

Pipeline Risk Assessment: New Guidelines

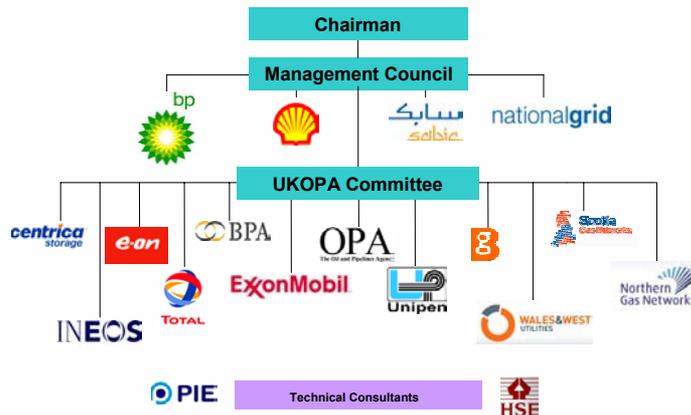
by: P Hopkins (Penspen)¹, R Ellis (Shell)², G Goodfellow (Penspen)², J V Haswell (PIE)², N Jackson (National Grid)².

¹ Presenter

² UKOPA members

'UKOPA'

- United Kingdom Onshore Pipeline Association
 - Independent organisation funded by UK pipeline operators.



Risk... driving... marriage... investments



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Outline of Presentation

Introduction and Objective



IGEM/TD/2 & PD 8010-3

Quantitative Risk Analysis (QRA)

Developing the QRA Methodology

Generic Curves

Conclusions

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Pipeline Standards

- Pipeline standards are safety standards, and aim to reduce all risks associated with a pipeline

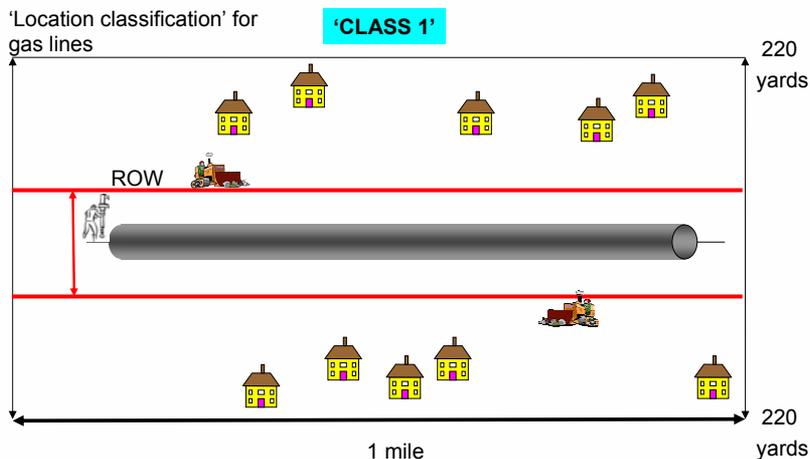


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Managing Pipeline Risk in Design

- Pipeline standards reduce risk by 'good practices'.



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Managing Pipeline Risk in Operation

- But failures still occur so we must do more.
- We need to manage these risks.

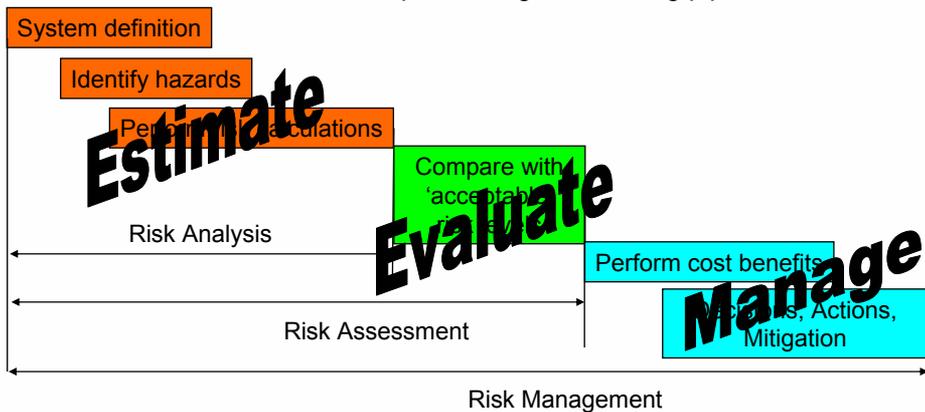


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Risk Management

- Risk = probability x consequence
- Risk management - the process of selecting and managing risk reduction measures and implementing them during pipeline



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Move to 'Risk Management'

- Regulations in USA now require 'integrity management' of liquid and gas pipelines: this requires a risk assessment
- What are the threats or risks to pipelines?
 - Impact damage from earth moving equipment, corrosion, etc., are major threats

- We have to quantify these threats:
- How often will they fail my pipeline and what will be the consequences of the failure?

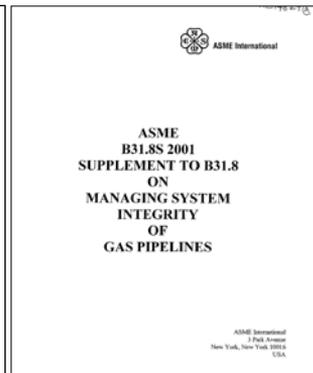
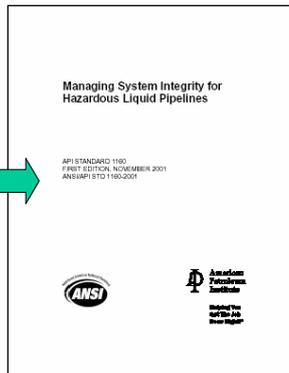
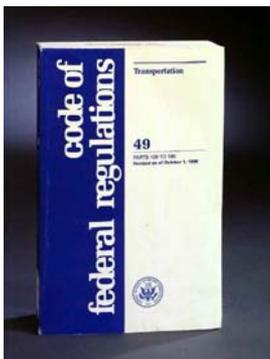


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Move to Risk Management

- API 1160 and ASME B31.8S give guidance on 'qualitative' risk assessments, that help satisfy the new USA Regulations

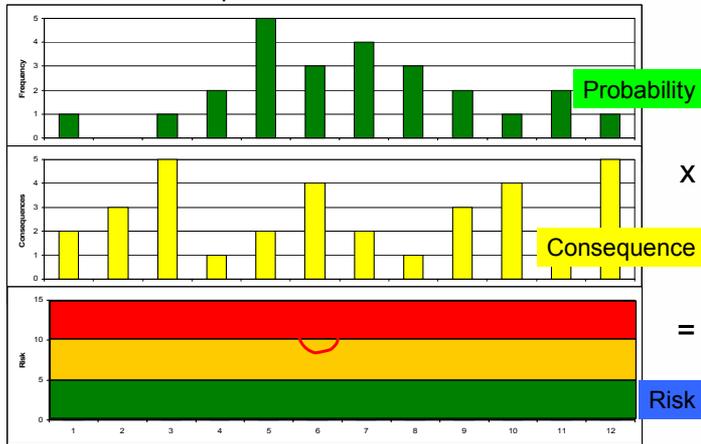


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Qualitative Risk Assessment

- API 1160 and ASME B31.8S help with 'qualitative' risk assessments, but not 'quantitative' risk assessments

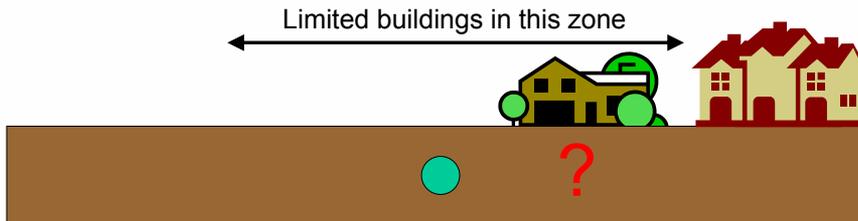


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Buildings around Pipelines

- Pipeline standards, particularly gas standards, limit buildings around a pipeline.
- During operation new buildings may be built close to pipelines



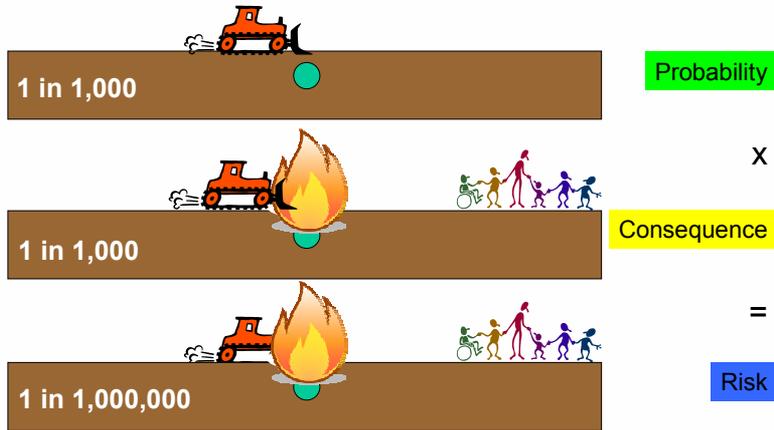
- How can we assess the risk on these new developments from the pipeline?
- We need a 'quantitative' risk assessment – 'QRA'

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Quantitative Risk Assessment

■ API 1160 and ASME B31.8S help with 'qualitative' risk assessments, but not 'quantitative' risk assessments

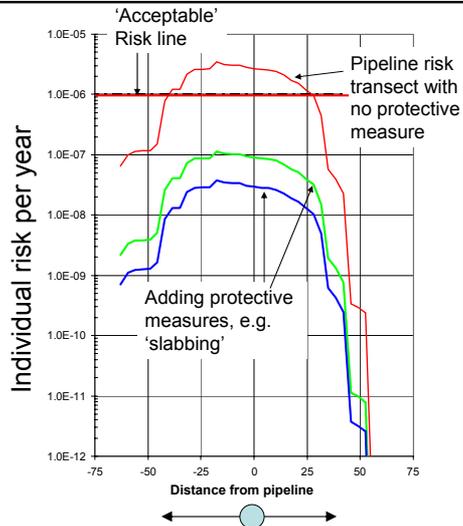


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QRA: 'Acceptable' Levels

- A QRA presents actual risk profiles around a pipeline which can be compared to 'acceptable' levels
- QRA requires input data, an agreed methodology, recognised parameters to help quantify risks and reduce risk, and acceptance criteria
- These variables can lead to an inconsistent approach and the potential for technical disagreements and inconsistencies in QRA results and decision-making



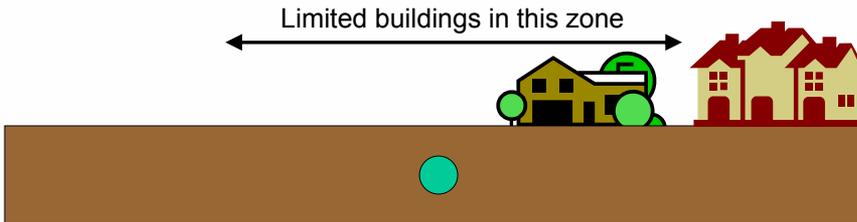
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Objective

■ Objective of presentation:

- This presentation briefly explains the new quantitative risk guidelines in IGEM/TD/2 and PD 8010-3



Outline of Presentation

Introduction and Objective

IGEM/TD/2 & PD 8010-3

Quantitative Risk Analysis (QRA)

Developing the QRA Methodology

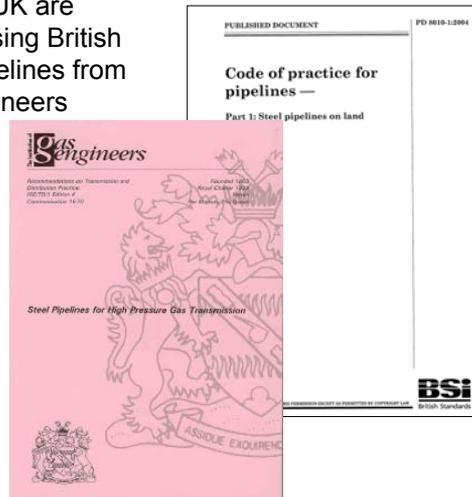
Generic Curves

Conclusions



Pipeline Standards in UK: pre-2009

- Onshore pipelines in the UK are designed and operated using British Standards (BSI) and guidelines from the Institution of Gas Engineers ('IGEM')
- These documents allow quantitative risk assessment but they did not have detailed guidelines
- Hence, there was a need for authoritative and accepted guidance on QRA



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PD 8010-3:2009 & IGEM/TD/2

- UKOPA has helped produce QRA guidance to the UK pipeline 'standards' BSI PD 8010 and IGEM/TD/1
 - these give recommendations on a range of aspects of pipeline risk assessment, including determining failure frequencies



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PD 8010-3:2009 & IGEM/TD/2

- Fluids covered:
 - Natural gas
 - Ethylene
 - Spiked crude
 - Ethane,
 - NGL
 - Propylene,
 - LPG,
 - etc.



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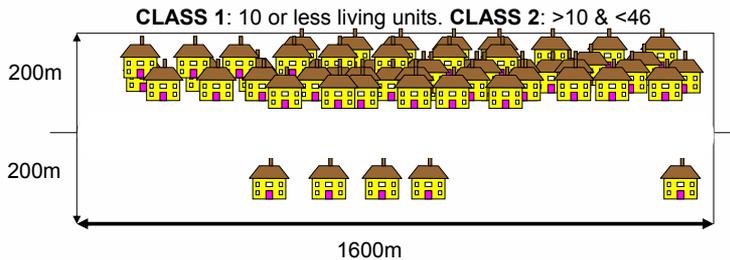
Generic Curves

Conclusions



Why use QRA?

- QRA is accepted practice in UK. It may be carried out:
 - As part of design (e.g. to allow higher design factors)
 - During operation (e.g. to assess population changes along the route)
 - To assess the acceptability of developments planned in the vicinity of the pipeline

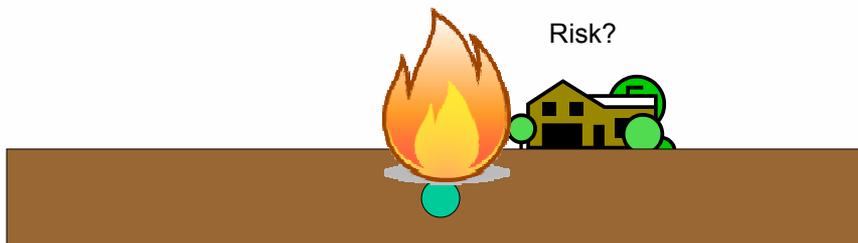


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QRA and Developments

- QRA can calculate risk at the location of a development
 - If this risk is below an acceptable level, the development can continue
 - If the risk is too high the development must stop, or
 - the risk must be reduced.

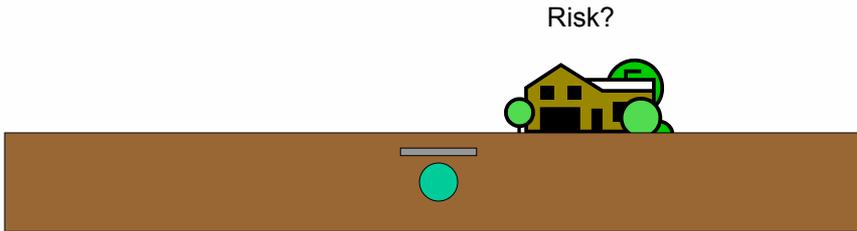


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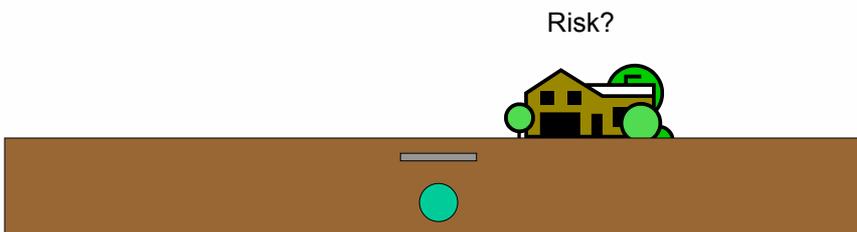
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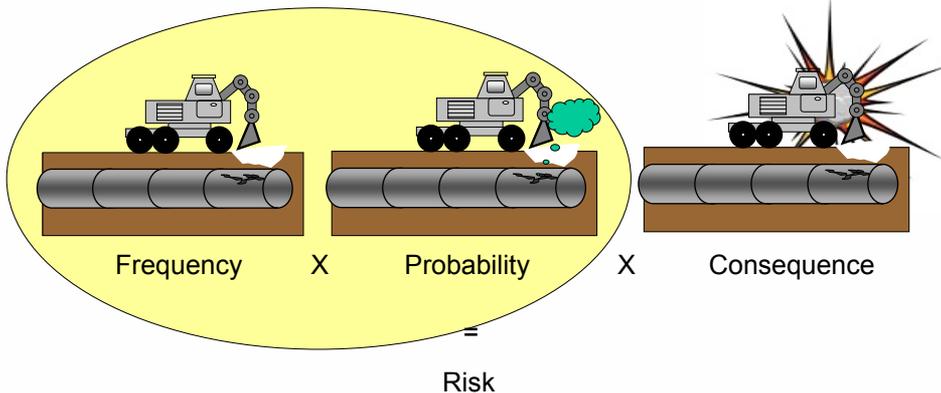
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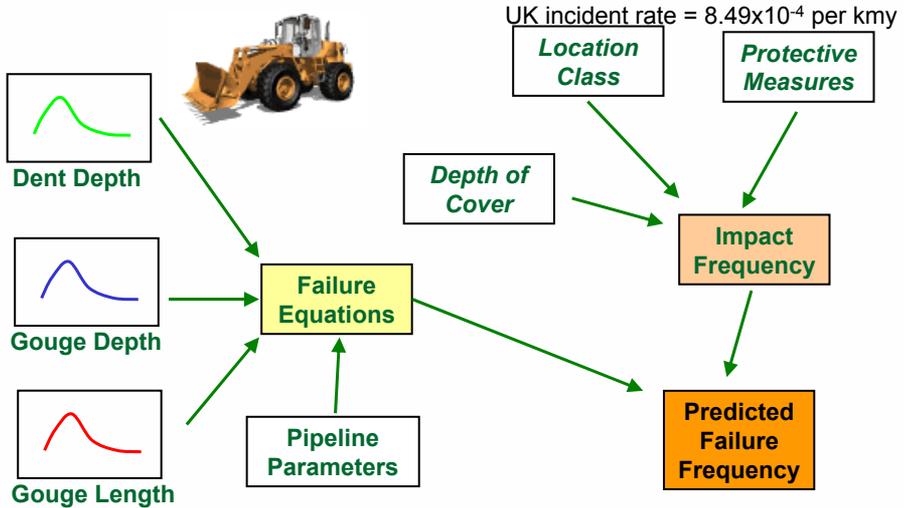


Key Elements of QRA

■ Risk = [Incident Frequency x Probability of Failure] x Consequence



Failure Frequency in QRA Methodology



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Failure Frequencies in UK

Damage Mechanism	Total
3rd Party Interference	0.057
External Corrosion	0.046
Internal Corrosion	0.003
Material & Construction	0.076
Ground Movement	0.009
Other	0.073
TOTAL	0.264

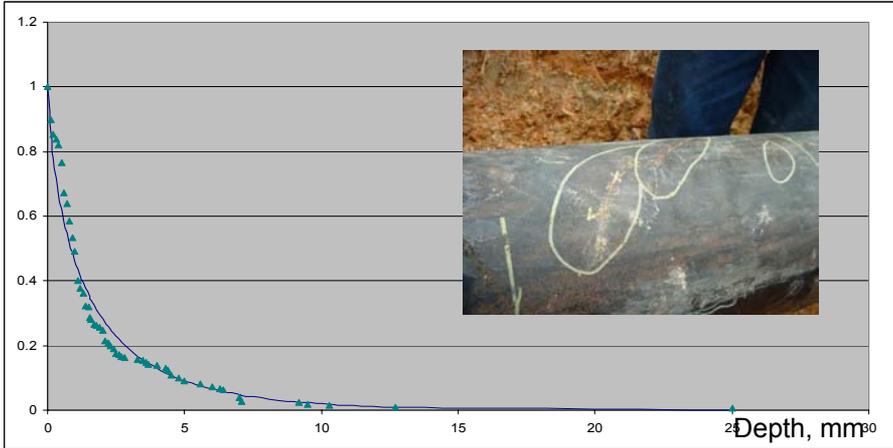
per 1000 km years

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Gouge Depth Probability

Cumulative probability



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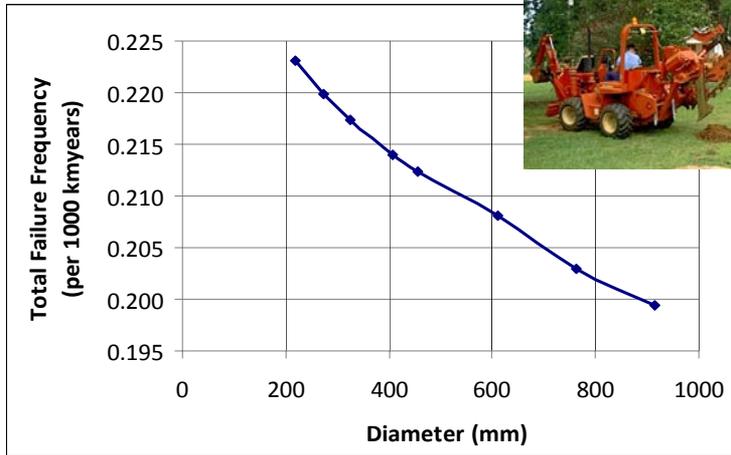


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Failure Frequencies: Generic curve

- A lower bound failure frequency curve can be used:

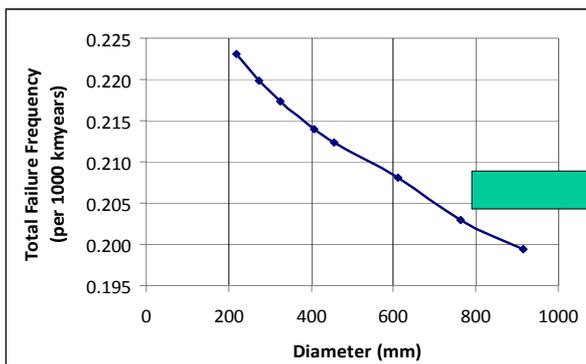


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Failure Frequencies: Generic curve

- Risk = [Incident Frequency x Probability of Failure] x Consequence
- Risk = Failure Frequency x Consequence

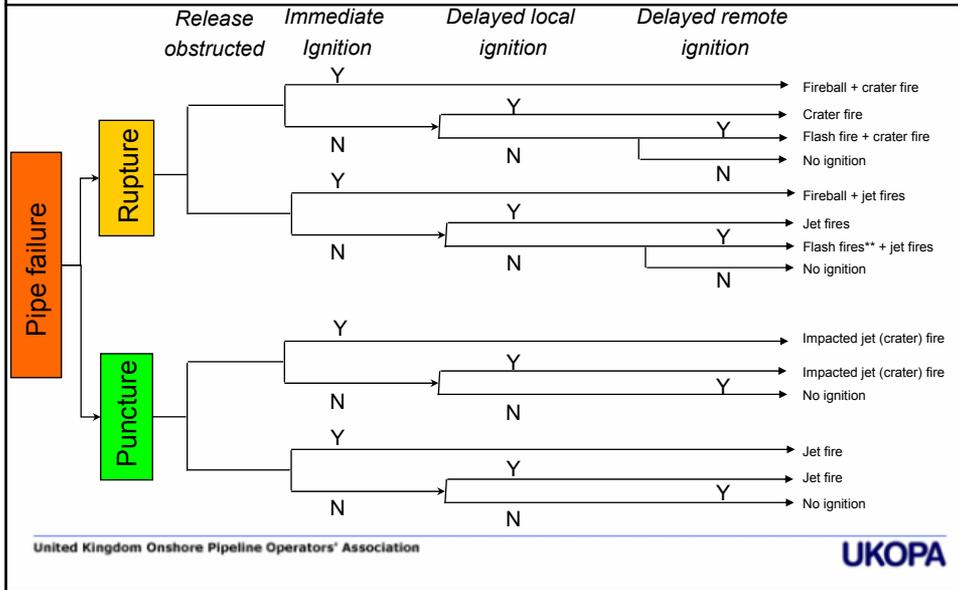


X Consequence = Risk

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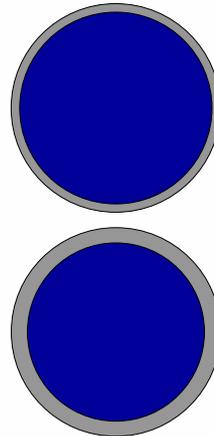
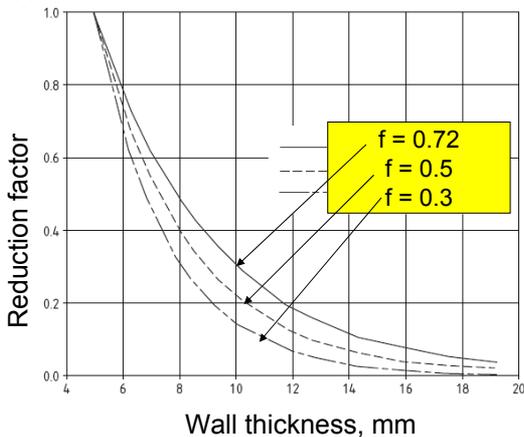
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Consequences

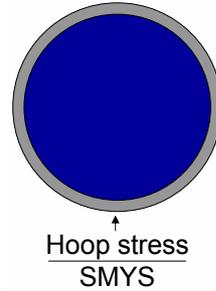
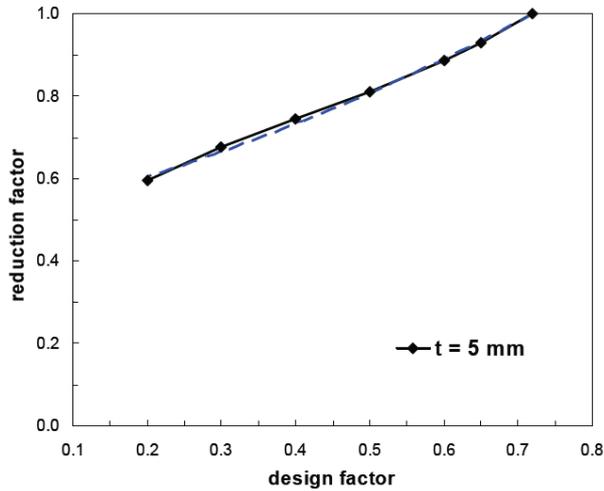


'Reduction Factors': PD 8010-3

■ Failure frequency can be reduced for thicker walls, deeper cover, etc.



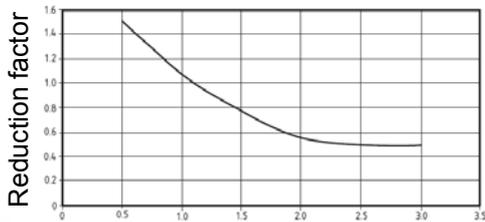
Reduction Factors: PD 8010-3



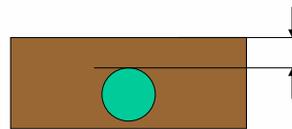
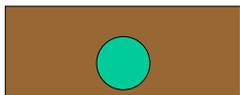
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Reduction Factors: PD 8010-3



Depth of cover



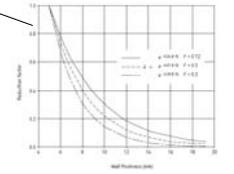
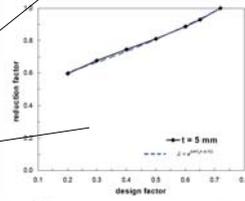
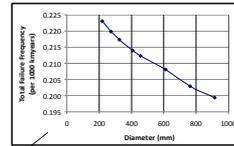
Surveillance interval

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Failure Frequency: Example

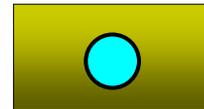
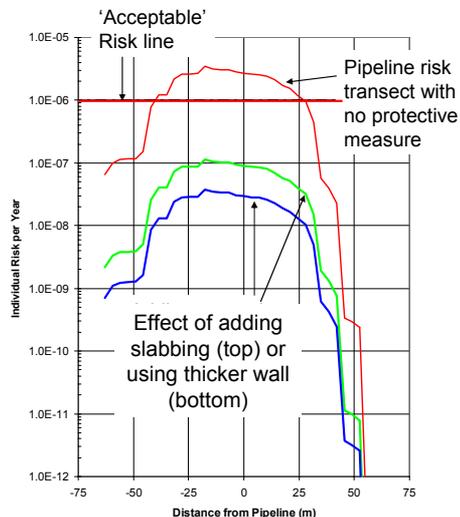
Diameter (mm)	914.4
Wall Thickness (mm)	9.52
Design Factor	0.5
Generic Total Failure Frequency (per 1000kmyrs)	0.199
Design Factor Reduction Factor	0.81
Wall Thickness Reduction Factor	0.34
Estimated Total Failure Frequency (per 1000kmyrs)	0.055



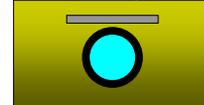
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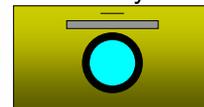
QRA: Example



Reduce by 0.16



Reduce by 0.05

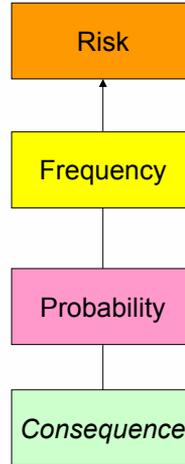


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Other Guidance in PD 8010-3 and IGEN/TD/2

- Guidelines also contain:
 - Example frequency calculations
 - Example of site specific calculation
 - Using other more detailed frequency methods
 - More detailed failure frequencies
 - Consequence modelling & assumptions
 - e.g. ignition probabilities
 - Tolerable risk levels
 - Etc.



Tolerable Risk Levels: Individual

UNACCEPTABLE

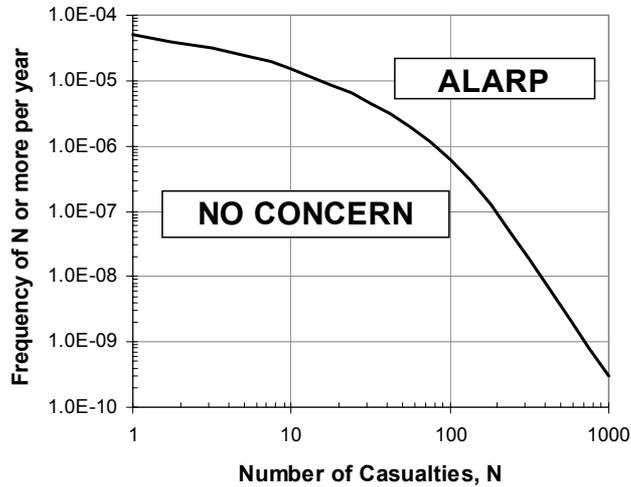


AS LOW AS IS
REASONABLY
PRACTICABLE ('ALARP')



BROADLY
ACCEPTABLE

Tolerable Risk Levels: Societal



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Conclusions

- UKOPA has helped produce 'best practice' pipeline risk assessment guidelines for the UK
- These are included in IGEM/TD/2 and BSI PD 8010-3
- These documents provide guidance on:
 - determining failure frequencies;
 - consequence modelling;
 - risk reduction factors to be applied for mitigation methods;
 - benchmark results for individual and societal risk levels.

