Institution of Chemical Engineers
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Development of Risk Assessment Code Guidance - the new UK Pipeline Design Codes IGEM/TD/2 and PD 8010 Part 3

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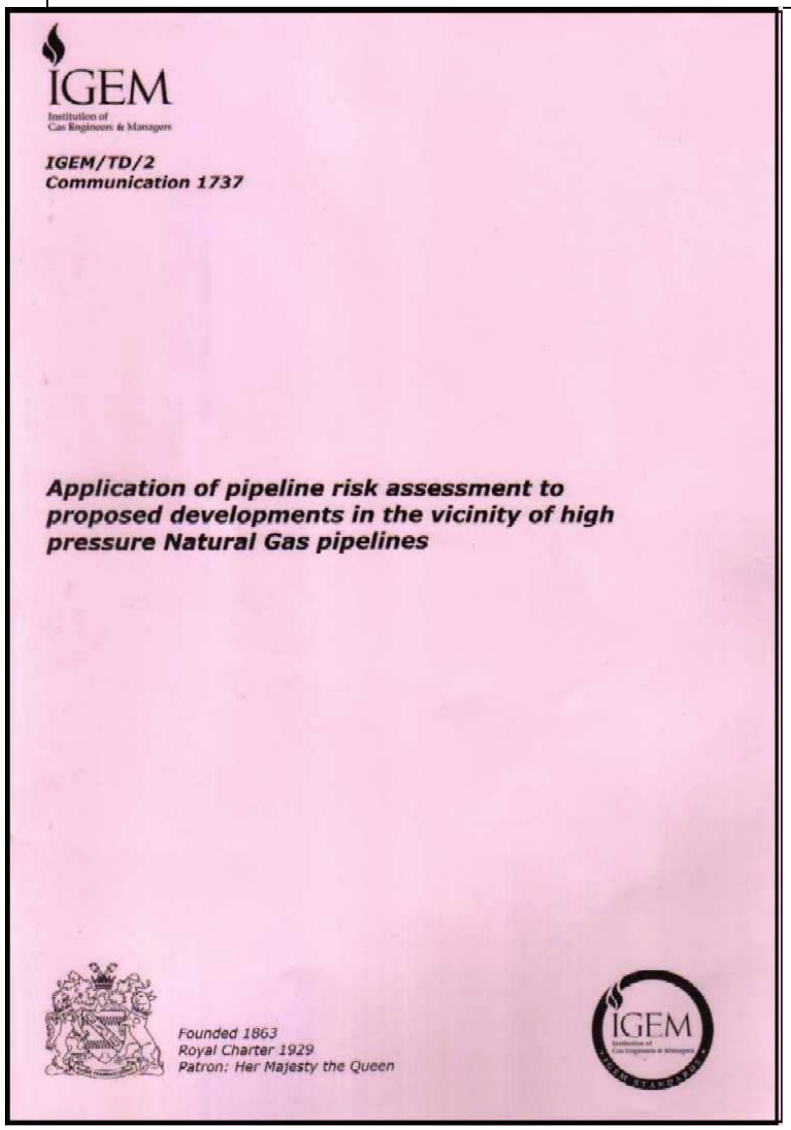
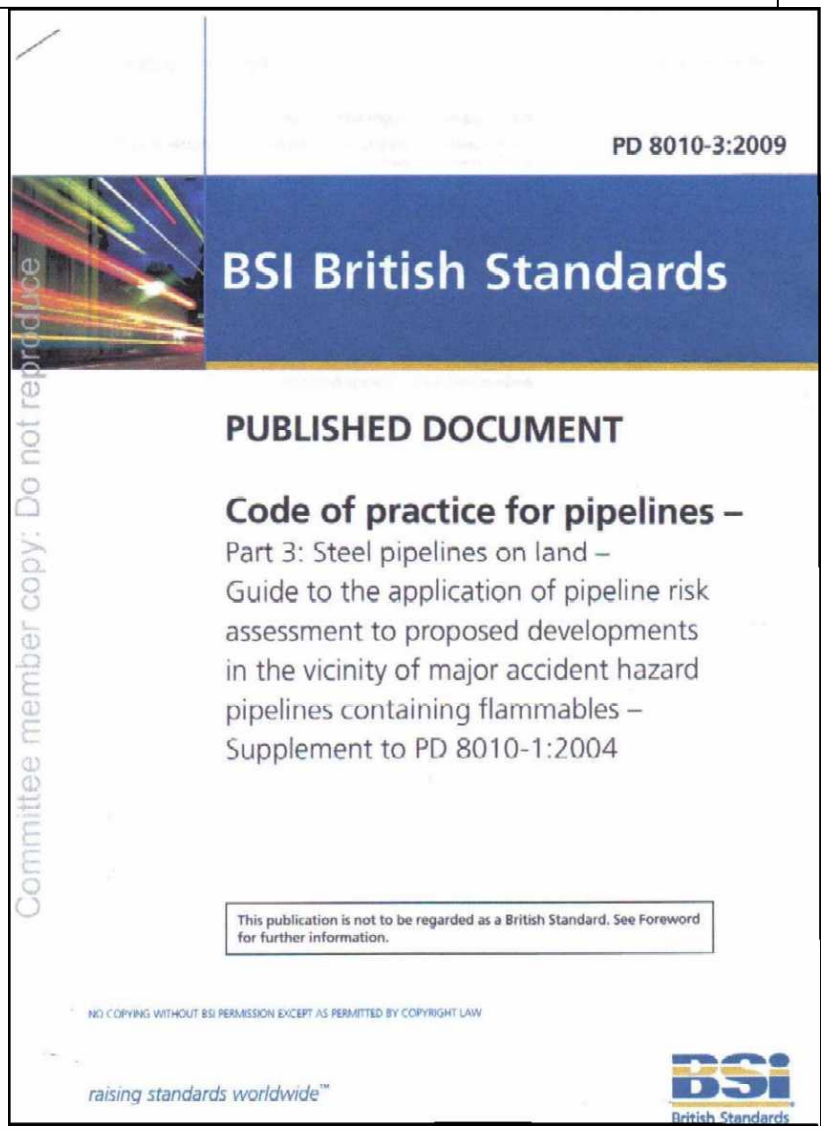
New Pipeline Risk Codes Published 2009

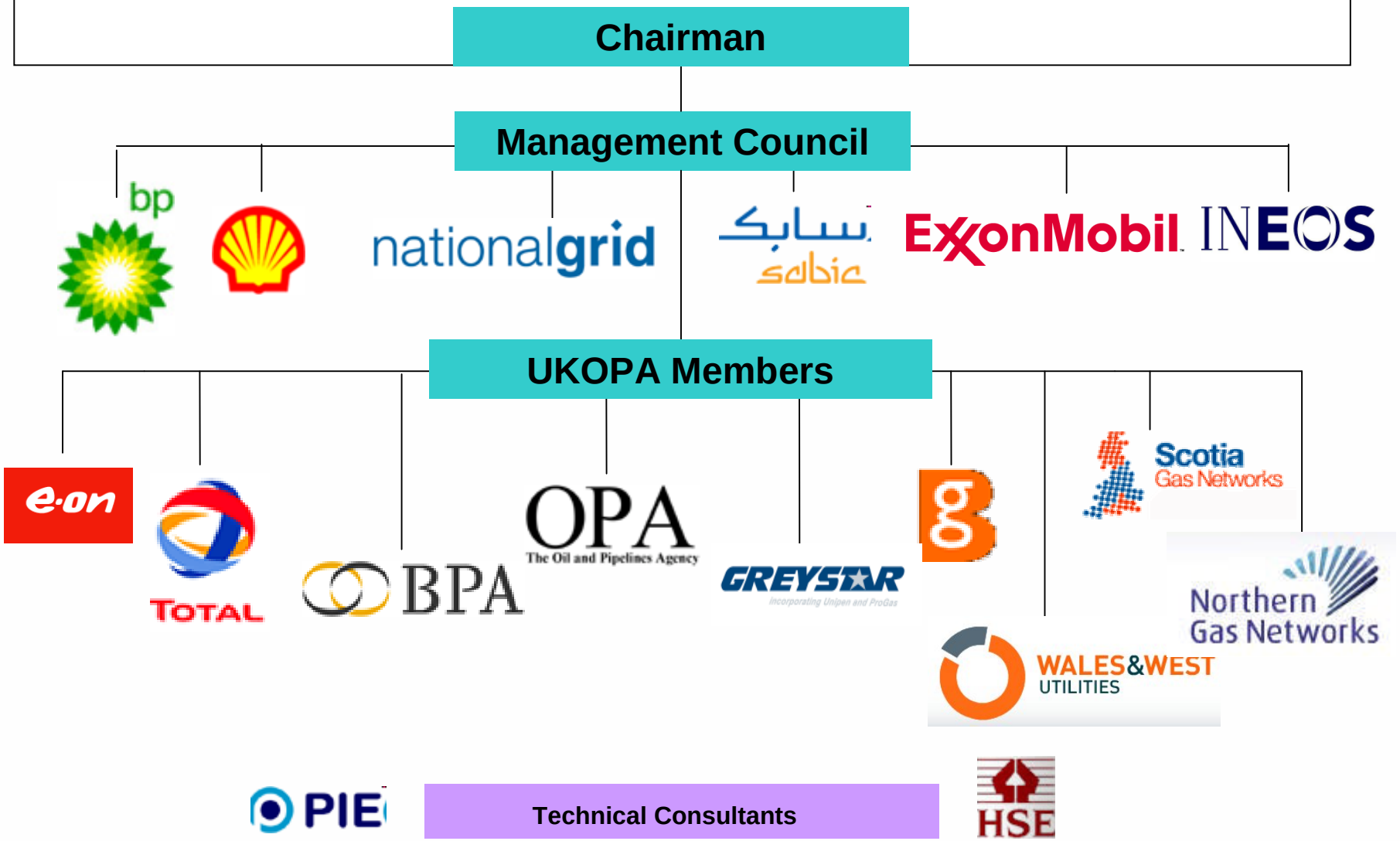




Presentation Overview

- UKOPA
- Current approach to Pipeline Quantified Risk Assessment (QRA)
- Need for Risk Assessment Guidance
- Guidance Contents
- Benefits
- Conclusions

UK Onshore Pipeline Operators' Association

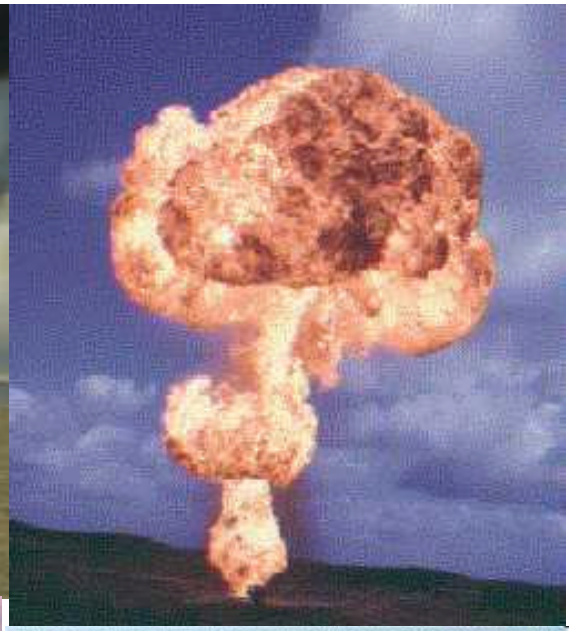


UK Onshore Pipeline Operators' Association

Working Groups:-

- Fault Data Management Group
  - Produces biennial report of UK pipeline failure rates
- Infringement Working Group
  - Collects data on unauthorised excavations near pipelines
- Emergency Planning Work Group
- Process Safety Working Group
- Risk Assessment Working Group
  - produced new risk codes during 2005-2008

Pipeline Risk

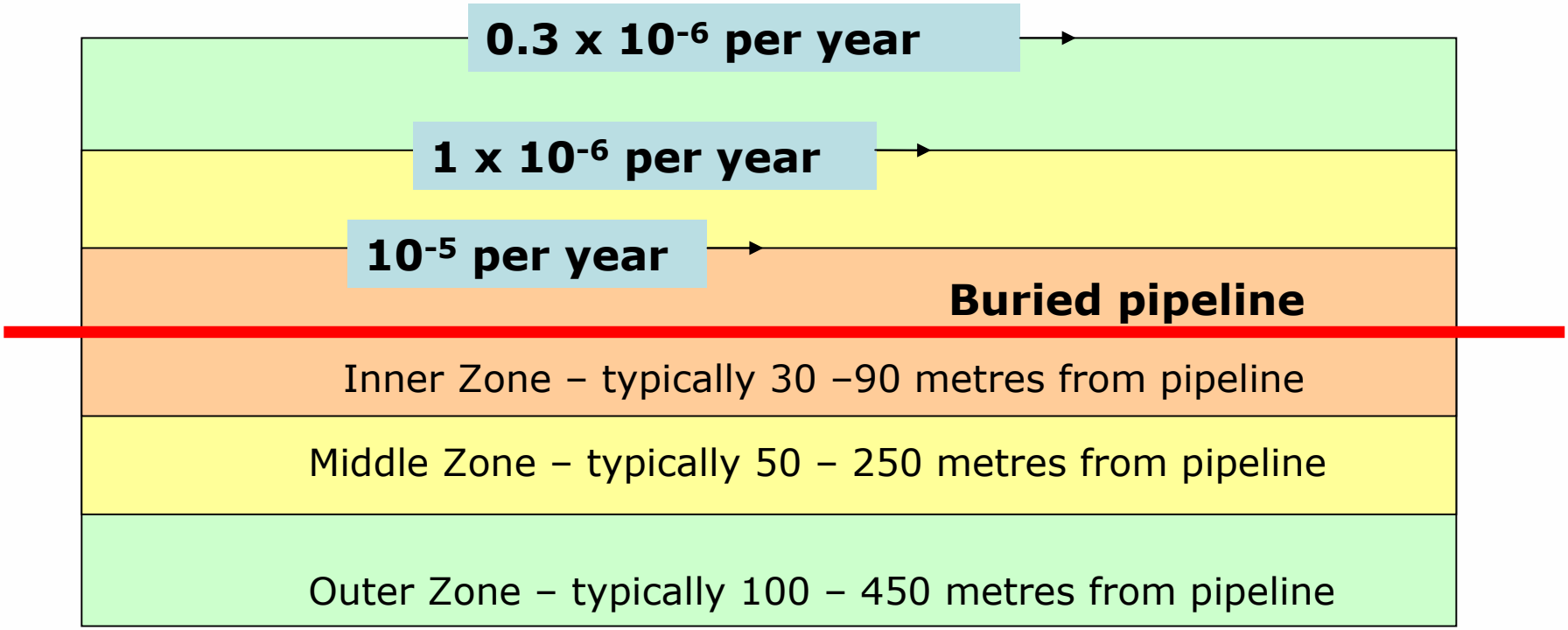


Current Approach to Pipeline Risk Assessment

- **Compliance with Pipeline Code IGEM/TD/1 (natural gas) or PD 8010 (all other fluids) demonstrates compliance with Pipeline Safety Regulations 1996**
- **Also demonstrates risks are As Low As Reasonably Practicable (ALARP)**
- **TD/1 and PD 8010 - not risk based codes, but allow application of QRA to assess risk levels**
- **Incremental increases in risk usually occur during pipeline lifetime – due to population increase**

Land Use Planning Zones and PADHI

- **3 zone Land Use Planning zones applied to Major Hazard Pipelines in late 1980s / early 1990s**



- **Permitted developments in each zone described in Health & Safety Executive's document PADHI – Planning Advice for Developments near Hazardous Installations**

Land Use Planning - PADHI

Sensitivity Level	Development Type	Examples
1	Workplaces, Parking areas	Offices, factories, warehouses etc
2	Developments for use by the general public	Houses, flats, residential caravans, mobile homes, hotels (up to 100 beds)
3	Developments for use by vulnerable people	Schools, hospitals, old peoples homes.
4	Very large sensitive developments	Large examples of 3 above plus large outdoor events

Level of Sensitivity	Inner Zone	Middle Zone	Outer Zone
1	Do Not Advise Against	Do Not Advise Against	Do Not Advise Against
2	Advise Against	Do Not Advise Against	Do Not Advise Against
3	Advise Against	Advise Against	Do Not Advise Against
4	Advise Against	Advise Against	Advise Against

Need for Code Guidance on QRA

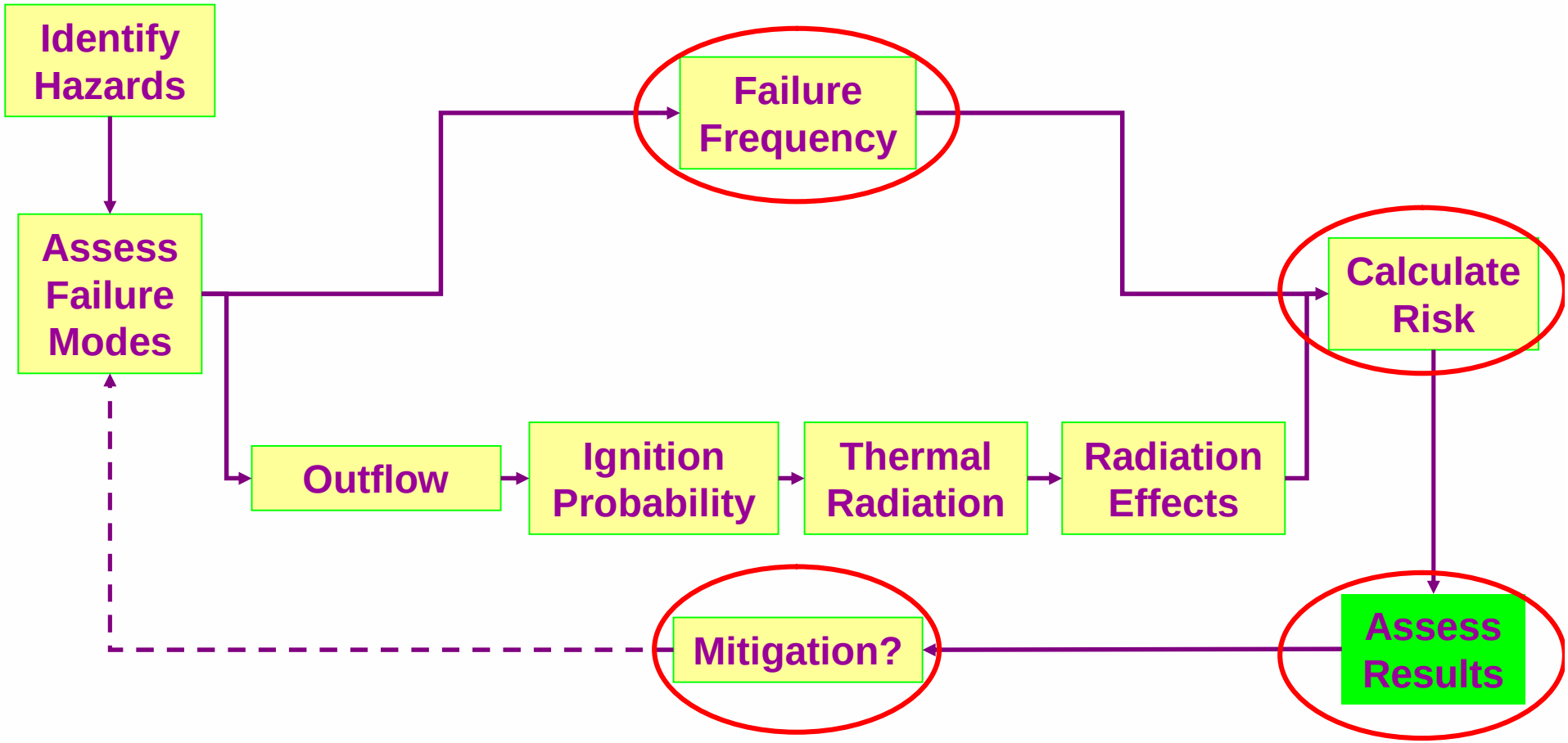
- HSE use QRA to calculate Land Use Planning zones
- PADHI "Advises Against" developments sometimes can be changed if risk reduction measures are applied – but need to assess using QRA
- Need to define common approach to risk reduction and failure frequency calculations
- Increase in population density above original code limits may also require risk reduction measures

Objectives for Code Guidance on QRA

- **Authoritative and accepted industry guidance**
  - Standard and consistent approach
  - Incorporate site specific pipeline details & risk mitigation
- **Reduce potential for technical disagreement with stakeholders – especially failure frequencies and risk reduction measures**
- **Best practice approach – but doesn't define particular software or models**
- **Allow assessment of incremental changes in risk, ensure risk levels remain ALARP, and inform risk management decisions**

Code Guidance Scope

Flammable fluids – not toxics



Code Guidance Contents

- Introduction – Scope – Overview
- Event Trees – flammable gases
- Prediction of pipeline failure frequencies
- Prediction of consequences
- Individual risk assessment
- Societal risk assessment – new societal risk criteria curve
- Risk reduction factors which reduce pipeline failure rates
- Summary of HSE methodology to provide PADHI advice including actual land use planning risk zones
- Guidance on assessing pipeline failure frequencies
- A worked example

Failure Rates – Failure Mechanisms

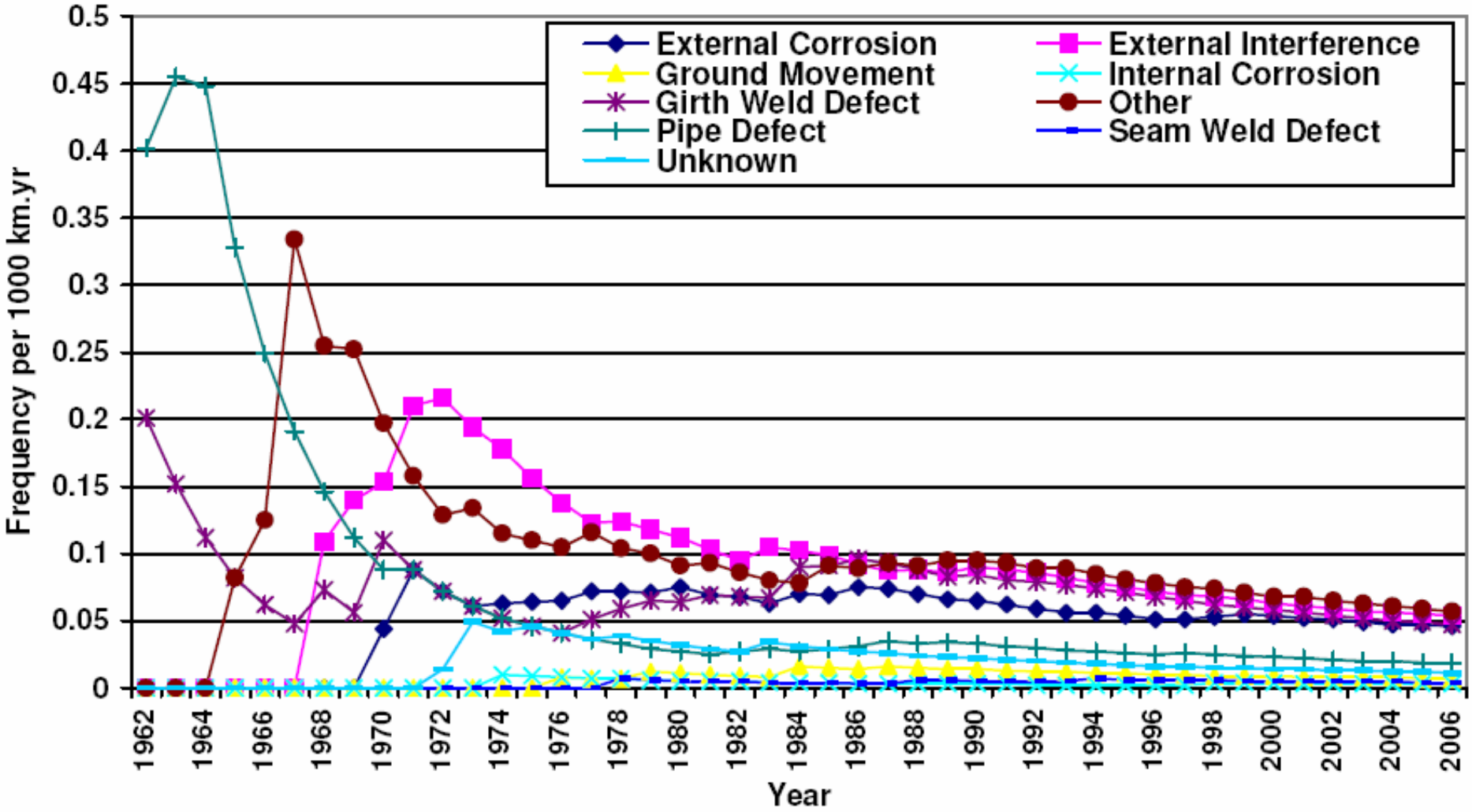
External Interference – highest frequency

Internal / external corrosion

Manufacturing / construction defect

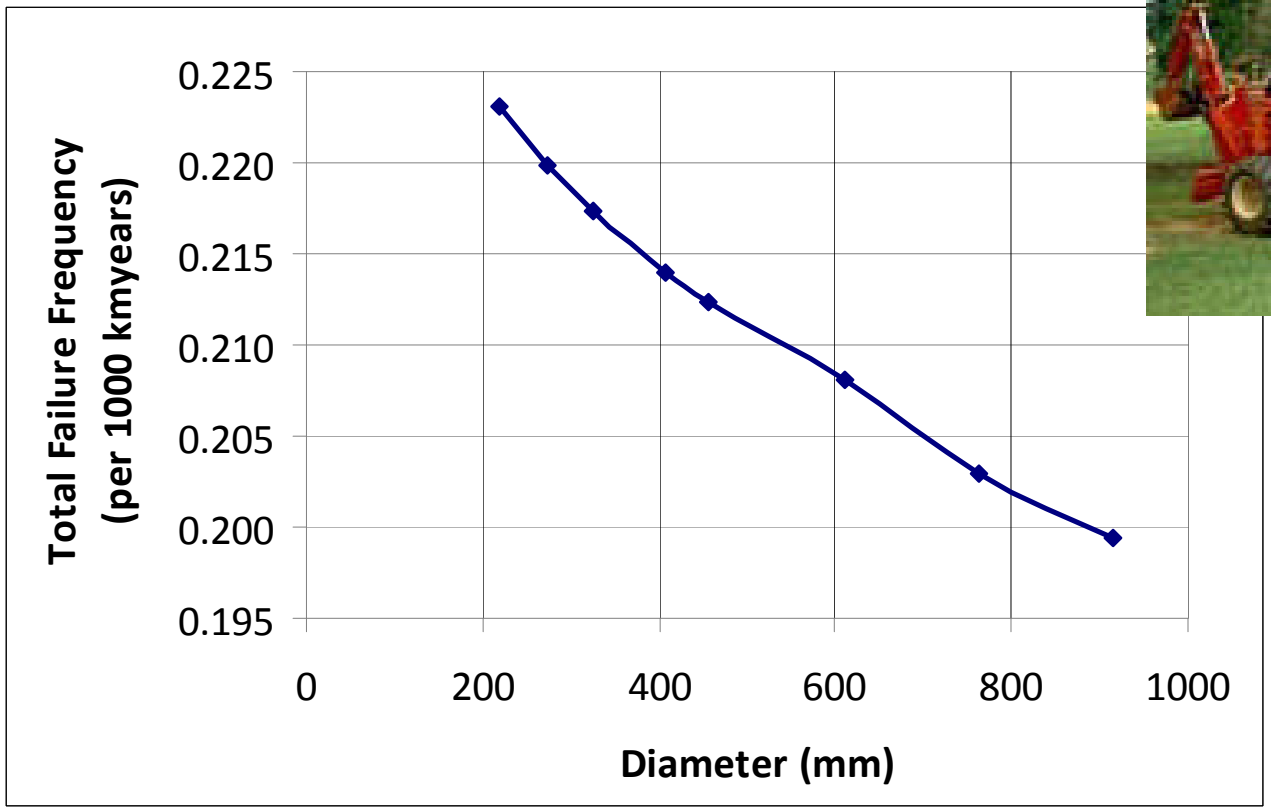
Ground movement

UKOPA Failure Data – see ukopa.co.uk



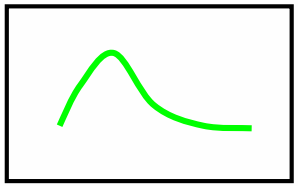
Generic Failure Frequency Curve

- For External Interference (use historical data for other failure rates)
- Design factor = 0.72 – directly related to pressure in pipeline
- Wall thickness = 5 mm
- Grade of steel = X65

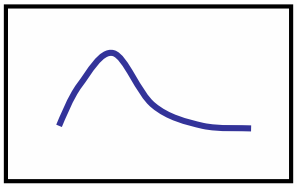


Failure Frequency Prediction – External Excavation

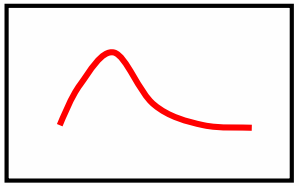
based on predictive modelling



Dent Depth



Gouge Depth



Gouge Length

Location Class
Rural, Suburban

Protective
Measures

Depth of
Cover

Impact
Frequency

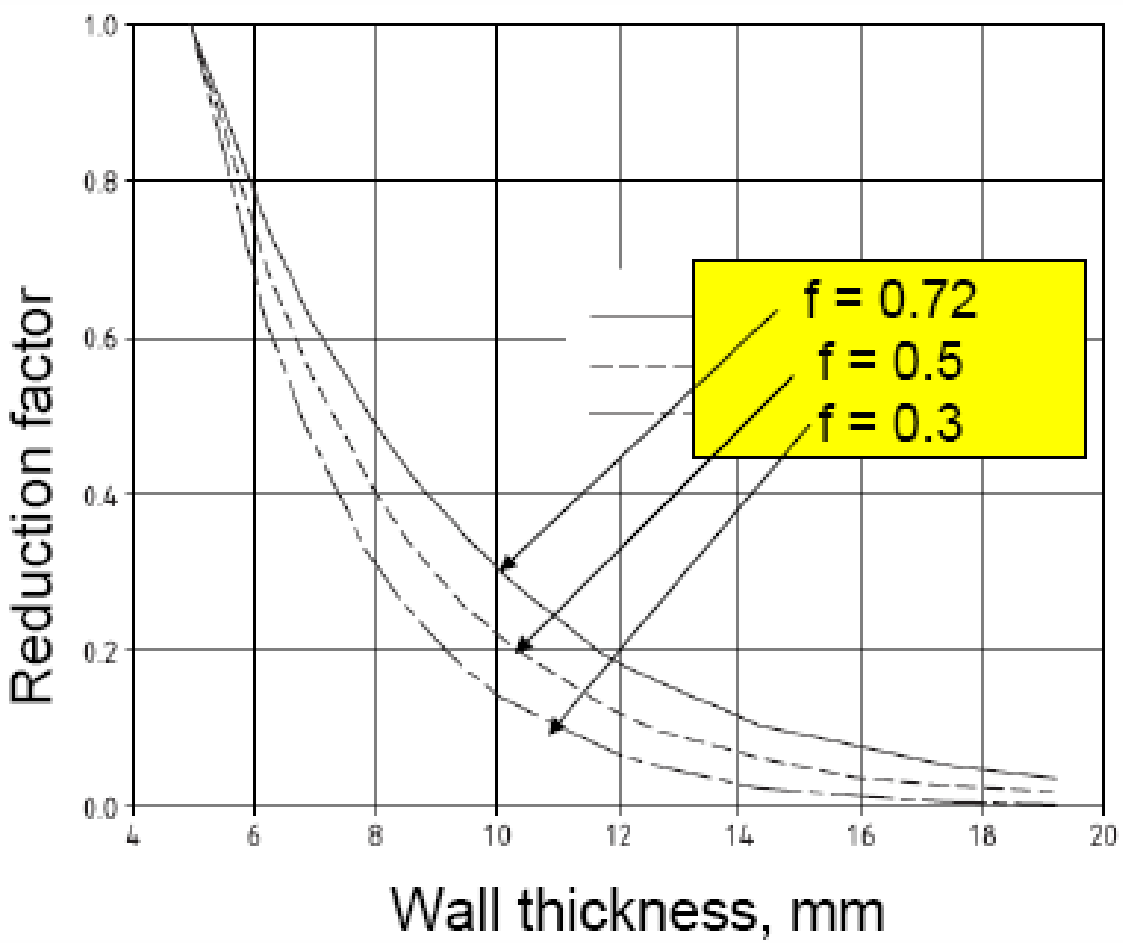
Failure
Equations

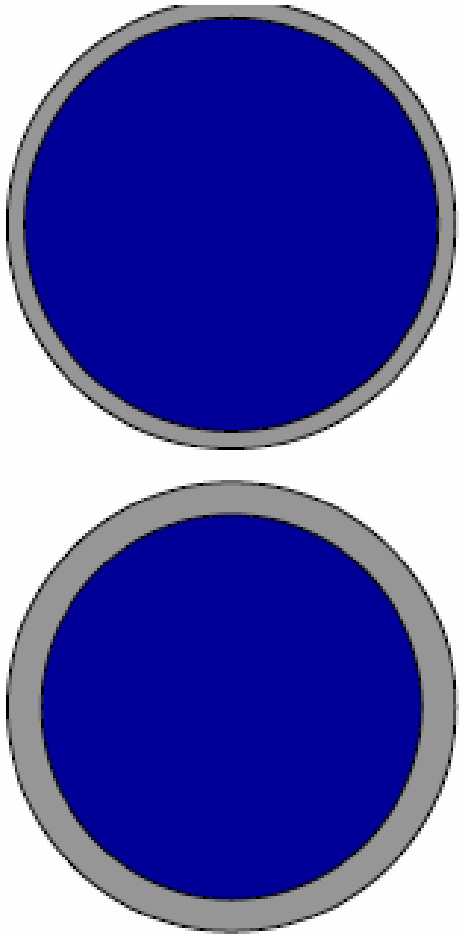
Predicted
Failure
Frequency

Pipeline
Parameters

Risk Mitigation Factors – External Interference

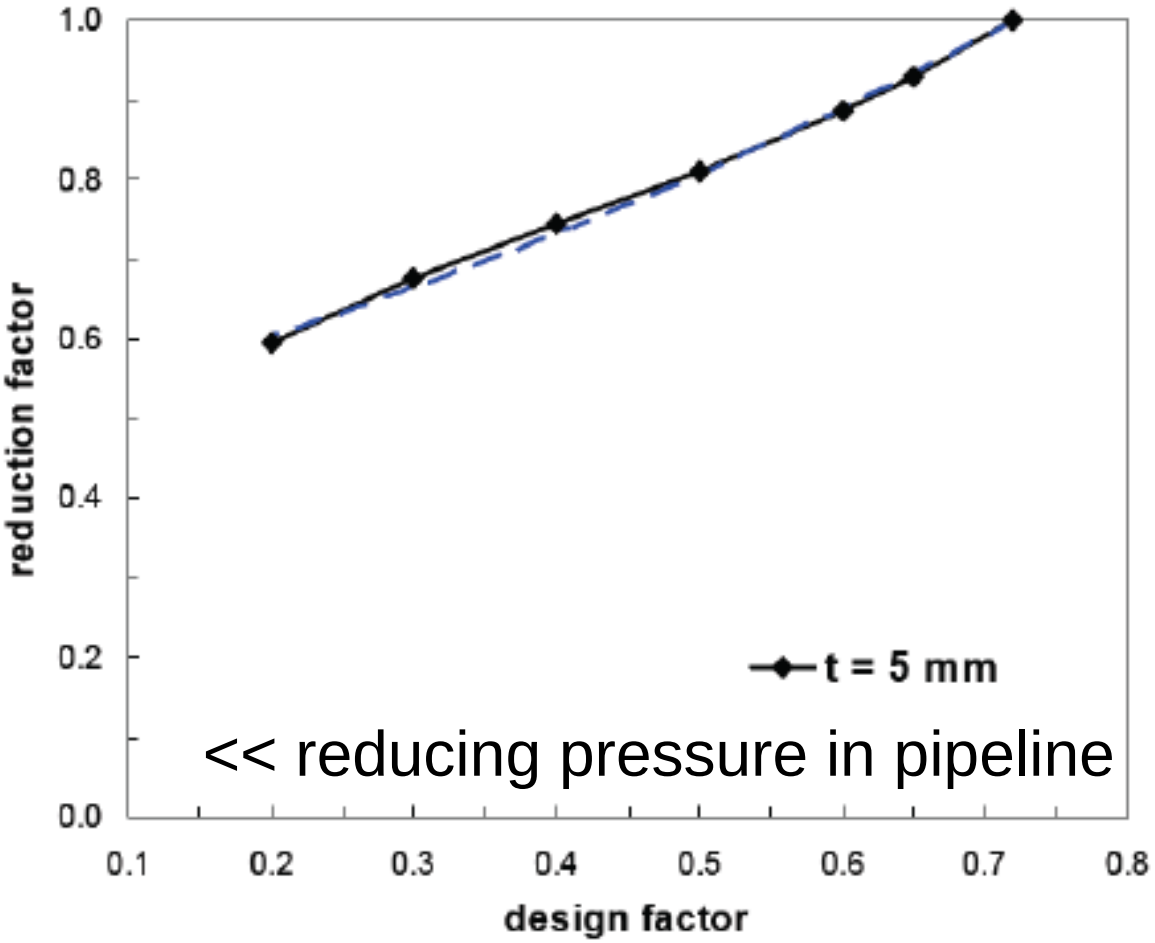
- Thicker pipe wall reduces probability of pipeline puncture

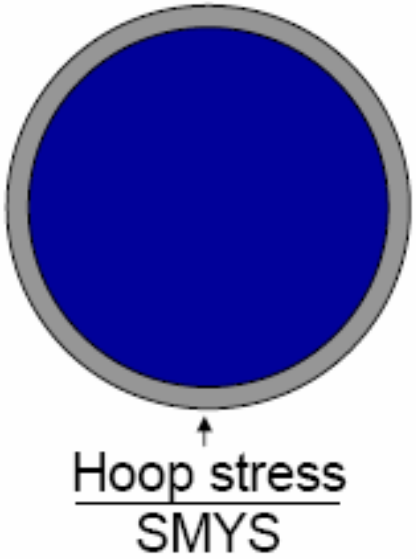




Risk Mitigation Factors – External Interference

- Lower pipeline stress (lower pressure) also reduces probability of pipeline puncture

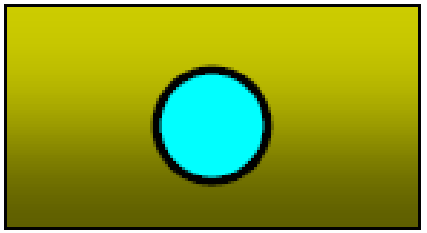




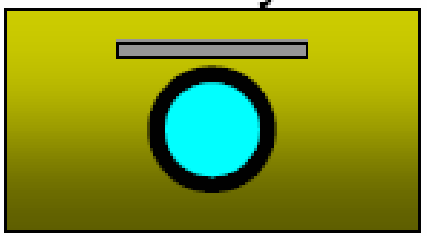
Risk Mitigation Factors – External Interference

- Concrete slabbing and marker tape reduces probability of pipeline puncture
- Based on 1990s field trails & FTA

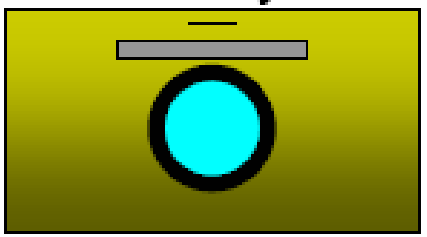
Mitigation	Reduction Factor
Concrete Slab	0.16
Slab plus visible warning	0.05



Reduce by 0.16

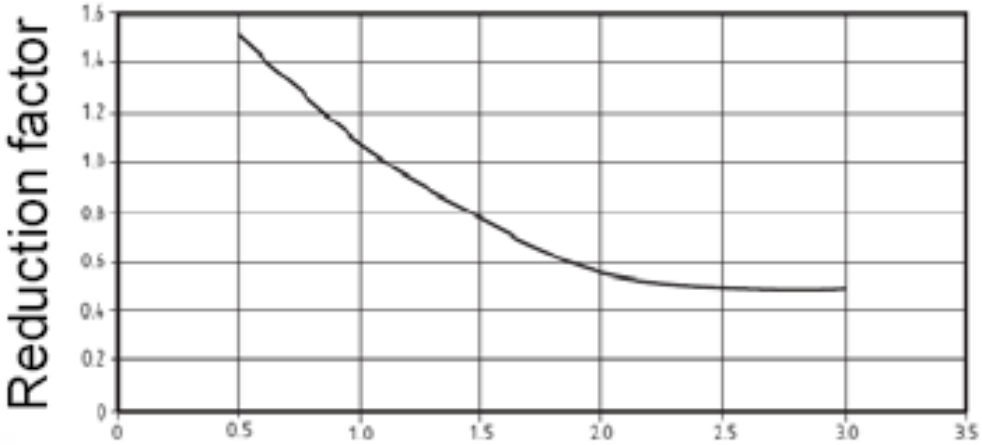


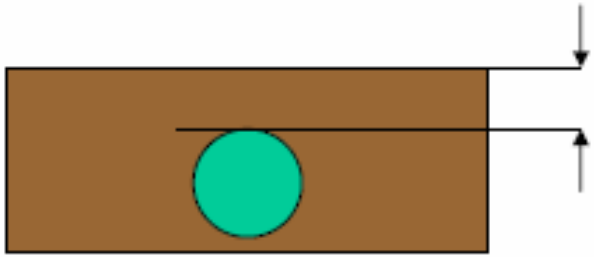
Reduce by 0.05

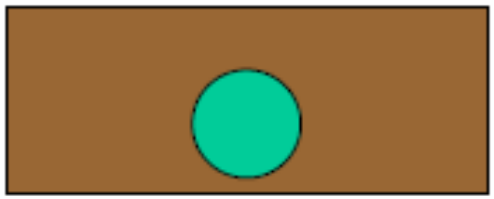


Risk Mitigation Factors – External Interference

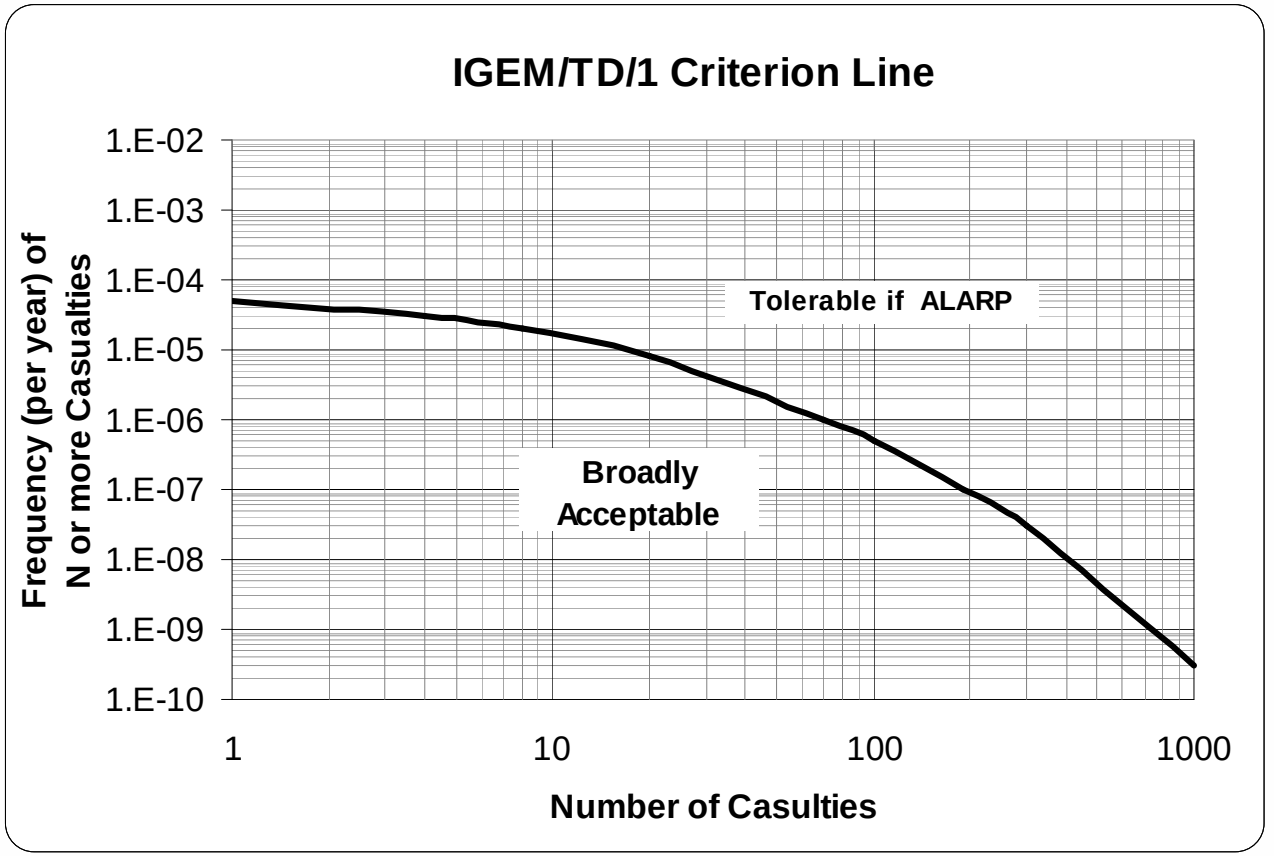
- Increased depth of cover and increased surveillance





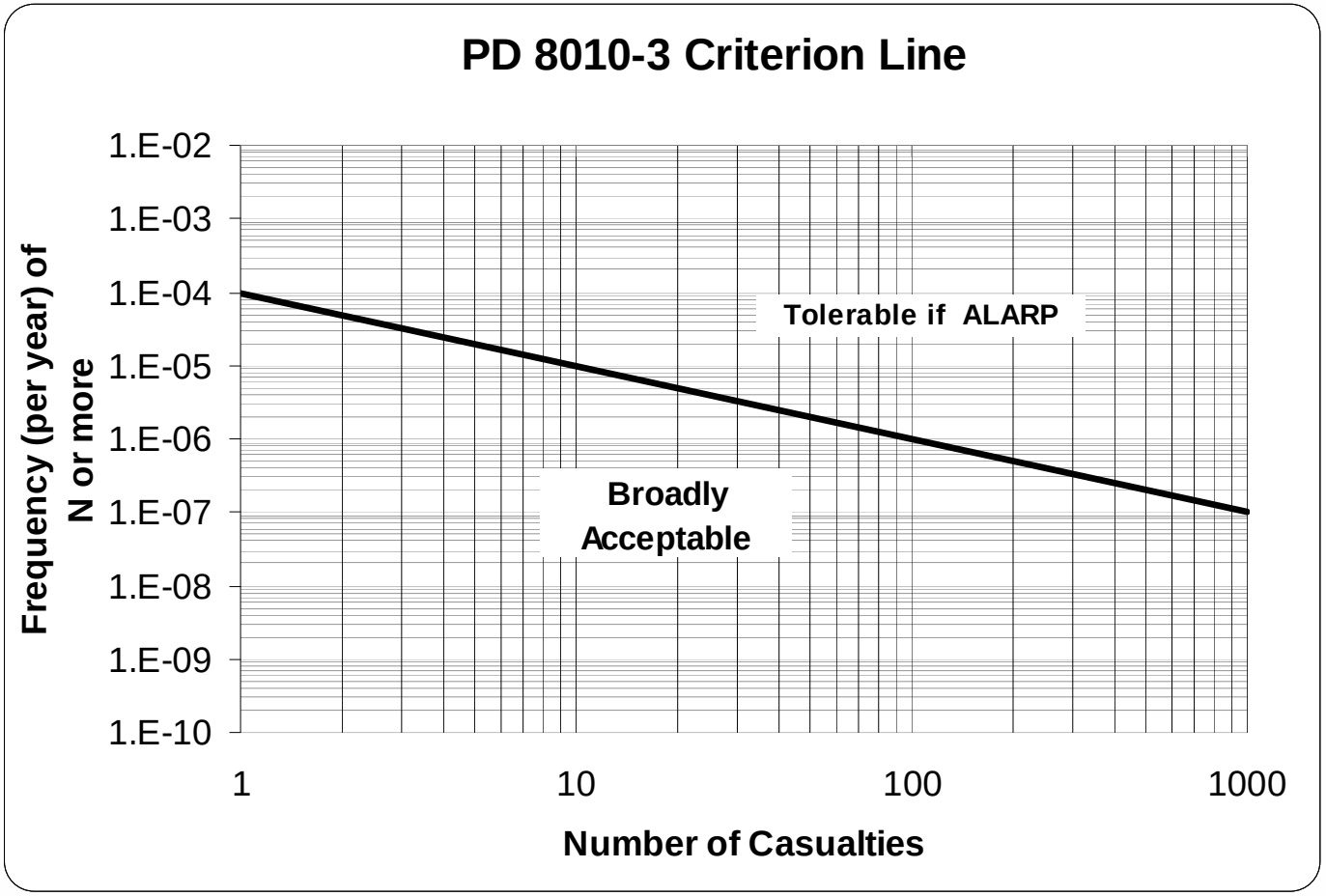


Societal Risk Criteria - Natural Gas



- As published in Gas Engineers Code IGEM/TD/1
- Based on experience of applying Code over 40 years
- Applied to 1600m of pipeline

Societal Risk Criteria – Other MAHPs



- New Criterion based on societal risk applied to fixed sites
- Applied to 1000m of pipeline

Benefits of Code Guidance

- **Greater consistency between all stakeholders**
- **Discusses current best practice assumptions and risk reduction methodologies**
- **Benchmark solutions - failure frequencies**
- **Allows operators to have a better understanding of risk - Better safety management**
- **Facilitates understanding of risk assessment process by non experts**
- **Hopefully lead to better discussions on risk acceptability…**
  - …and away from methodology, models and assumptions

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.