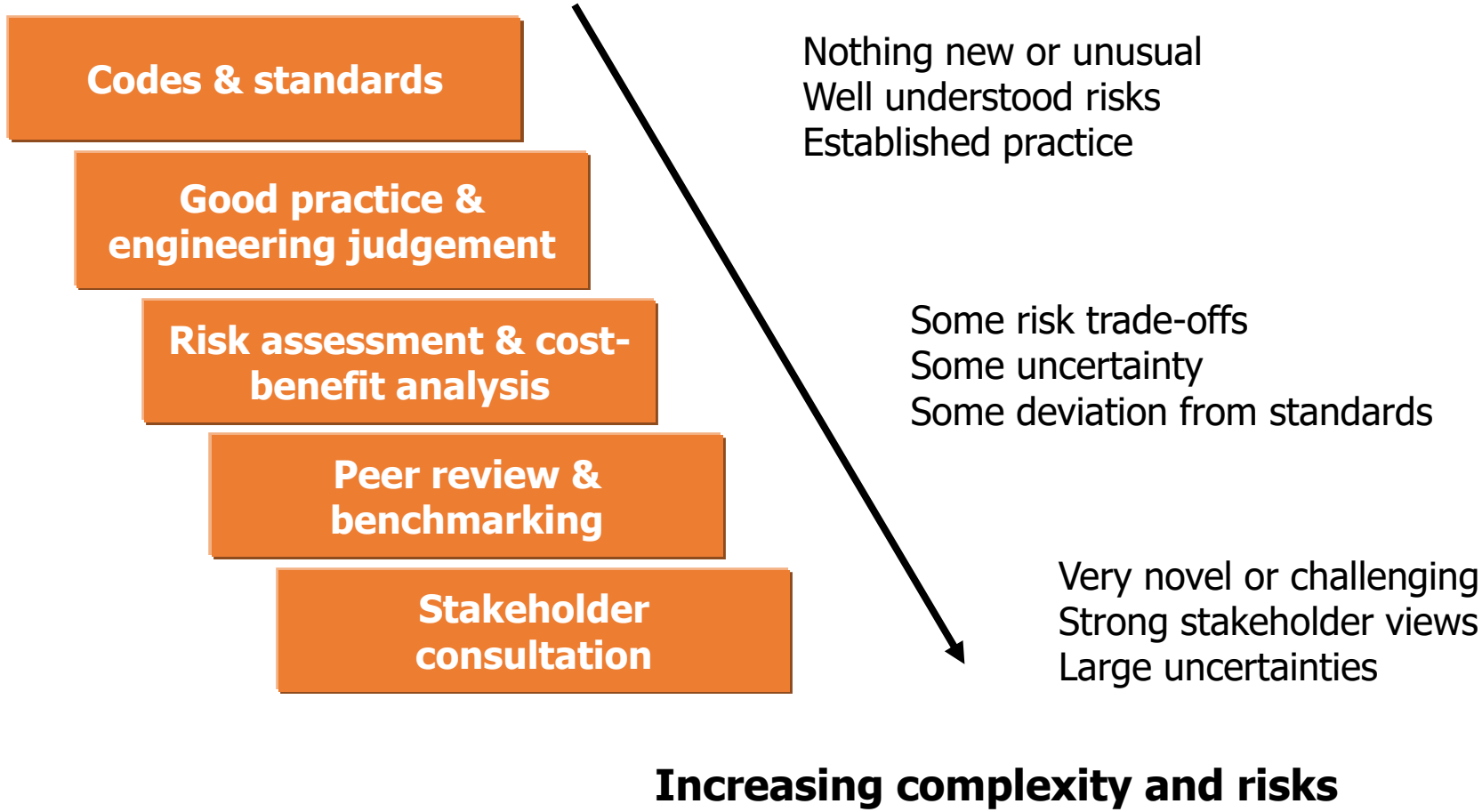


But demonstrating ALARP is not a numbers game – it is a process

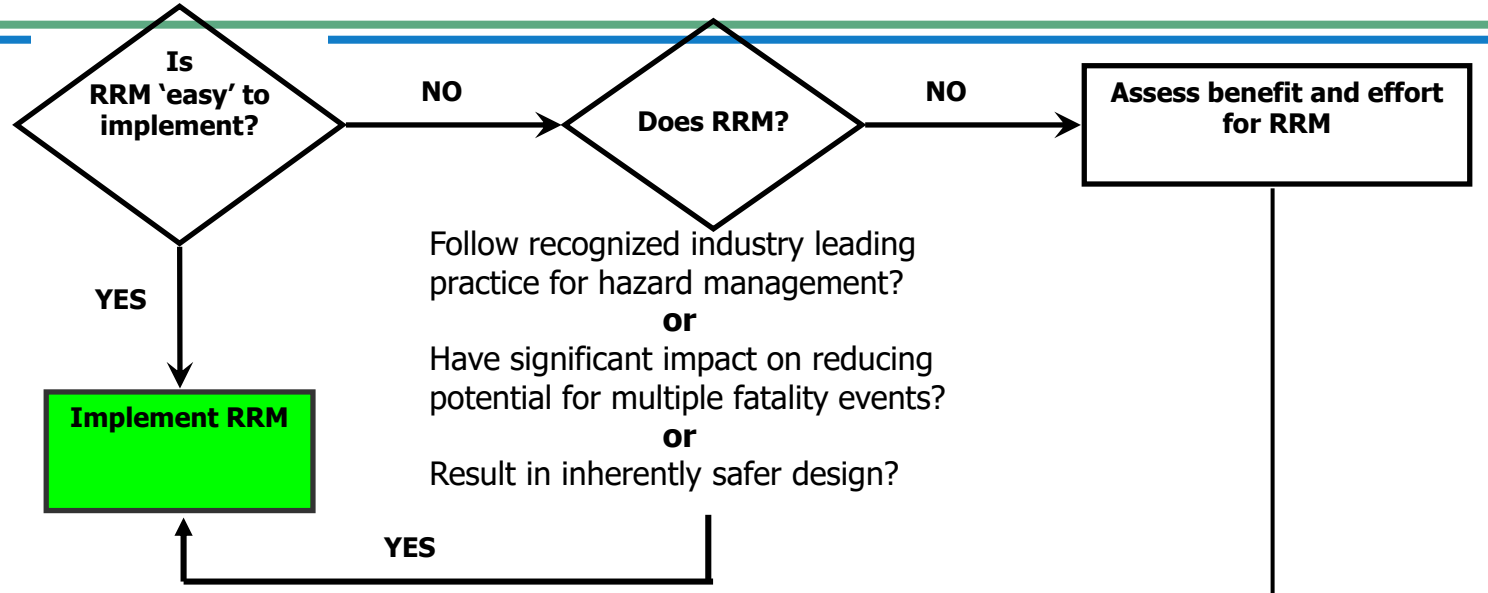


Risks are <u>only</u> ALARP once every measure has either been implemented or proven to be not reasonably practicable

ALARP tools - the more complex or risky the project, the more sophisticated the tools required



Qualitative ALARP assessment



An ALARP assessment should <u>start</u> with a qualitative approach before even considering ICAFs

		Effort (time and/or cost)		
		Low	Medium	High
Benefit (risk reduction)	Low	Consider	Do not implement	Do not implement
	Medium	Implement	Consider	Consider, if risk high
	High	Implement	Implement	Consider

Qualitative example, bow-tie diagrams

Assessment of ALARP branch-by-branch

"What else can we do?"

"Can we improve control effectiveness?"

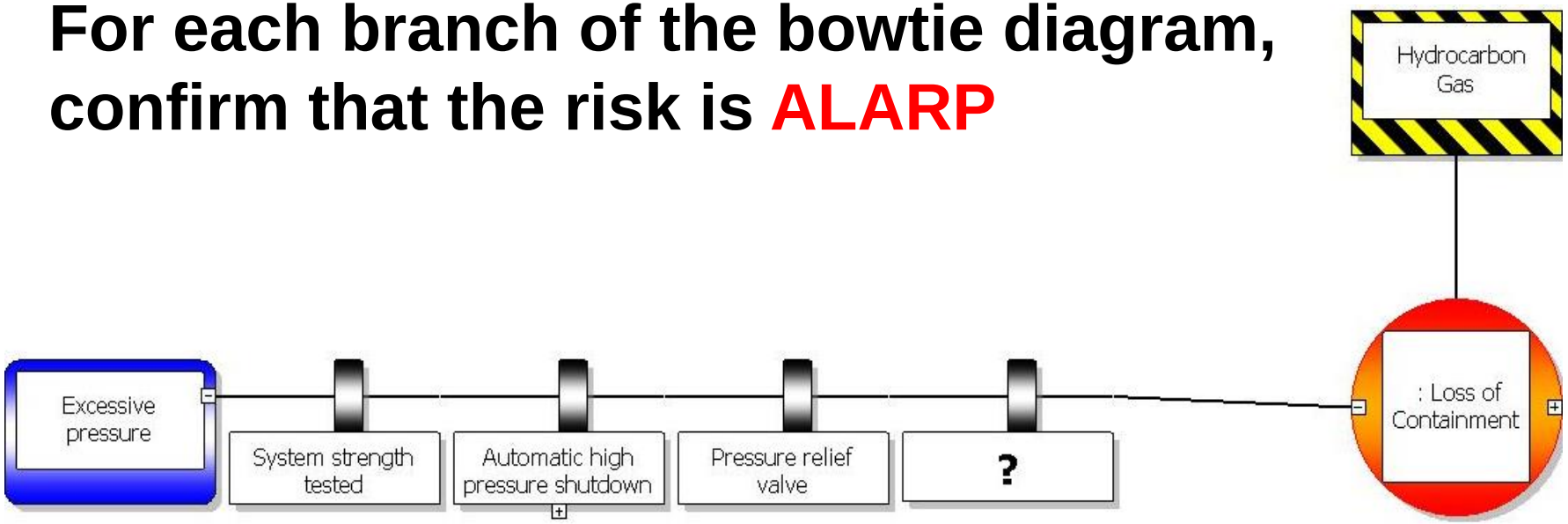
"Can we add more controls?"

"Is it practical to do so?"

But be wary of barrier counting!

ALARP demonstration using bow-tie diagrams

For each branch of the bowtie diagram, confirm that the risk is ALARP



- How effective are the existing controls?
- Do they fully meet industry best practice?
- What extra measures would reduce the risk?
- Are they practical?
- Be wary of assessing ALARP by barrier counting!

ALARP assessment - summary

- Definition implies a mathematical formula
- QRA & CBA very powerful when comparing options during design or modifications during operations
- Experienced based, qualitative approaches often identify vast majority of cost-effective improvements
- In practice, amounts to taking balanced view and reaching defensible consensus
- Convincing ALARP demonstration:
  - document assessment of improvement options – implemented and discounted
  - level of assessment appropriate to facility life-cycle and magnitude of risk

Summary

- Individual risk criteria are generally accepted internationally; societal risk criteria show large variation
- Most facilities lie in ALARP zone and require qualitative and sometimes quantitative demonstration of risk reduction
- A single multiple-fatality accident at an industrial facility can seriously threaten future of operator
- QRA is inexact - quantitative criteria should be seen as guidelines
- In practice, amounts to taking balanced view and reaching defensible consensus amongst stakeholders

Thank you for your attention

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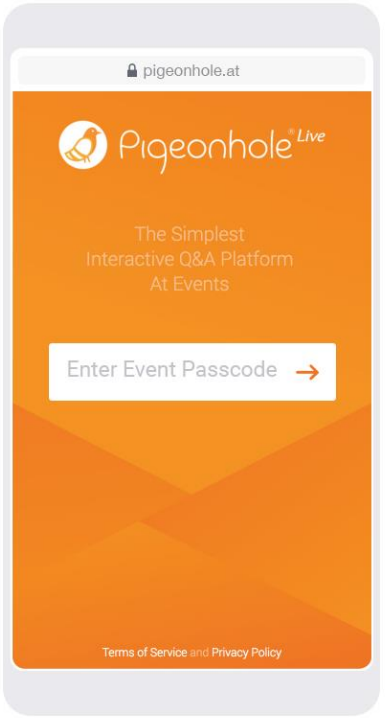

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