

# **UKOPA Dent Management Strategy**

**RAWG Update  
October 2010**

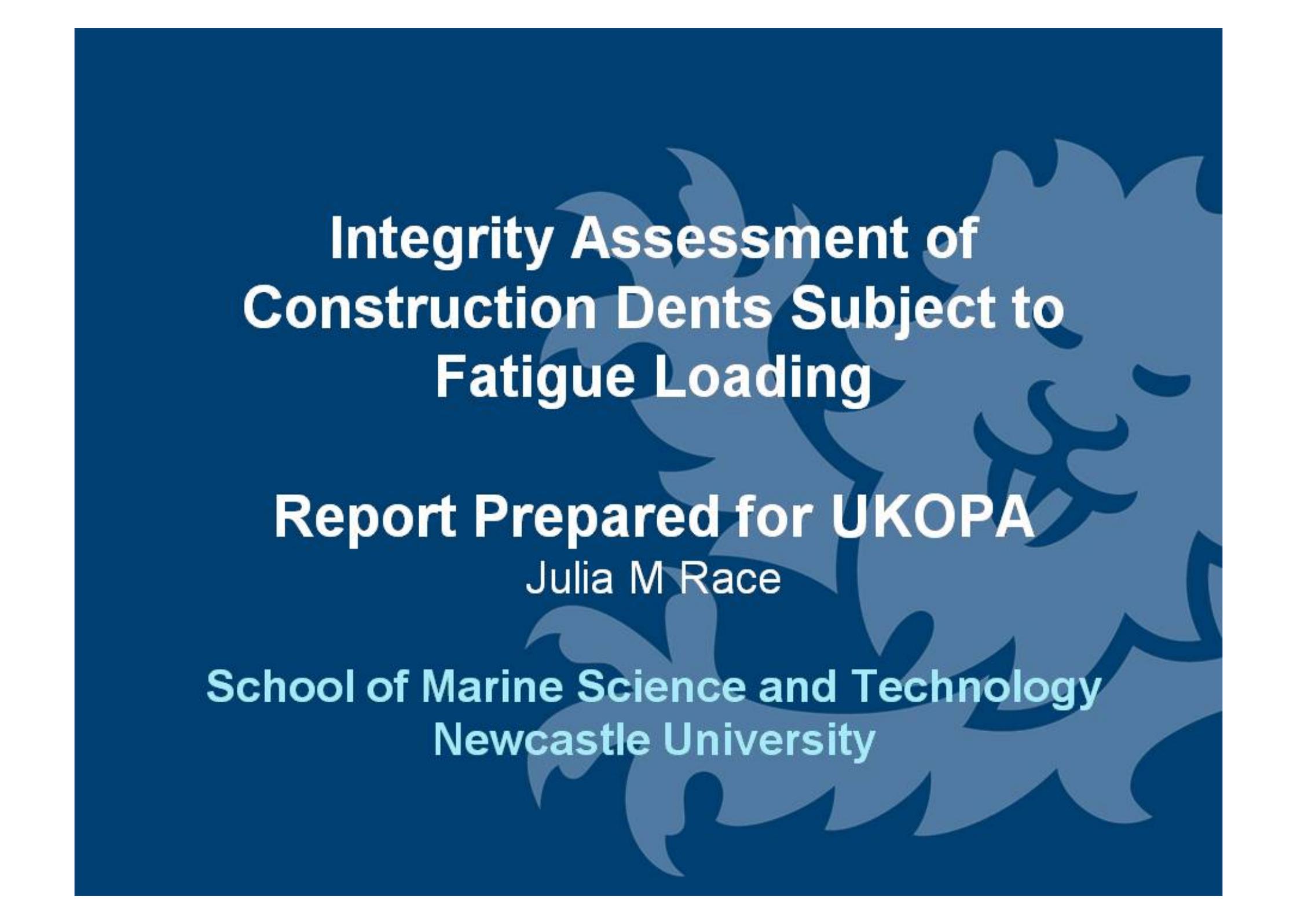
UKOPA/10/0052

# Background

- The majority of pipeline in-line inspections (ILI) are carried out using the magnetic flux leakage (MFL) inspection tools.
- MFL tools are capable of identifying and locating dents in the pipeline, but do not size dents.
- As a result, large numbers of dent features are reported by ILI companies for further consideration by the operator with little or no information for identifying any critical features which require investigation.
- Geometric ILI tools are capable of sizing the dent. However, where dents have been identified by MFL ILI only, there may be a time delay before geometric inspection can be scheduled.
- A Dent Management Strategy is therefore required which uses all available information and highlights critical actions.

# Purpose

- Prioritisation of dent features detected by ILI for investigation based on
  - Type of ILI tool
  - Feature location, characteristics, association with other damage & welds
- Assessment of dents subject to static and cyclic loading



**Integrity Assessment of  
Construction Dents Subject to  
Fatigue Loading**

**Report Prepared for UKOPA**

Julia M Race

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# **Integrity Assessment of Construction Dents Subject to Fatigue Loading**

- Code requirements and criteria
- Dent related pipeline failures
- Depth and strain based assessment approaches
- Static and fatigue assessment models
- Dent detection and measurement

# **Advantica Work for NG & Gas Networks – High Level Dent Assessment from ILI**

- Considers plain, smooth and kinked dents
- Applies the gas industry pipeline defect assessment procedure - P11
- Reviews ILI tools for dent identification, location and measurement
- Presents current understanding of the effect of dents on pipeline integrity
- Presents a high level dent assessment algorithm

# UKOPA WG Approach

- Operator workshops
  - requirements
- Assessment of operator data
  - Case studies
- Document results, conclusions
- Develop guidance
- Independent expert review

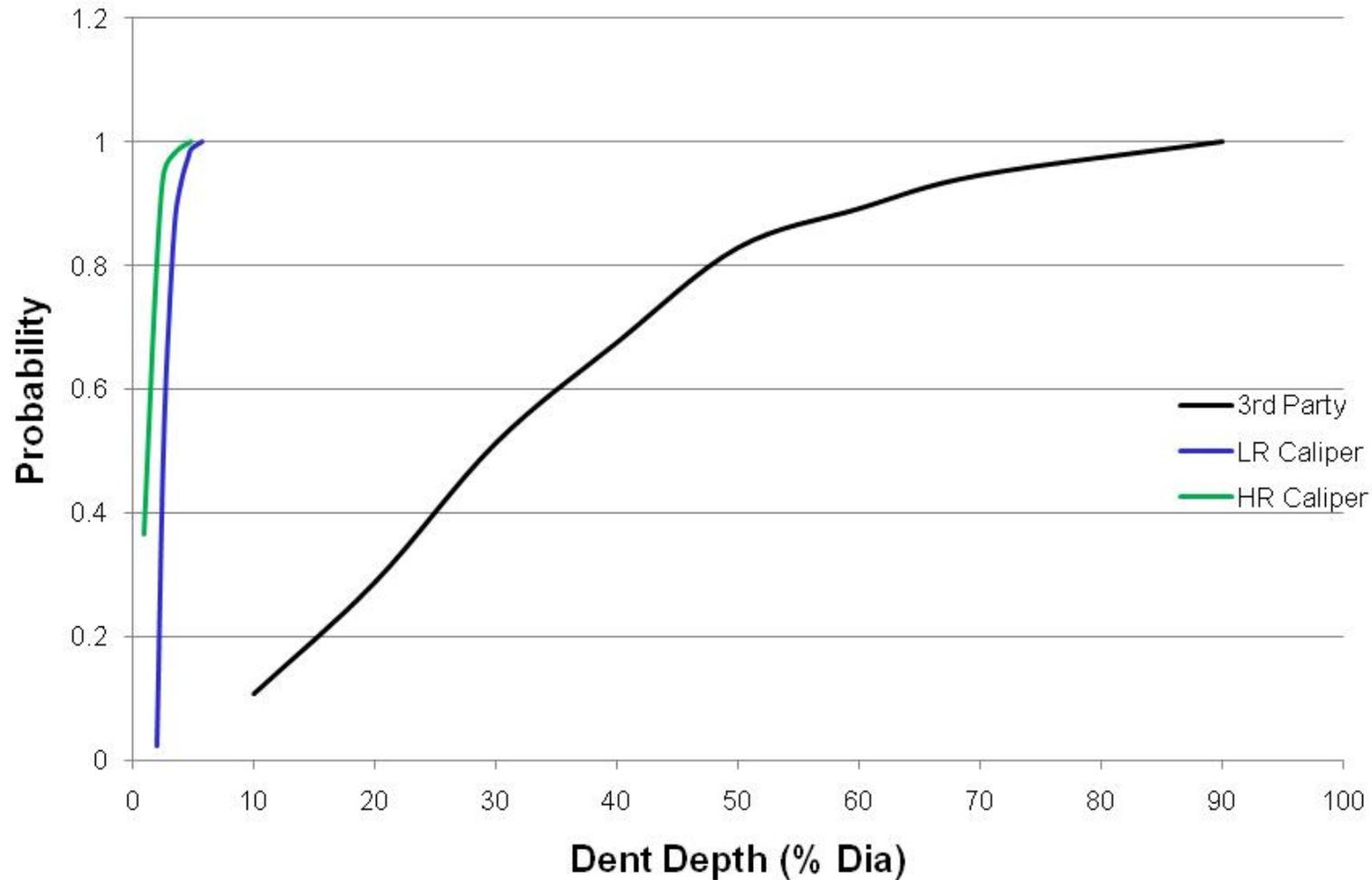
# Work Completed

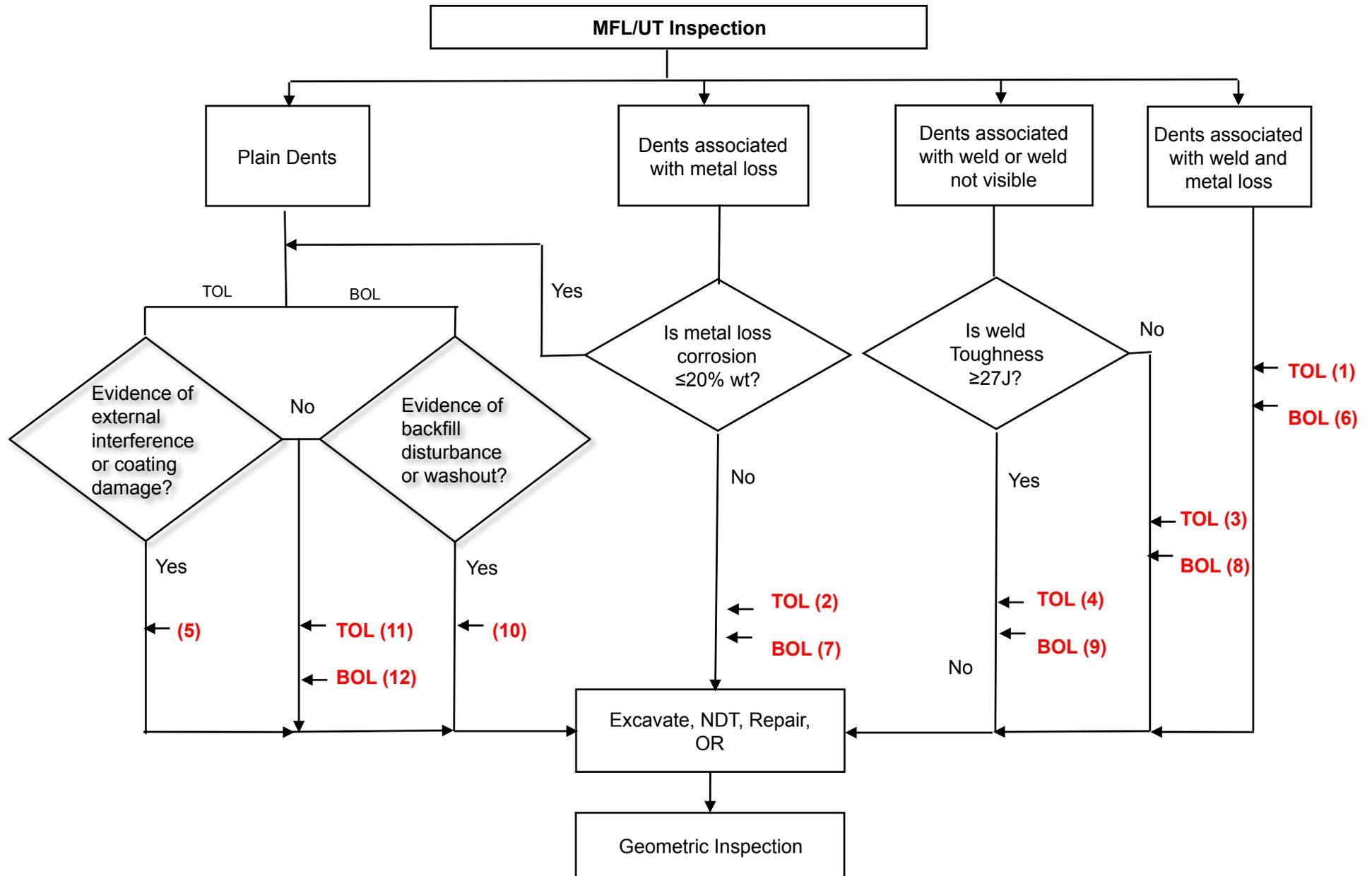
- 3 Operator workshops
- Review of operator data
- Development of prioritisation algorithms, simple assessment rules, dent assessment algorithm
- Review dent fatigue calculation model
- Operator review of above (2 gas and 2 liquid operators)
- Completion of UKOPA Strategy – Stage 1
- External publication

# Interesting Data

Data	Pipeline type	Measure	Dents /km	Depth profile	Location
Operator 1	Liquid	Low res geometry tool	2	Max – 5.7% dia 80% < 3.25% dia	All between 4 & 8 o'clock
Operator 2	Gas	High res geometry tool	3	Max 4.8% dia 80% < 2% dia	All between 4 & 8 o'clock
Ext int data	Both	Investigation	$5 \times 10^{-3}$ (1 in 200 km)	Max 89% dia 80% < 50% dia	Majority 8 & 4 o'clock

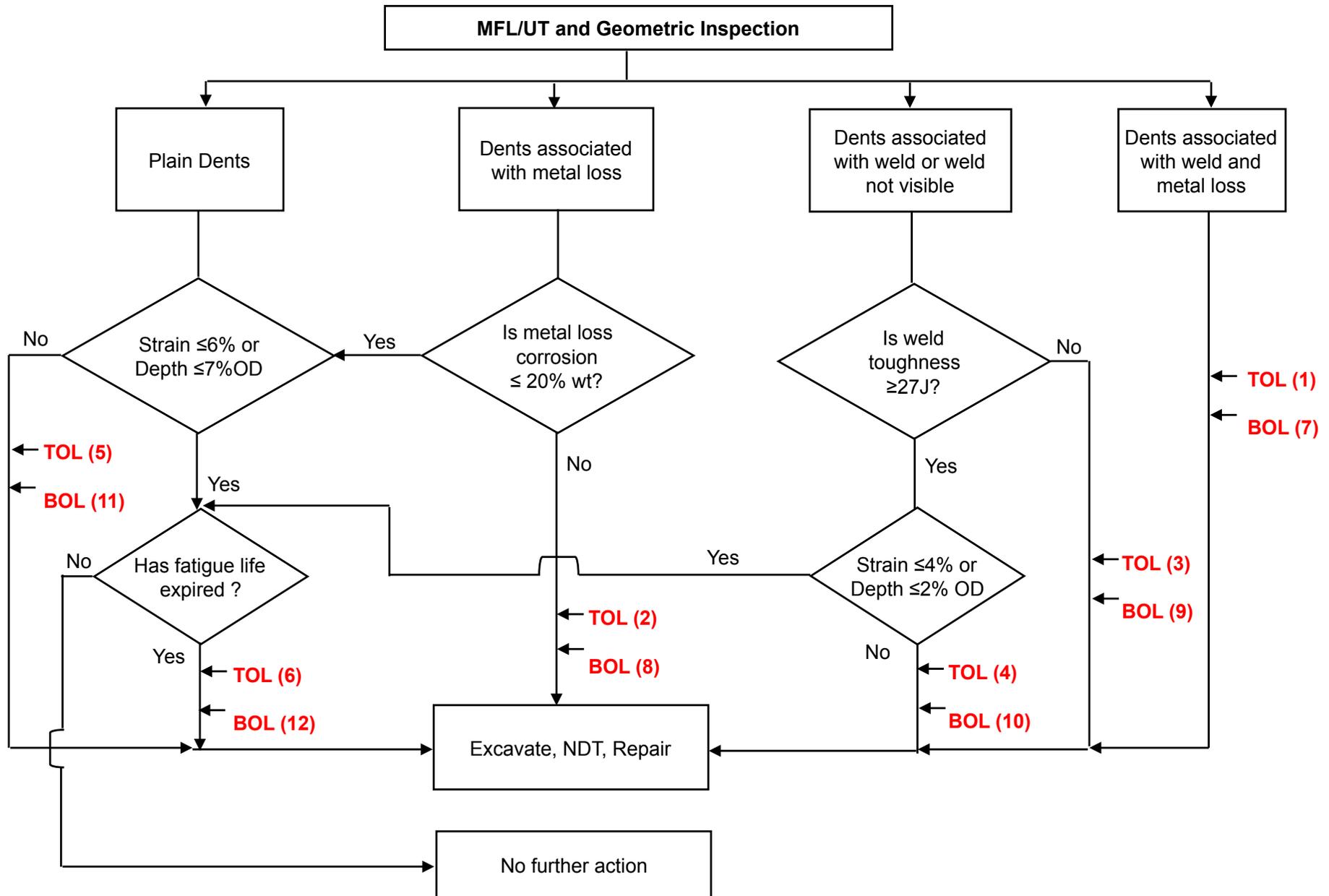
# Distributions of Dent Depths in Operating Pipelines





# Table 1 – Prioritisation Rationale – MFL/UT Inspection

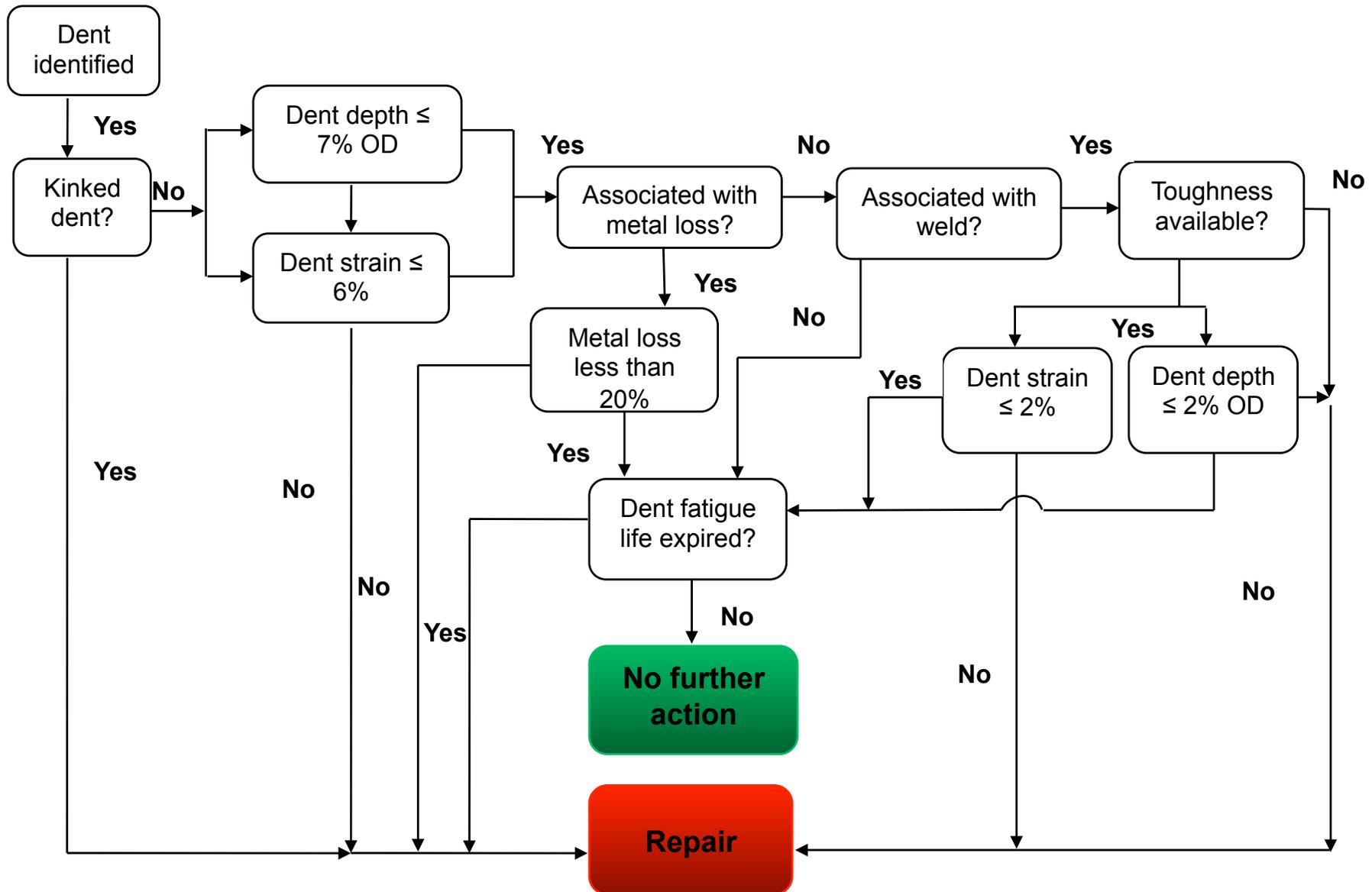
Description	Priority for Investigation	Additional guidance
Dent associated with metal loss and weld, TOL	1	Excavate, NDT, repair or geometric inspection
Dent associated metal loss which is not corrosion, TOL	2	Excavate, NDT, repair or geometric inspection
Dent associated with weld or weld not visible, weld toughness < 27J, TOL	3	Excavate, NDT, repair or geometric inspection
Dent associated with weld or weld not visible, weld toughness ≥ 27J, TOL	4	Excavate, NDT, repair or geometric inspection
Plain dent associated with coating damage, TOL	5	Excavate, NDT, repair or geometric inspection
Dent associated with metal loss and weld, BOL	6	Check CIPS and DCVG data. Check for any evidence of local ground movement, backfill disturbance, and washout. If yes, reprioritise as 1.
Dent associated metal loss which is not corrosion, BOL	7	Check CIPS and DCVG data. Check for any evidence of local ground movement, backfill disturbance, washout. If yes, reprioritise as 2.
Dent associated with weld or weld not visible, weld toughness < 27J, BOL	8	Check CIPS and DCVG data. Check for any evidence of local ground movement, backfill disturbance, and washout. If yes, reprioritise as 3.
Dent associated with weld or weld not visible, weld toughness ≥27J, BOL	9	Check CIPS and DCVG data. Check for any evidence of local ground movement, backfill disturbance, and washout. If yes, reprioritise as 4.
Plain dent associated with coating damage, BOL	10	Excavate, NDT, repair or geometric inspection
Plain Dent, no evidence of coating damage, TOL	11	Excavate, NDT, repair or geometric inspection
Plain Dent, no evidence of coating damage, BOL	12	Excavate, NDT, repair or geometric inspection



## Table 2 – Prioritisation Rationale – MFL/UT + Geometric Inspection

Description	Priority for Investigation	Additional guidance
Dent associated with metal loss and weld, TOL	1	Excavate, NDT, repair (or refer for assessment)
Dent associated metal loss which is not corrosion, TOL	2	Excavate, NDT, repair (or refer for assessment)
Dent associated with weld or weld not visible, weld toughness < 27J, TOL	3	Excavate, NDT, repair (or refer for assessment)
Dent associated with weld or weld not visible, weld toughness ≥ 27J, strain > 4%, depth > 2% OD, TOL	4	Excavate, NDT, repair (or refer for assessment)
Plain dent, strain > 6%, depth > 7% OD, TOL	5	Excavate, NDT, repair (or refer for assessment)
Plain dent, strain ≤ 6%, depth ≤ 7% OD, fatigue life expired, TOL	6	Excavate, NDT, repair (or refer for assessment)
Dent associated with metal loss and weld, BOL	7	Excavate, NDT, repair (or refer for assessment)
Dent associated metal loss which is not corrosion, BOL	8	Excavate, NDT, repair (or refer for assessment)
Dent associated with weld or weld not visible, weld toughness < 27J, BOL	9	Excavate, NDT, repair (or refer for assessment)
Dent associated with weld or weld not visible, weld toughness ≥ 27J, strain > 4%, depth > 2% OD, BOL	10	Excavate, NDT, repair (or refer for assessment)
Plain dent, strain > 6%, depth > 7% OD, BOL	11	Excavate, NDT, repair (or refer for assessment)
Plain dent, strain ≤ 6%, depth ≤ 7% OD, fatigue life expired, BOL	12	Check CIPS and DCVG data. Check for any evidence of local ground movement, backfill disturbance, and washout. If yes, reprioritise as 6. Excavate, NDT, repair (or refer for assessment)
Plain dent, strain ≤ 6%, depth ≤ 7% OD, fatigue life OK	No further action	

# Dent Assessment Algorithm



**Table 3 – Criteria applied to Assessment of Dents in Gas and  
Liquid Pipelines**

Criterion		Reference Source
Plain dent – maximum depth <sup>1</sup>	7% OD	EPRG, PDAM
Plain dent strain – maximum strain <sup>1</sup>	6%	ASME B31.8 <sup>2</sup>
Dent associated with ductile <sup>3</sup> weld – maximum depth <sup>1</sup>	2% OD	ASME B31.8 <sup>2</sup>
Dent associated with ductile <sup>3</sup> weld – maximum strain <sup>1</sup>	4%	ASME B31.8 <sup>2</sup>
Dent associated with metal loss due to corrosion	If corrosion $\leq$ 20% wt, treat as plain dent	UKOPA Member procedures <sup>4</sup>

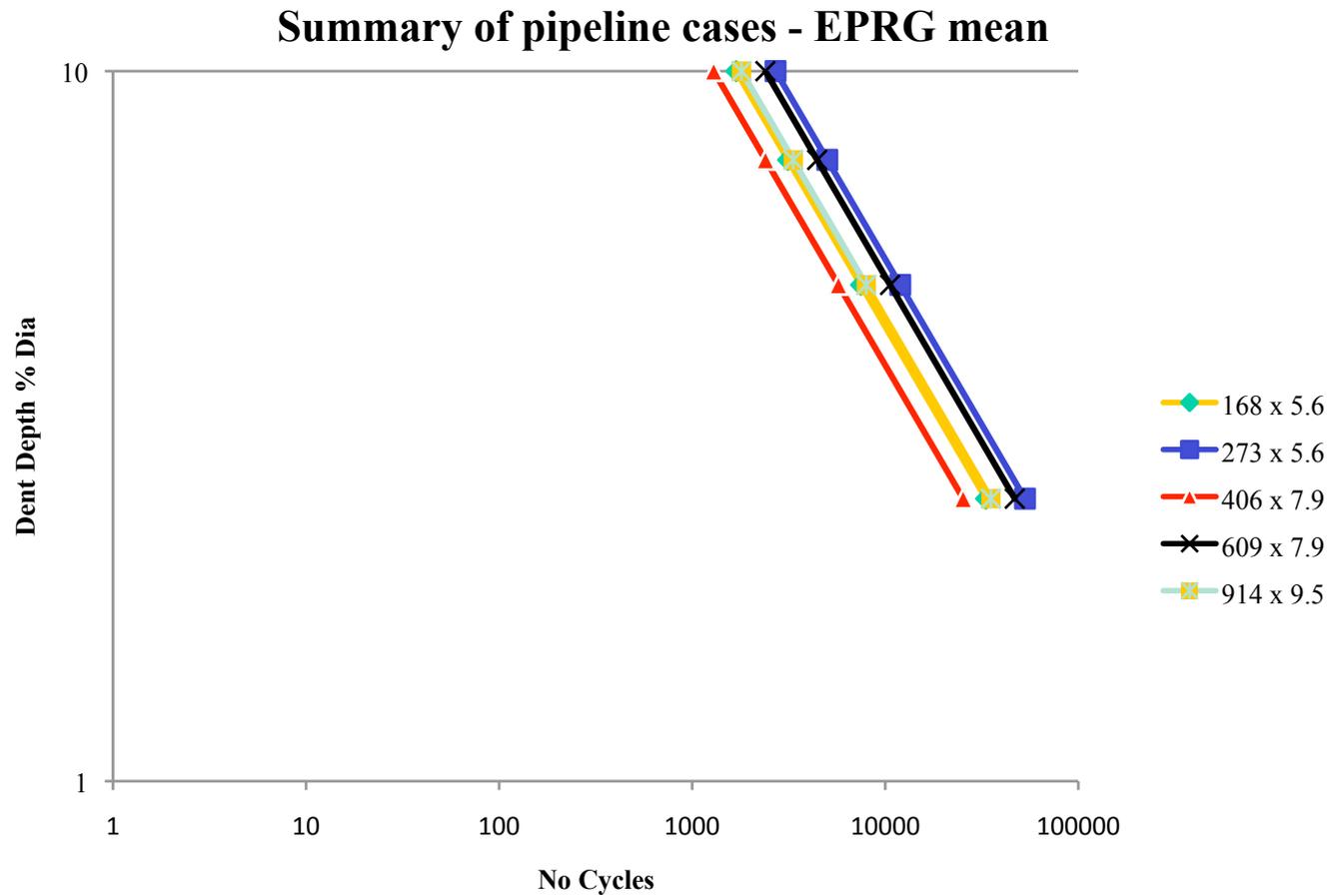
Notes:-

- 1 Where both dent depth and depth strain are available, dent depth should be used to prioritise dents.
- 2 ASME B31.8 addresses gas pipelines, integrity criteria are assumed to apply to all products.
- 3 Ductile weld Charpy energy  $\geq$  27J (full size)
- 4 Corrosion limit is proposed based on that applied by a number of UKOPA member companies and is being checked as part of the future work to develop the UKOPA Dent Management Strategy. The accepted code limit is 12% wt depth.

# Simple Dent Assessment Rules

- Kinked dents (eg wrinkles) – repair
- Static assessment of dents – depth/strain limits
- If pipeline is pressure cycled – assess dent location for damage:-
  - TOL – coating damage (DCVG/Pearson)
  - BOL – disturbance, washout etc
- BOL dents in rocky locations should be monitored not excavated
- Dents associated with welds  $\leq 2\%$  dia - acceptable if weld toughness & quality are acceptable
- New dent features identified between MFL/UT inspections - investigate

# Pipelines with Dents - Fatigue Assessment



# Pipelines with Dents - Fatigue Assessment

Plain dent depth % dia	Fatigue life assessment	
	EPRG Mean	EPRG Lower Bound
2.5	Similar to design life of undented pipeline	10% of design life for undented pipeline
5	Reduced to 20%	Reduced to 2%
7.5	Reduced to 10%	Reduced to 1%
10	Reduced to 5%	Reduced to 0.5%

**Paper No IPC2010-31588**

**UKOPA Dent Assessment  
Algorithms: A Strategy for  
Prioritising Pipeline Dents**

Julia M Race – Newcastle University, UK

Jane V Haswell – Pipeline Integrity Engineers

Robert Owen – National Grid plc

Barry Dalus – Northern Gas Networks Ltd

# Response to IPC Paper

## General:-

- Operators are concerned about how to prioritise and dent features identified by ILI
- Knowledge gaps identified by UKOPA are recognised by experts and operators
- Work being proposed and carried out by UKOPA is not being carried out elsewhere.

## Detailed:-

- High Quality ERW pipe – seam weld not visible – treat as plain dents?
- Consideration of dents with SCC?
- Development/availability of software for dent prioritisation?

# Future Work

- Collation and review of dent investigation data
- Consideration of effect of pressure and tool accuracy on dent sizing by geometric tools
- Development and application of dent strain & stress concentration factors
- Fatigue model
- Case Studies