UKOPA
United Kingdom Onshore Pipeline Operators' Association

ALARP & Cost Benefit Analysis (UKOPA/GP/025)

Graham Goodfellow – FARWG
Principal Consultant – PIE
graham.goodfellow@pieuk.co.uk

Teams Webinar
Thursday 2nd July 2020

FARWG Webinar Series

- 4th June - UKOPA Fault Data – Why it's vital for operators and how we collect it
- 18th June - Assessing Risks – Overview of Pipeline QRA & IGEM/TD/2
- 2nd July - ALARP & Cost Benefit Analysis (UKOPA/GP/025)

- Please
  - Ensure your microphone is muted & webcam is off
  - Sign in to chat so we can keep a record of attendance…
    …and get back to you if we didn't have time to answer your question

Agenda

- Operators Predicament & Perspective
- Good Practice Guide – Application of CBA to demonstrate ALARP
  - Legislative requirements
  - Code requirements
  - ALARP Principle
  - Risk Management, ALARP & Good Practice
  - Cost Benefit Analysis Process
  - Cost Benefit Analysis Examples
- Conclusions
- Questions?

Operators Predicament

- The risk to people from pipelines are a constant and continuing threat
  - Towns expand closer to once rural pipelines.
  - Developers and landowners try to maximise the land for buildings.

Operators Perspective

- Major Accident Hazard Pipeline (MAHP) operators are required to demonstrate that risks from their pipelines are ‘As Low As Reasonably Practicable’ (ALARP).
  - Demonstration of this generally requires compliance with recognised industry good practice, supported where necessary by risk analysis.
  - If the risk analysis exceeds broadly acceptable then risk reductions need to be considered.

- This can present problems to operators…

Operators Perspective

- Cost Benefit Analysis is commonly used for making decisions on funding for all types of pipeline inspection & maintenance
  - e.g. Intervals…
- All of us use (informal) CBA in life to make decisions
  - Health
  - Travel
  - Shopping
  - Going to the beach….
- Where there are significant safety hazards, we have to be more formal

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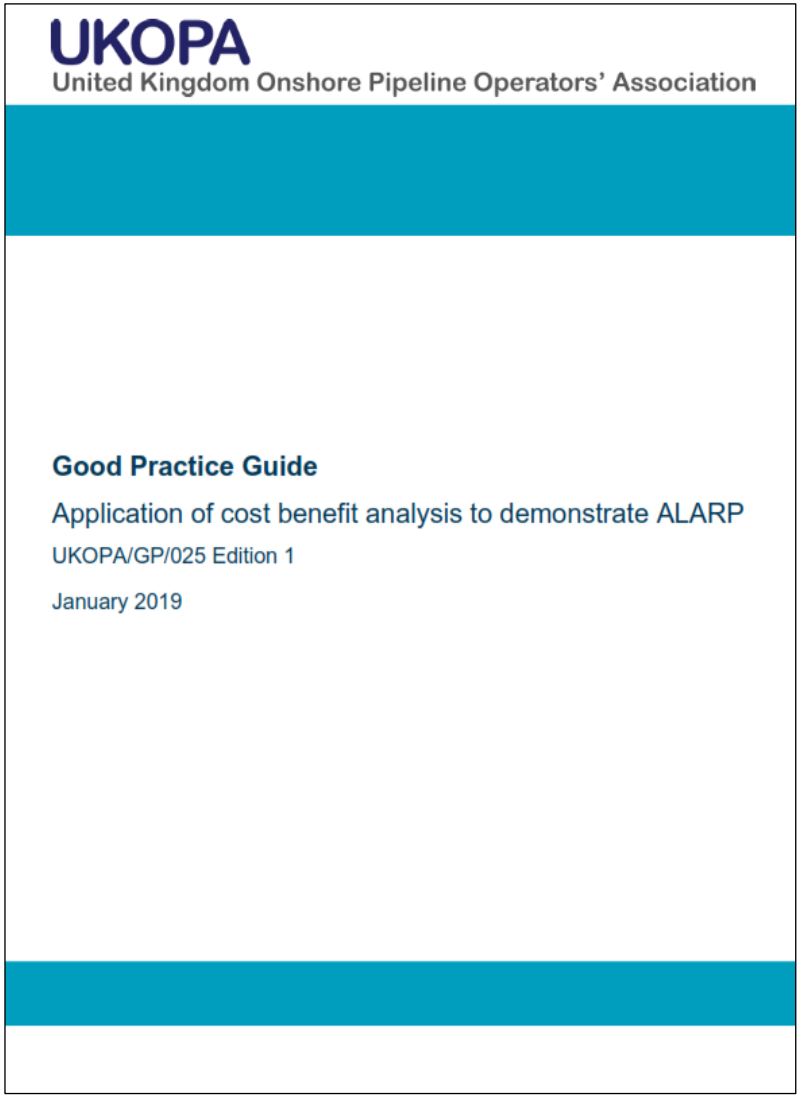
- 2 Objectives
  - Explain how and why the concept of ALARP is implemented by operators
  - Explain how cost benefit analysis is applied by operators to demonstrate that risks are ALARP



Legislative Requirements (1/2)

- Health & Safety at Work etc. Act 1974 (HASWA)
  - "It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his/her employees"

- Management of Health & Safety at Work Regulations 1999
  - "Every employer shall make a suitable and sufficient assessment of-

    (a) the risks to the health and safety of his employees to which they are exposed whilst they are at work; and

    (b) the risks to the health and safety of persons not in his employment arising out of or in connection with the conduct by him of his undertaking"

Legislative Requirements (2/2)

- Pipelines Safety Regulations (PSR) 1996
  - Goal-setting
  - Design, construction and safety systems
    - Limited by reasonable practicability clauses
  - Major Accident Prevention Document (MAPD)
    - MAHPs only!
      - All hazards identified and risks arising from those hazards evaluated
      - Adequate Safety Management System for ensuring risk of major accident is ALARP

Code Requirements

- IGEM/TD/1 Edition 5
  - Affirmation of MOP including infrastructure survey – every 4 years
    - 'TD/1 Survey'
  - QRA allowed to justify proximity & population density infringements as part of a safety evaluation
  - Cost benefit analysis to demonstrate ALARP required when
    - Individual Risk is in the tolerable region, or
    - Societal Risk is outside the broadly acceptable region
- PD 8010-1:2015
  - Currently lighter on O&M details but does require Affirmation of MAOP in accordance with requirements of IGEM/TD/1
    - UK HSE does expect operators of pipelines designed to earlier versions of PD 8010 to complete MAOP Affirmation
- IS 328-2015 broadly similar to IGEM/TD/1
  - Review of MOP every 4 years

Background – ALARP Principle

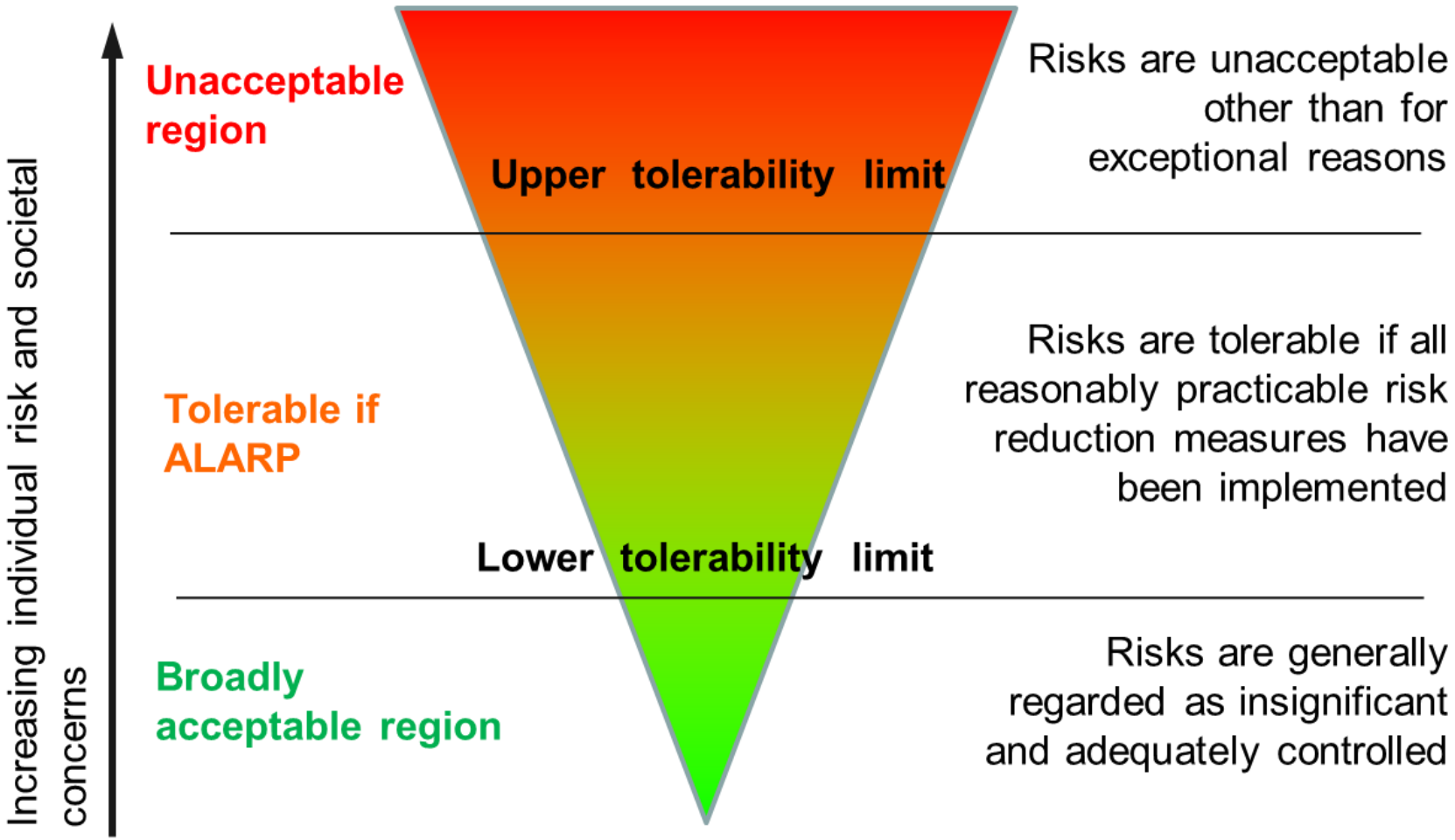
- Concept of ALARP introduced in Appeal Court judgement from Edwards vs National Coal Board [1949] 1 All ER 743

"…in every case, it is the risk that has to be weighed against the measures necessary to eliminate the risk. The greater the risk, no doubt, the less will be the weight to be given to the factor of cost"

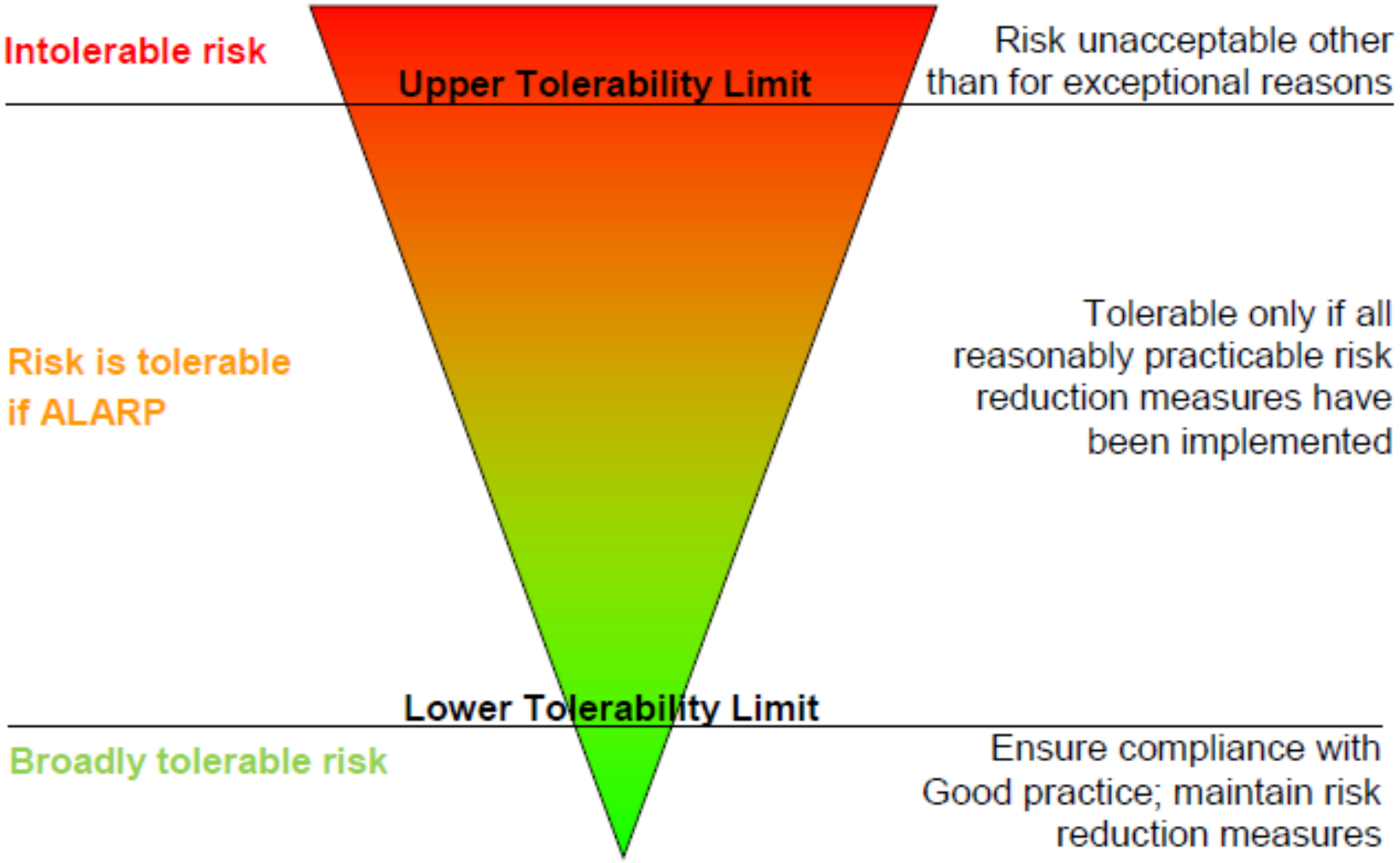
"'Reasonably practicable' is a narrower term than 'physically possible' … a computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them – the risk being insignificant in relation to the sacrifice – the defendants discharge the onus on them."

- In Ireland, definition of reasonably practicable is the same
  - Boyle vs Marathon Petroleum (Irl) Ltd [1999] 2 I.R. 460 at the Supreme Court

ALARP Principle – UK HSE



ALARP Principle – CER



Tolerability Limits – Individual Risk

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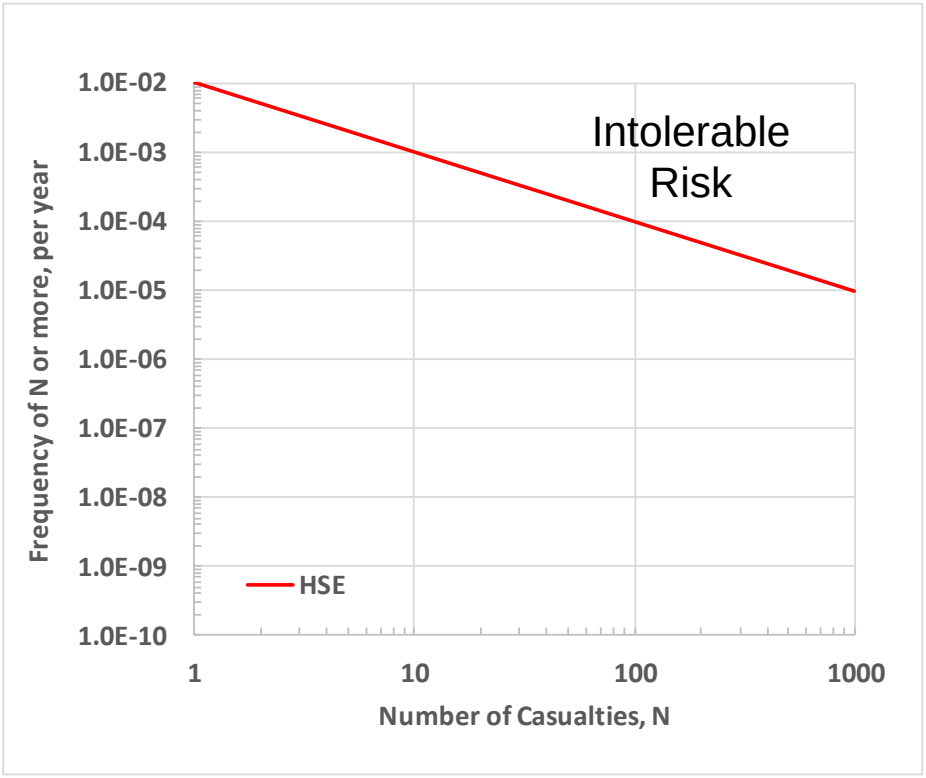
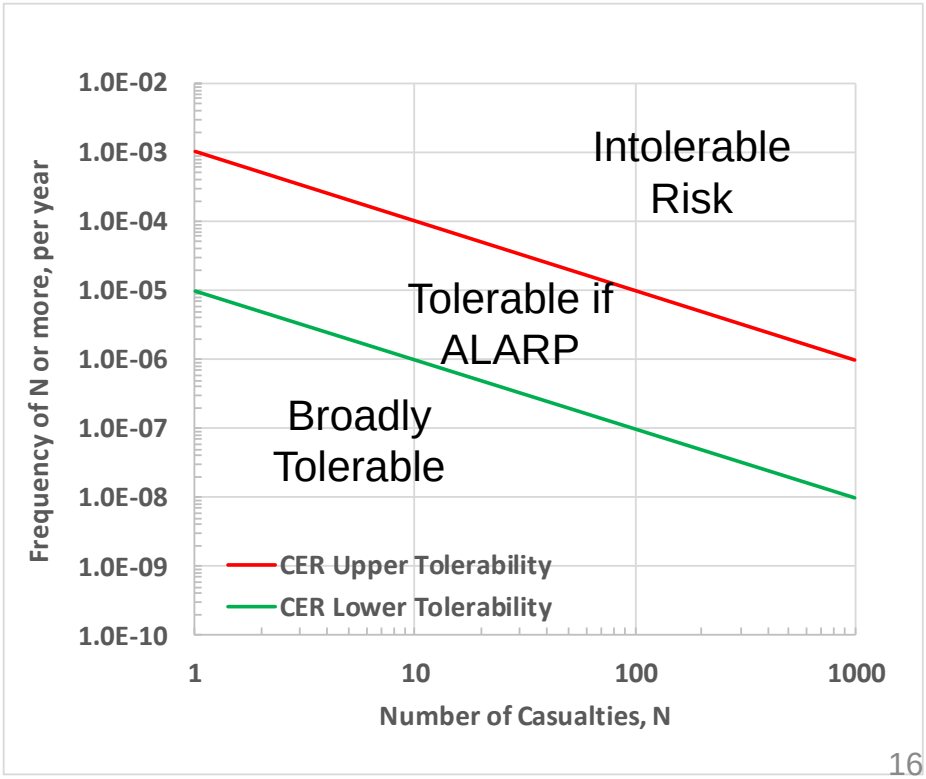
- HSE (UK) & CRU (ROI)
  - Upper Tolerability Limit (Worker) – 1×10^{-3} per year
  - Upper Tolerability Limit (Public) – 1×10^{-4} per year
  - Lower Tolerability Limit – 1×10^{-6} per year

- Average risk of death from all causes is approximately 1×10^{-2} per year
  - i.e. Risks at lower tolerability limit add 0.01% to overall individual risk for average person

Tolerability Limits – Societal Risk

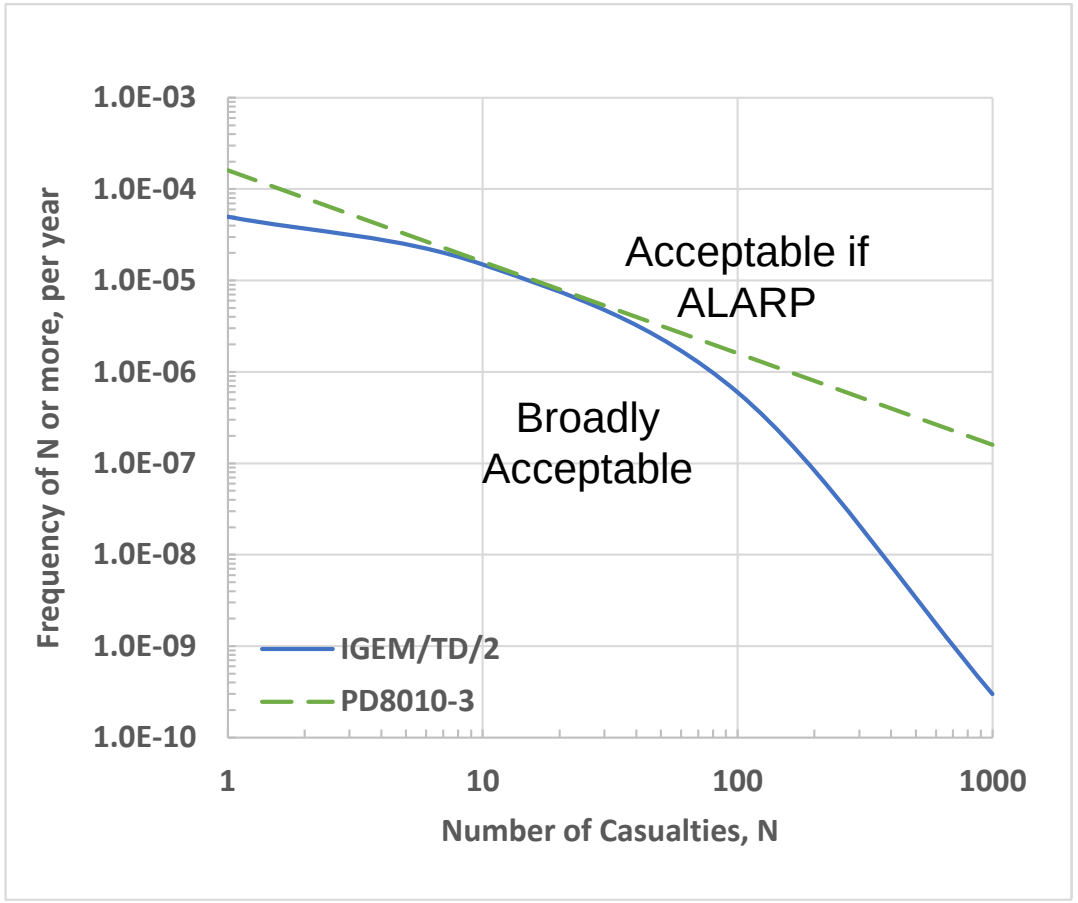
- UK HSE
  - Intolerable region defined as 50 people at more than 2 x 10^{-4} per year with slope of -1 (no aversion)
    - Canvey local scrutiny line
- ROI CRU
  - One order lower & Tolerable if ALARP Region defined





Tolerability Limits – Societal Risk

- IGEM/TD/1 &TD/2
  - 1.6 km of pipeline
- PD8010-3
  - 1 km of pipeline



General Risk Management Process

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1. Identify all (major accident) hazards associated with the activity
2. Good practice (or its equivalent) must be implemented
3. Undertake Quantitative Risk Assessment of all Major Accident Hazards
4. If risk is between upper and lower tolerability limits
   a) Identify appropriate risk reduction measures
   b) Implement each measure unless it is not reasonably practicable to do so

ALARP Demonstration

- 3 key aspects
  1. Demonstrating that relevant industry standards, codes and good practice have been / are being followed in the design, construction, operation and maintenance of the pipeline.

  2. Highlighting where additional measures have been implemented to reduce risk.

  3. Identifying additional risk reduction measures that could be considered and performing a cost benefit analysis to determine whether the cost of implementing a measure is commensurate with the safety benefit experienced.

Good Practice

- 1st step in an ALARP assessment is to determine if relevant good practice risk reduction measures have been adopted
  - Defined by recognised codes / standards / ACOPs / etc.

- Design, construction, operation and maintenance to IGEM/TD/1 or PD 8010-1 considered to be good practice by UK HSE
  - Implicit assumption that risk levels of pipelines to code are ALARP
    - QRA of the residual risk used where code is infringed
  - Be careful with cherry-picking!

Cost Benefit Analysis Process

- Similar in both UK and ROI
  - Calculate the Cost of Preventing a Fatality (CPF) or Implied Cost of Averting a Fatality (ICAF)
    - Sometimes called Cost per Life Saved (CPLS) or Cost per Casualty Averted (CPCA)
- Compare with Value of Preventing a Fatality (VPF) or Defined ICAF criterion
  - UK – Approximately £1 million in 2001
  - ROI – €2.5 million in 2015

Adjust for inflation!

- Determine the Disproportion Factor (DF) or Gross Disproportion Factor (GDF)
  - UK guidance not totally clear on what is gross disproportion but robust justification required if less than 10
    - i.e. CPF or ICAF should be greater than ≈ £20 million / €25 million
  - In practice QRAs typically use a larger value to account for uncertainty in frequency and consequence predictions

Cost of Preventing a Fatality

$$CPF = ICAF = \frac{Cost\ of\ Risk\ Reduction\ Measure}{Reduction\ in\ Potential\ Loss\ of\ Life}$$

$$= \frac{Annualised\ Cost}{\Delta EV} = \frac{Cost}{\Delta EV\ \times Remaining\ Life}$$

- EV = Expectation Value
  - Statistical expression for average number of casualties per year
  - Also known as Potential Loss of Life (PLL)

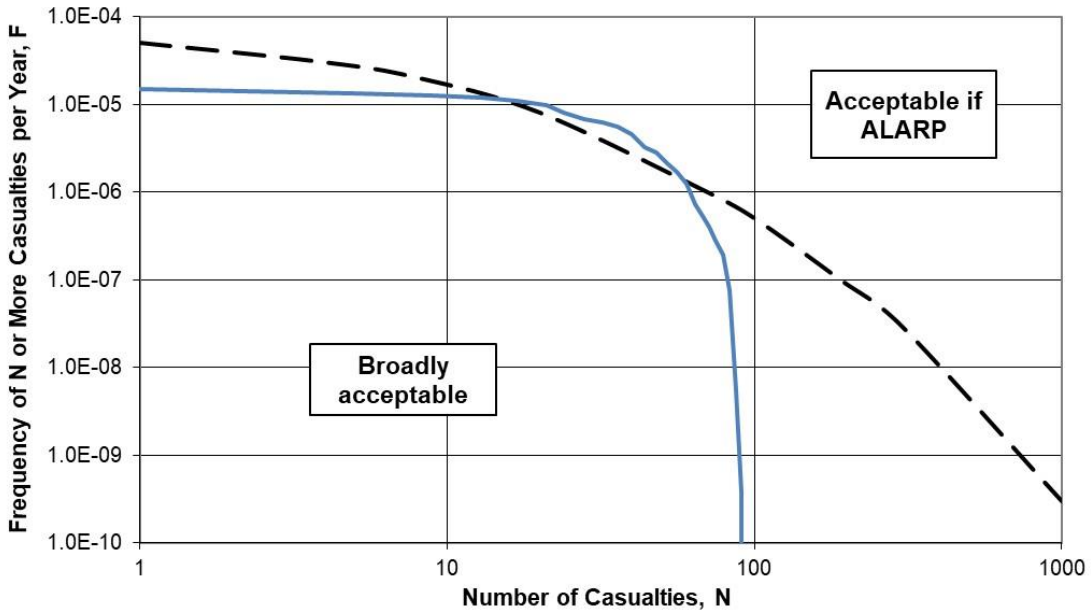
$$EV = PLL = \sum f.n$$

  - Equivalent to area under FN curve

- Remaining Life
  - Typical to assume a rolling 40 years for gas networks

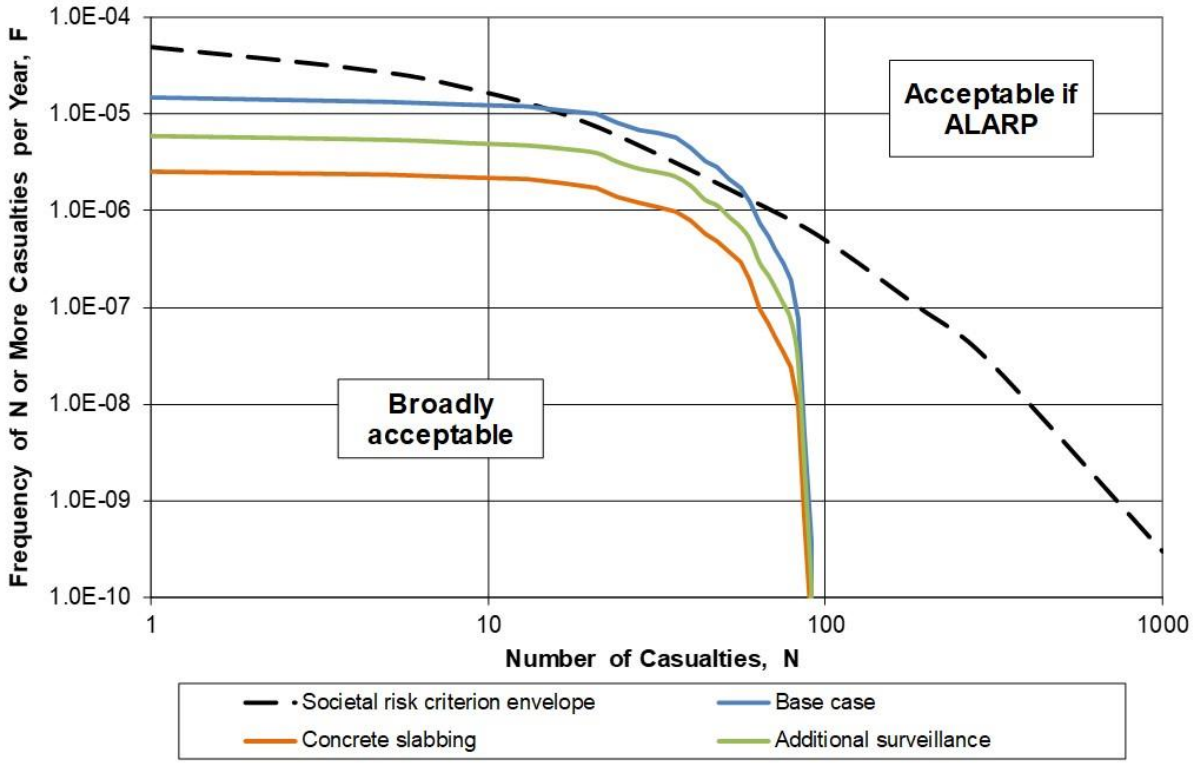
CBA Example 1

- Suburban Area
  - Current societal risk levels just greater than IGEM/TD/1 criterion
- Consider
  - Additional surveillance
  - 100 m concrete slabbing



CBA Example 1 – QRA Results

- Both bring risk level below criterion
  - Risk reductions due to slabbing greater than additional surveillance



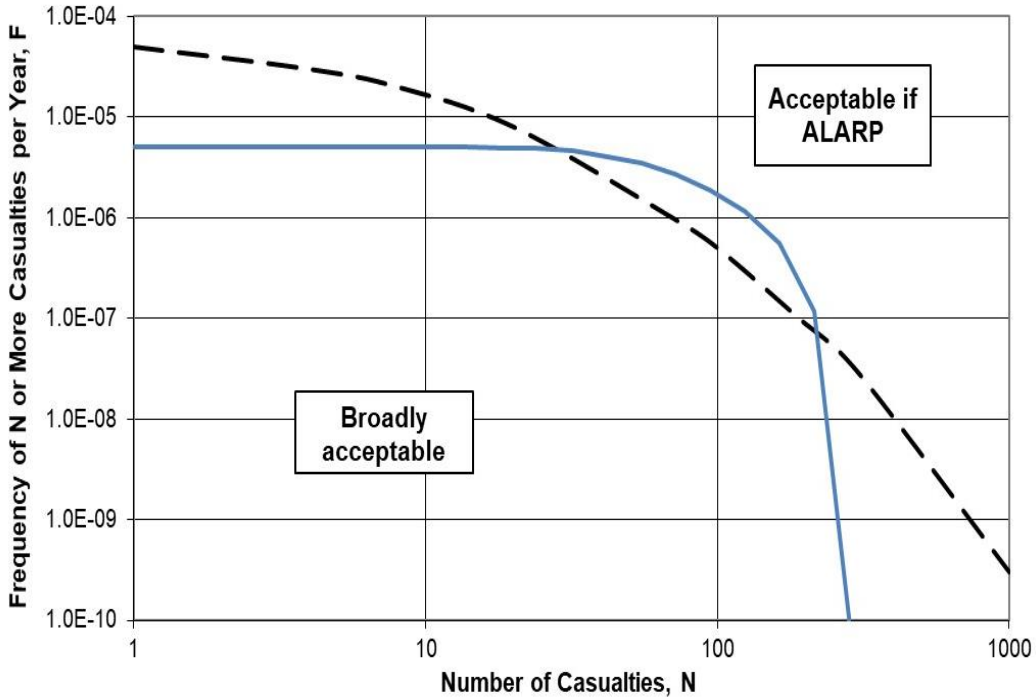
CBA Example 1 – Results

Risk Reduction Measure	Original Expectation Value	Reduced Expectation Value	Annualised Cost	VPF / ICAF	DF / GDF
Surveillance	4.41×10^{-4}	2.64×10^{-4}	£1,620	£6.14 million	3.8
Slabbing		7.68×10^{-5}	£2,500	£6.86 million	4.3

- Both considered ‘reasonably practicable’
  - i.e. not ‘grossly disproportionate’
- HSE typically prefers physical not procedural protection measures
  - May assume surveillance budget likely to be cut at a future RIIO…

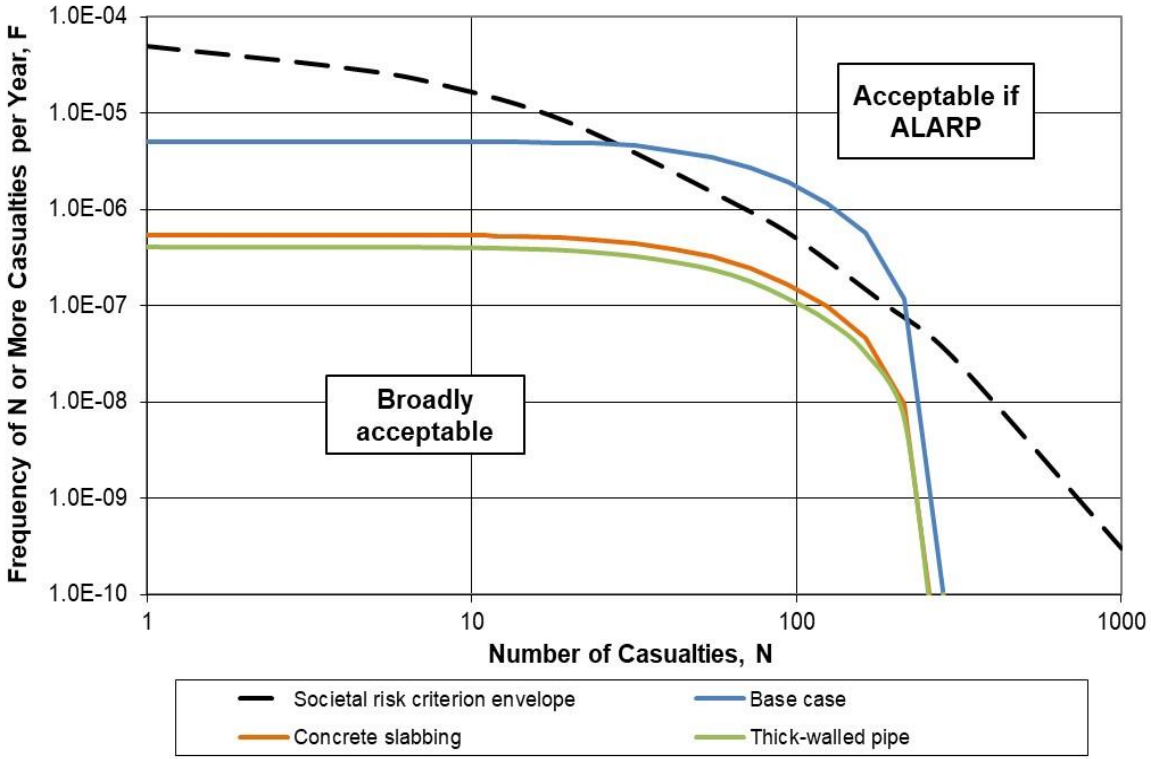
CBA Example 2

- Rural Area
  - Current risk levels greater than IGEM/TD/1 criterion
- Consider
  - 100 m concrete slabbing
  - 250 m thick wall



CBA Example 2 – QRA Results

- Both bring risk level below criterion
  - Risk reductions due to slabbing and thick-wall are broadly similar



CBA Example 2 – Results

Risk Reduction Measure	Original Expectation Value	Reduced Expectation Value	Annualised Cost	VPF / ICAF	DF / GDF
Slabbing	4.31×10^{-4}	4.42×10^{-5}	£6,250	£16.2 million	10.1
Relaying		2.95×10^{-5}	£17,500	£43.6 million	27.2

- Relaying in thick-wall considered ‘grossly disproportionate’
- Slabbing is borderline
  - Most operators would probably install the slabs
    - Especially if you can get the developer to lay them for construction protection!

Considerations

- Risk reduction models and factors exist in IGEM/TD/2 for
  - Thicker-wall / Deeper cover / Increased surveillance / Concrete slabs
  - But what is the effect of increased land-owner liaison or improved marker posts?
- Managerial or procedural risk reduction measures need to be maintained for life of pipeline
  - Given changes in industry over last 40 years HSE may struggle to believe this!
- Would a shorter length of slabbing or thick-wall be better?
  - May depend on the location of the majority of the effected population
  - Sensitivity study if DF/GDF is close to 10?
- You don't need to get inside broadly acceptable curve for risk mitigation to be ALARP
  - Residual risk should be reduced as far as reasonably practicable

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Conclusions

- Legislation requires operators to demonstrate ALARP
  - Good Practice
    - Follow IGEM/TD/1 or PD 8010-1 & UKOPA GPGs
  - Identify additional risk mitigation where code infringed
  - Assess using QRA and CBA to demonstrate ALARP
- IGEM/TD/2 & PD 8010-3 provide advice on use of QRA
- UKOPA/GP/025 for Cost Benefit Analysis

Further Reading

- UKOPA
  - UKOPA/GP/025
    - https://www.ukopa.co.uk/published-documents/good-practice-guides/
- HSE (UK)
  - ALARP suite of guidance
    - https://www.hse.gov.uk/risk/theory/index.htm
  - Reducing risks, protecting people (R2P2)
    - https://www.hse.gov.uk/risk/theory/r2p2.htm
- CRU (Ireland)
  - ALARP Guidance (CER/16/106 v3.1)
    - https://www.cru.ie/wp-content/uploads/2017/11/CER16106-ALARP-Guidance-V3.0.pdf

Questions?

- Please use chat function
  - Any questions not answered now will be covered in a follow up written response.

- Any suggestions for future topics, please email Nikki Barker (nikki.barker@pieuk.co.uk)