Use and Application of Results:
Defect Assessment.

Phil Hopkins

Technical Director

Penspen Ltd., Newcastle, UK

UKOPA

20th June 2007

Presentation

- Why do Pipelines Fail?
- Inspection of Pipelines
- Defect Limits/Standards
- User Competency.

Pipelines Fail

Carlsbad, New Mexico, August 2000

failure in a gas pipeline due to microbial internal corrosion

Pipelines Fail

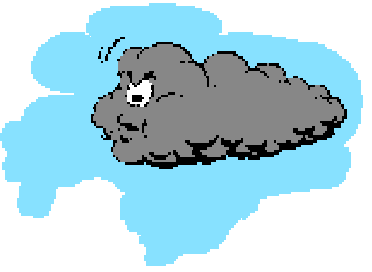
Ghislengien, Belgium, July 2004

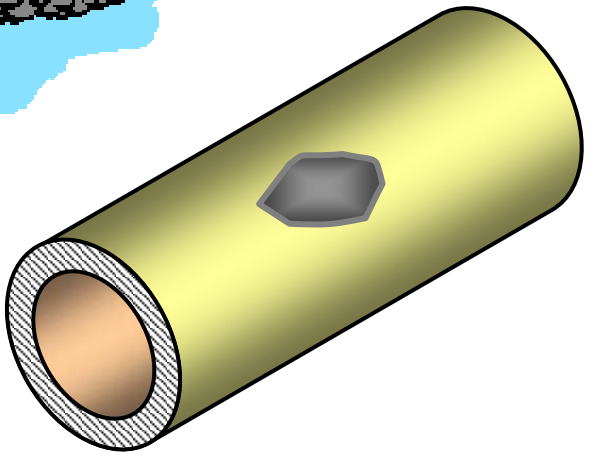
Failure in a gas pipeline due to mechanical damage

Pipelines Fail

Pipelines Fail… Why?

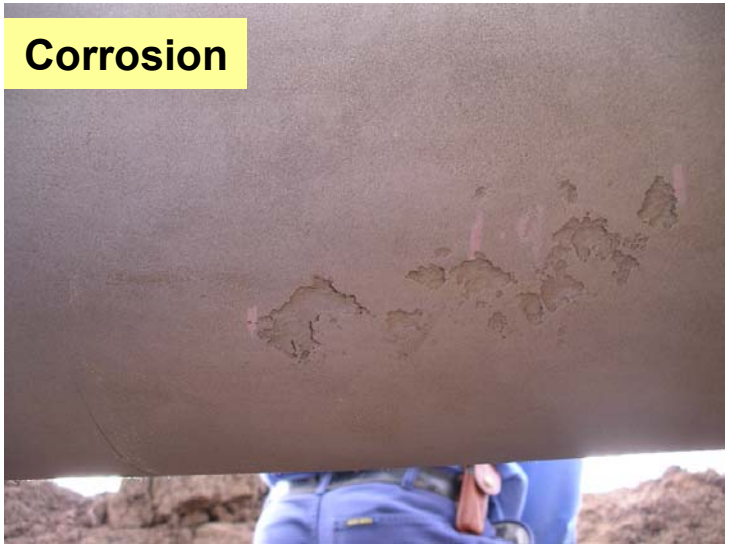
- Pipeline will have high reliability if it is correctly designed, maintained and operated.
- Pipelines can fail due to:
  - natural disasters,
  - gross human error,
  - sabotage/wars,
  - existing defects in a new pipeline, or
  - defects introduced during operation.
- Engineers can do little to prevent (i) to (iii).

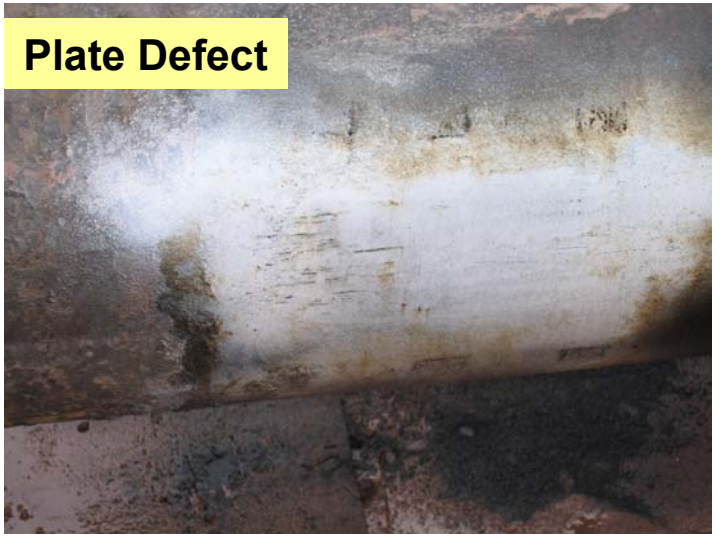


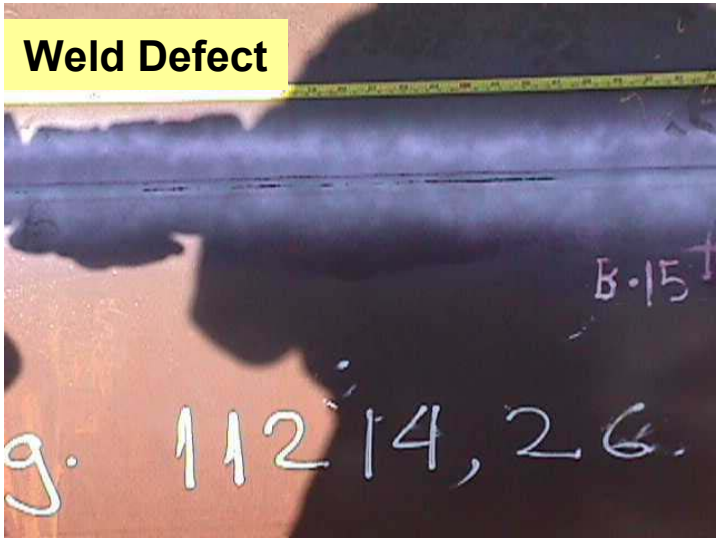


Therefore, engineers maintain the safety of a pipeline by prevention, or elimination, of defects that can cause failure.

Pipelines Fail… from ‘defects’

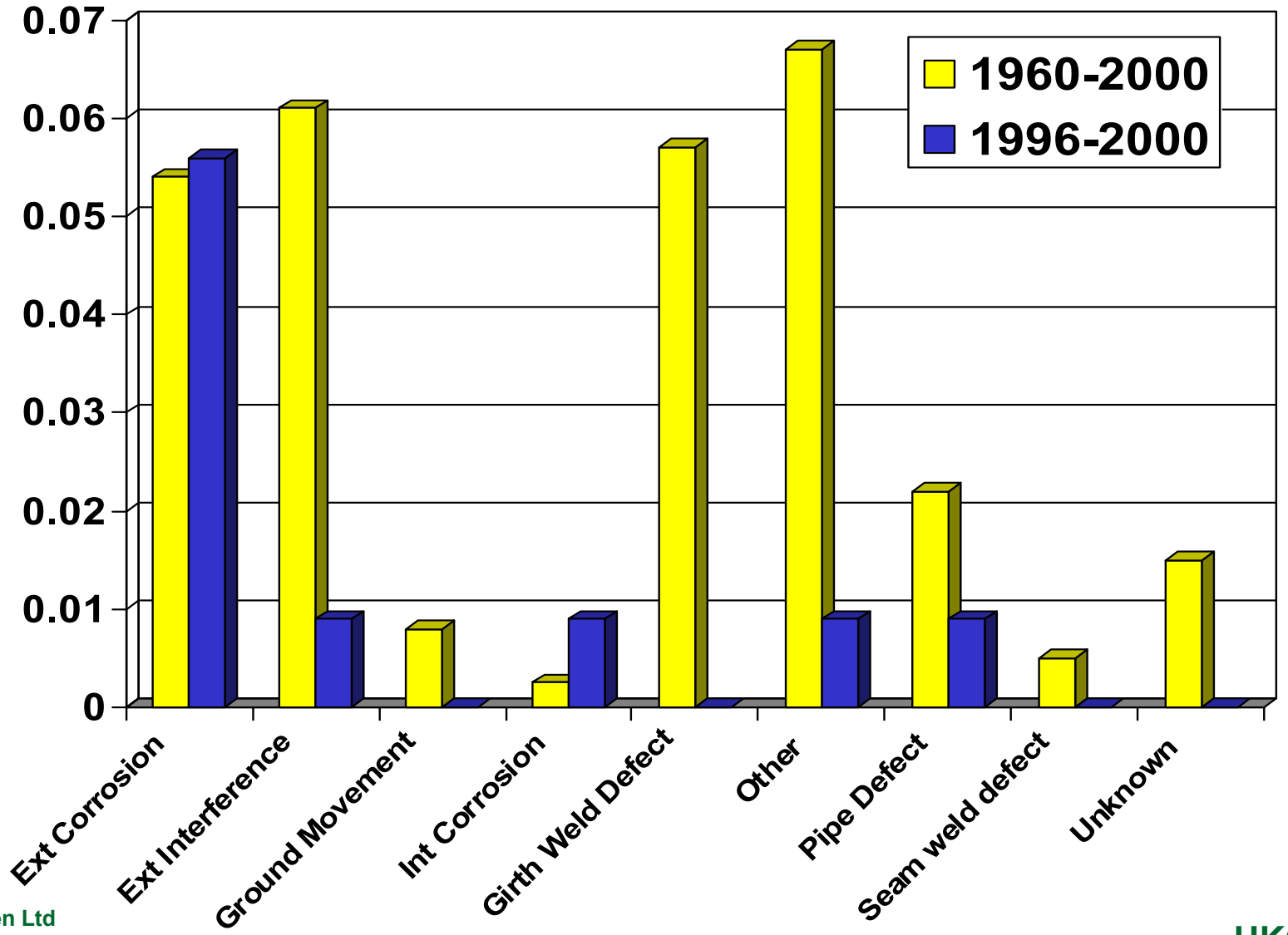






Pipelines Fail… Causes

Frequency per 1000 km.yr

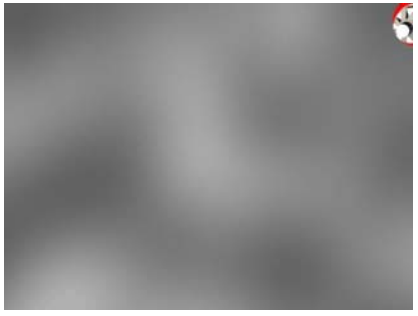


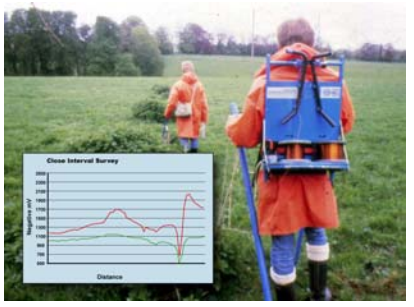
Presentation

- Why do Pipelines Fail?
- Inspection of Pipelines
- Defect Limits/Standards
- User Competency.

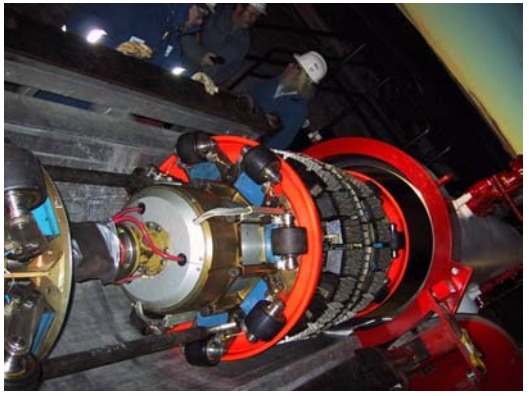
Pipeline Inspection… types

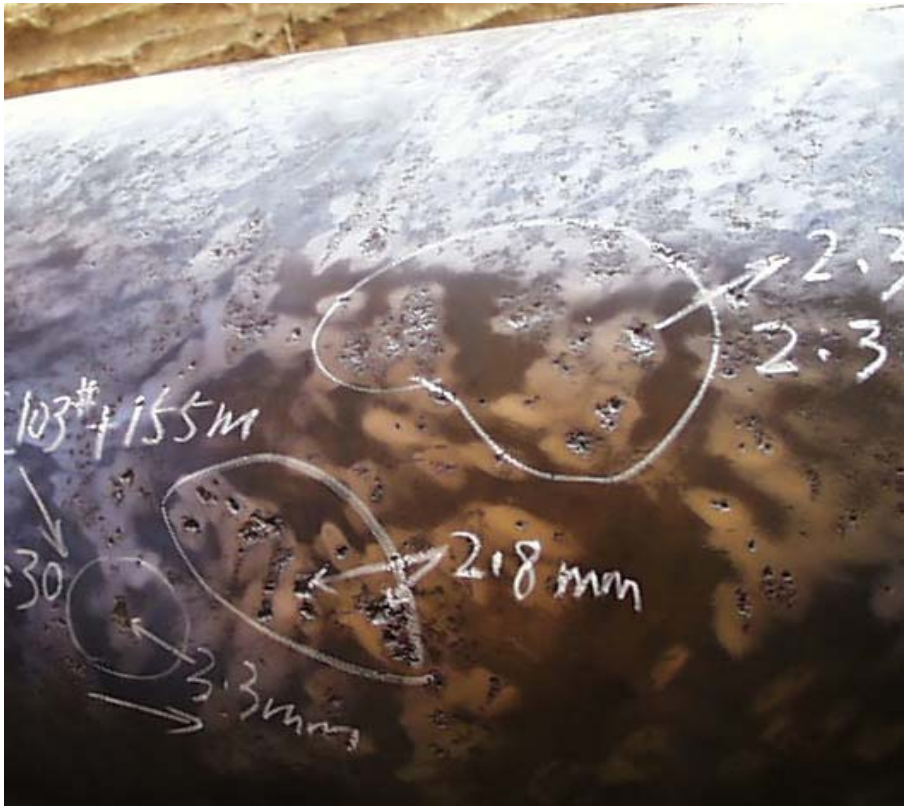
- The industry has 4 categories of inspecting (‘assessing’) our pipelines:
  - In-line inspection, using smart pigs;
  - Hydrotesting;
  - ‘Direct Assessment’;
  - ‘Other’ technologies – this allows new & future technologies.



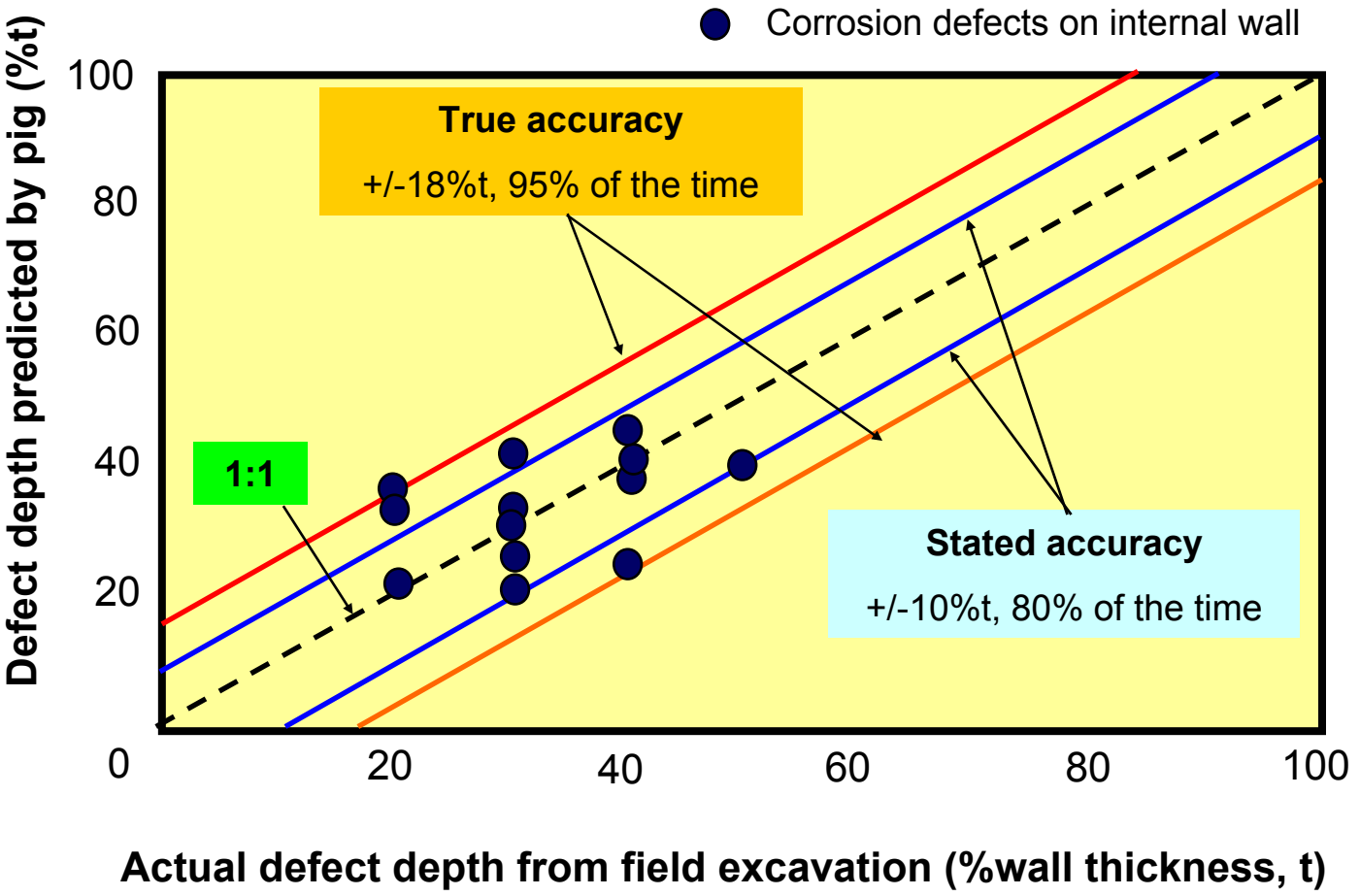


Pipeline Inspection… smart pigs



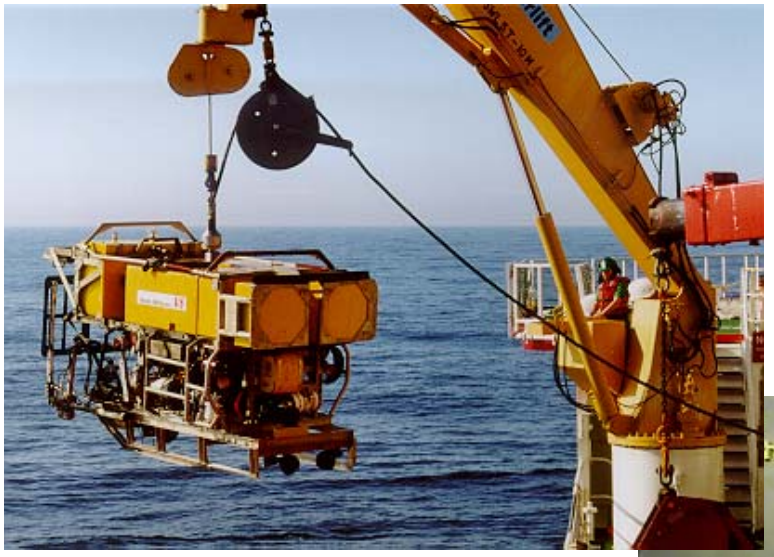


Pipeline Inspection



Pipeline Visual Inspection

Pipeline Visual Inspection



In-line Inspection Standards

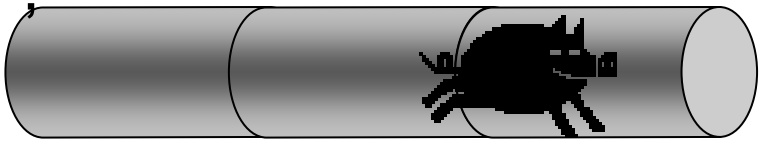
- API 1163
  - "In-Line Inspection Systems Qualification Standard'. August 2005. Ed. 1.

American Petroleum Institute

- NACE RP0102-2002
  - "Standard Recommended Practice, In-Line Inspection of Pipelines", 2002

NACE INTERNATIONAL THE CORROSION SOCIETY

- ASNT ILI-PQ-2005
  - In-Line Inspection Personnel Qualification and Certification", ANSI.ASNT ILI-PQ-2005



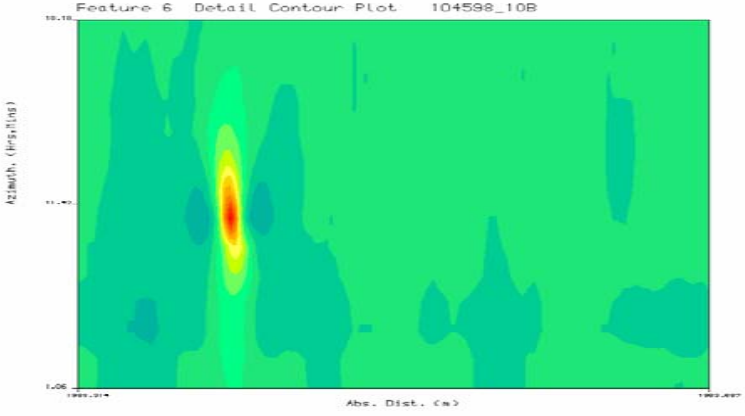
Presentation

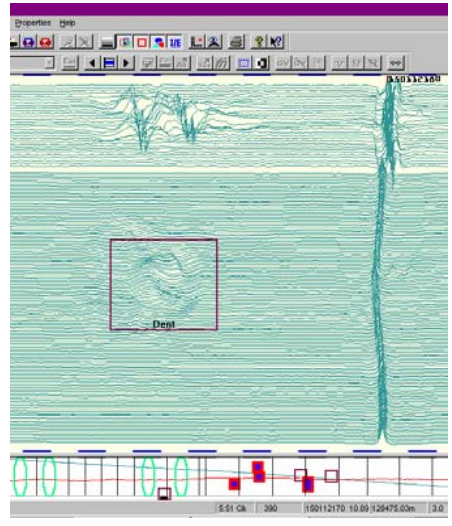
- Why do Pipelines Fail?
- Inspection of Pipelines
- Defect Limits/Standards 
- User Competency.

Pipeline Defect Assessment

We rarely assess a ‘defect’… we usually assess a defect report.

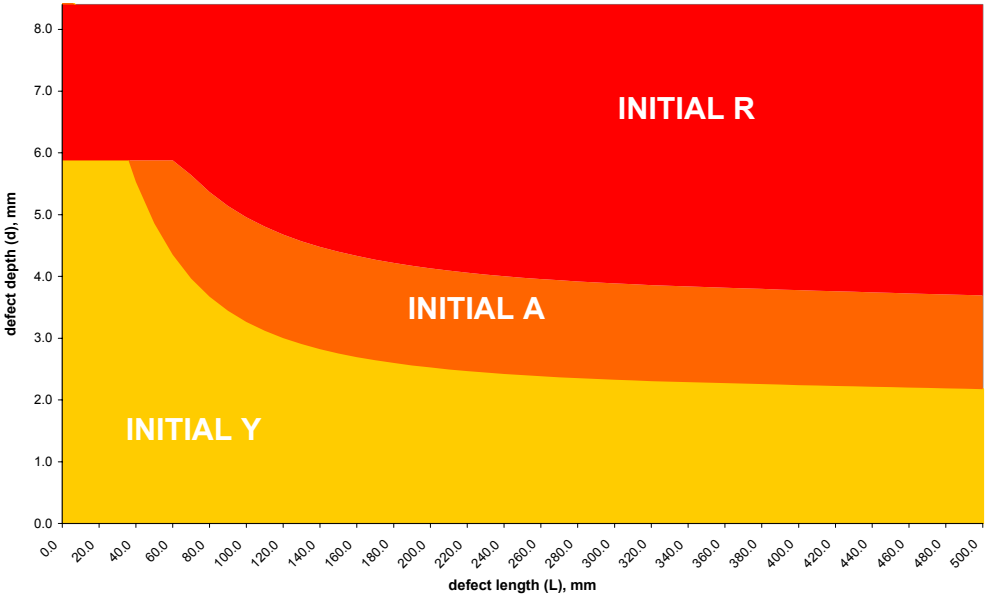
Rubbish in…. Rubbish out!





Defect Assessment

- Guidance exists:
  - Generic Standards: e.g. BS 7910, API 597
  - Screening: e.g. ASME B31G, NG's 'P11'
  - Regulations: e.g. USA
- Industry-specific, best practice: 'PDAM'



Defect Assessment… Regulations

IMMEDIATE REPAIR	EVALUATE & REPAIR	
	Within 60 days of discovery	*Within 180 days of discovery*
-Defect has predicted BURST pressure <established MOP (e.g. ASME B31G) -Metal loss >80% wt -Dents on top of line (4-8 o'clock) with depth >6% nom. pipe diameter -Dents on top of line (4-8 o'clock) containing any defect -Any other defect considered serious	-All dents on top of pipeline with depth >3% pipe diameter (or >0.25" for NPS of < 12") -Dent in bottom of pipe with any stress raiser, crack or metal loss	-Defect has predicted (e.g. by RSTRENG) 'operating' pressure <current established MOP -Dents > 2% pipe diameter (or 0.25" for NPS less than 12") containing a weld -Dents > 2% pipe diameter (or 0.25" for NPS less than 12") at top (4-8 o'clock) of pipe -Dents at bottom of pipe of depth > 6% pipe diameter -Corrosion > 50% nominal wt, -Corrosion of, or along, a longitudinal seam weld -Metal loss > 50% @ pipeline crossings, with widespread circumferential extent, or at girth weld -Possible Crack, that is confirmed by excavations -Gouges/groove > 12.5% nominal wt

Assessments needed…

- Defect-Free Pipe
- Corrosion
- Gouges
- Plain Dents
- Kinked Dents
- Smooth Dents on Welds
- Smooth Dents containing Gouges
- Smooth Dents containing other types of defect
- Manufacturing Defects in the Pipe Body
- Girth Weld Defects
- Seam Weld Defects
- Cracking
- Environmental Cracking

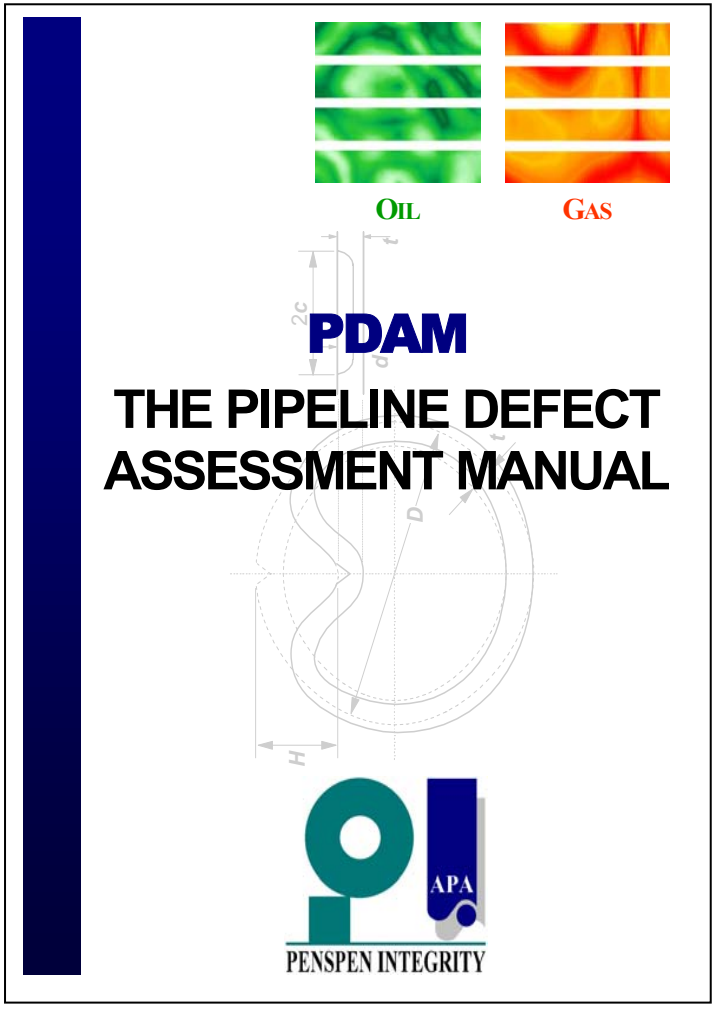
The Pipeline Defect Assessment Manual (PDAM)

PDAM: A Joint Industry Project

- JIP
- £25000 one-off payment
- Commenced 1999, ongoing
- 'Best practice' in defect assessment
- Sponsors:

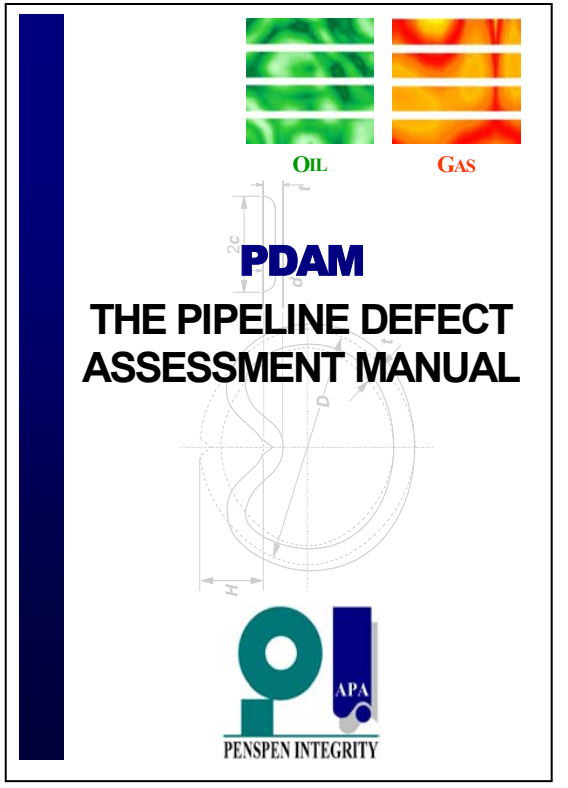
Advantica (NG),
BP,
CSM
Chevron Texaco,
DNV,
Saipem,
Gaz de France,
HSE

MOL,
GE-PII,
Petrobras,
Promigas,
SNAM,
Statoil,
Total,
Toho Gas,
Shell



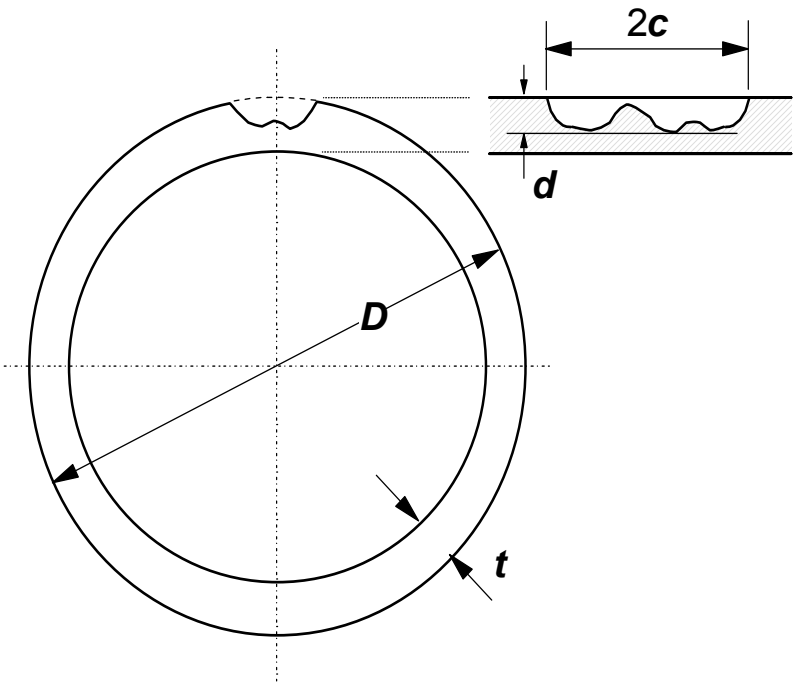
PDAM: Contents

- Background and guidance notes for assessing each type of damage.
- A treatment of model and other uncertainties.
- Safe Working Practices (pressure reductions to avoid time dependent failures).
- General guidance on measuring damage.
- General guidance on appropriate repair methods.
- Simple excel spreadsheets for easy implementation of the ‘best’ methods.



PDAM: Defects considered

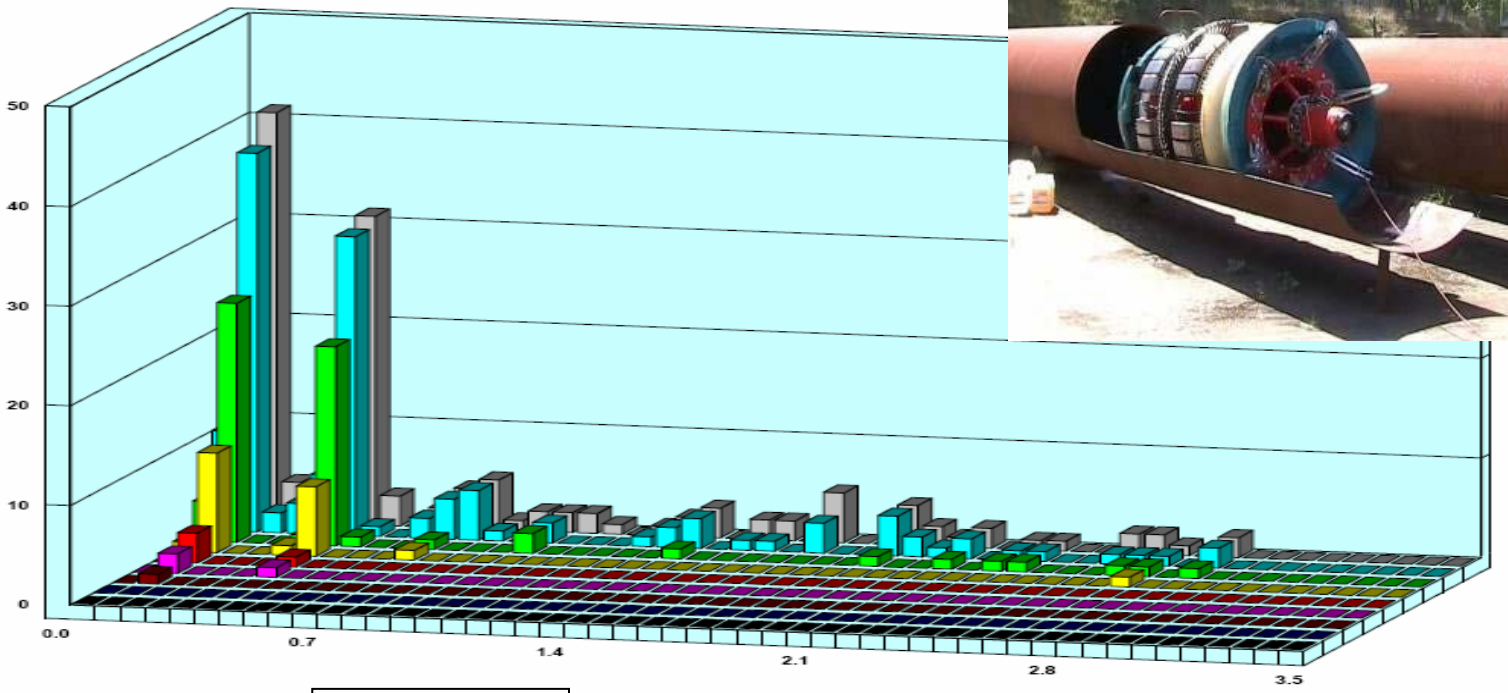
- Defect-Free Pipe
- Corrosion
- Gouges
- Plain Dents
- Kinked Dents
- Smooth Dents on Welds
- Smooth Dents containing Gouges
- Smooth Dents containing other types of defect
- Manufacturing Defects in the Pipe Body
- Girth Weld Defects
- Seam Weld Defects
- Cracking
- Environmental Cracking

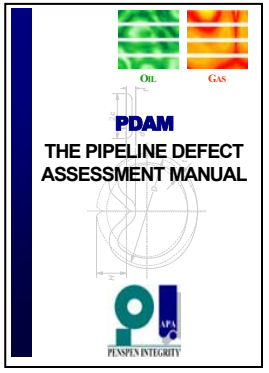


PDAM: Defects considered

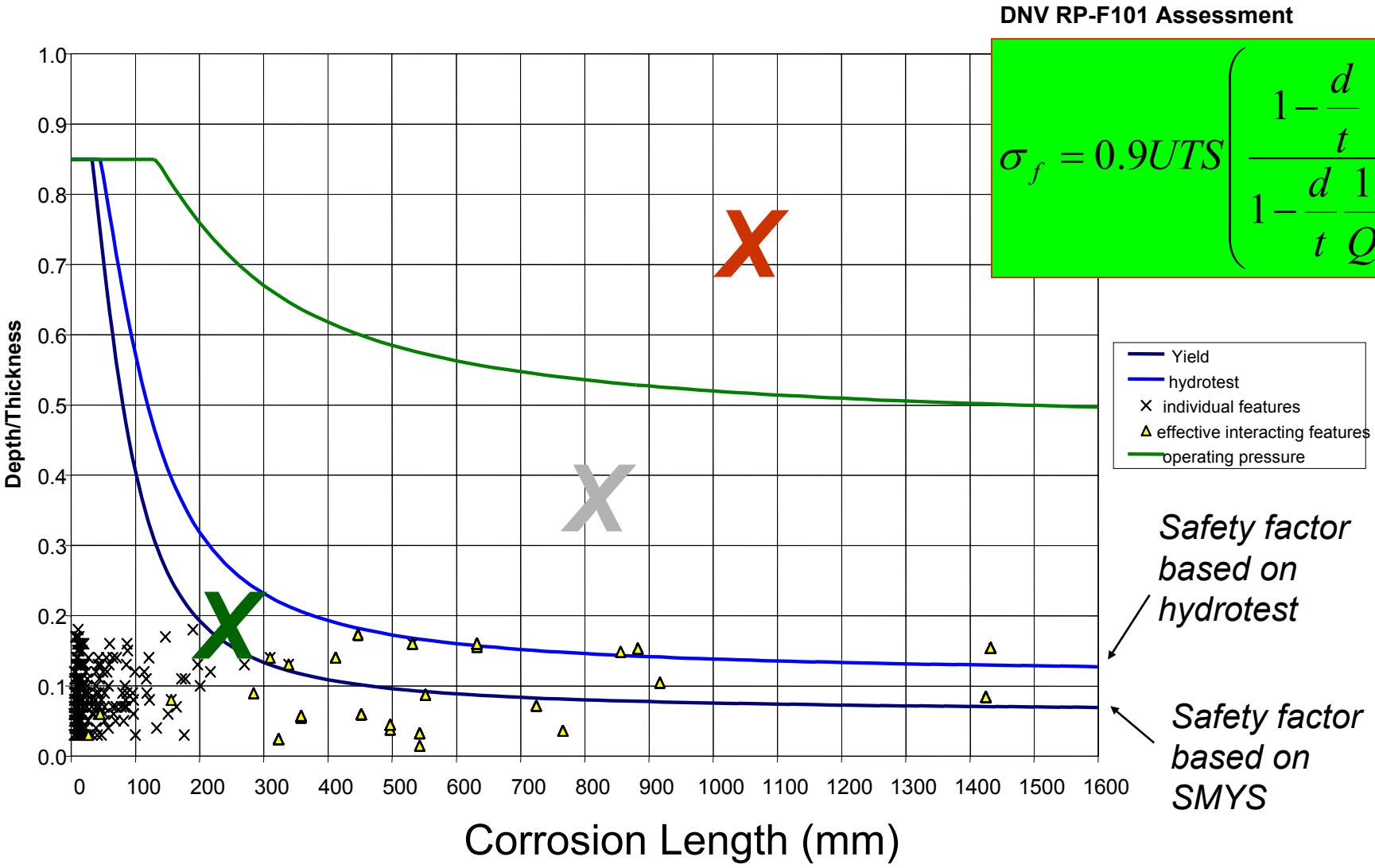
- PDAM will tell you when an assessment method is poor or non-existent.
- As pigs get better, more defects are being detected, and defect assessment methods are not keeping pace

PDAM: Example

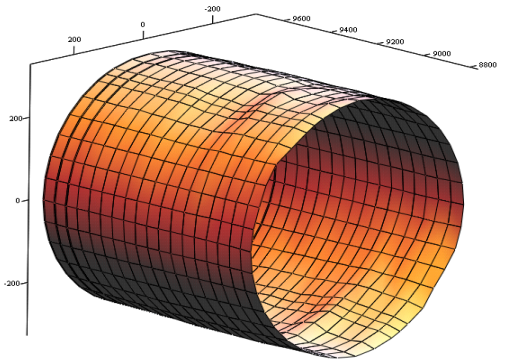


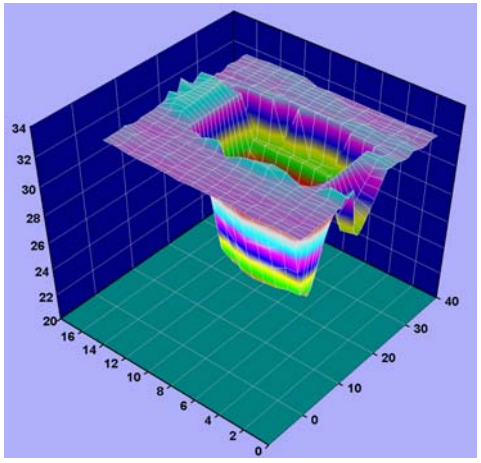


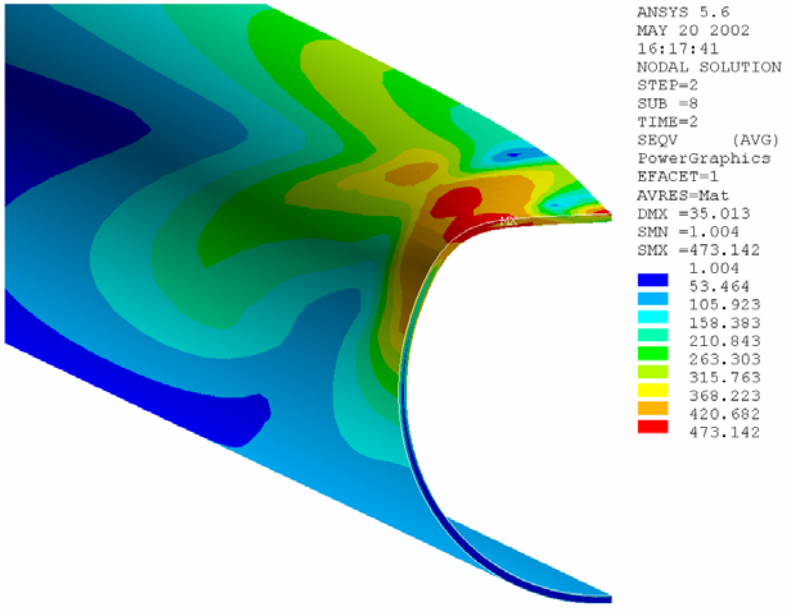
PDAM: Example



PDAM: Expert level







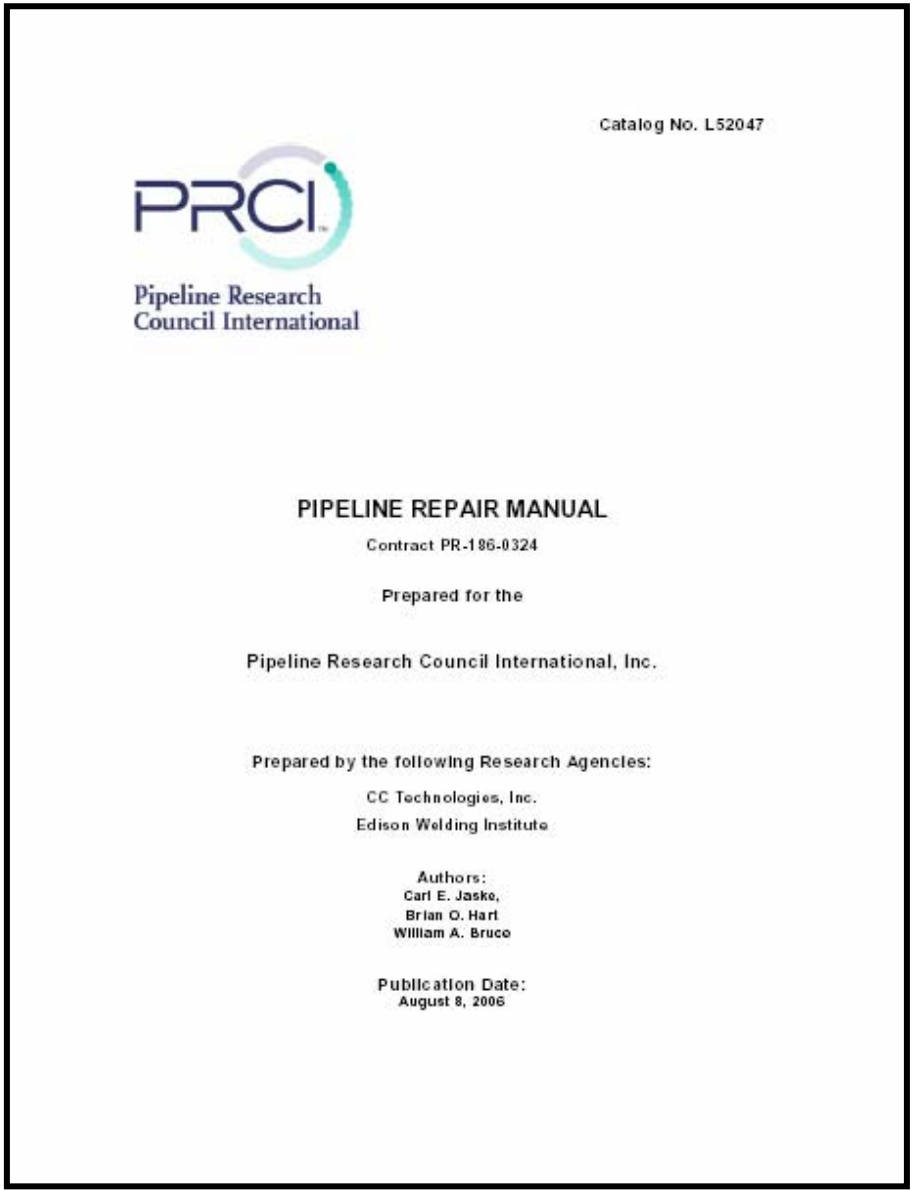
PDAM: Warning

Gas pipeline failure

PDAM: NB!

- There has been comparatively little research conducted on defect assessment in the past 15 years (dramatic drop in research funding).
- This contrasts with huge advances in inspection technologies (commercially-driven)
- Inspection now leads assessment!
- Don't be surprised if you detect a defect that cannot be assessed!

Defect Repair



Catalog No. L52047

Pipeline Research Council International

PIPELINE REPAIR MANUAL

Contract PR-186-0324

Prepared for the

Pipeline Research Council International, Inc.

Prepared by the following Research Agencies:

CC Technologies, Inc.

Edison Welding Institute

Authors:
Carl E. Jaske,
Brian O. Hart
William A. Bruce

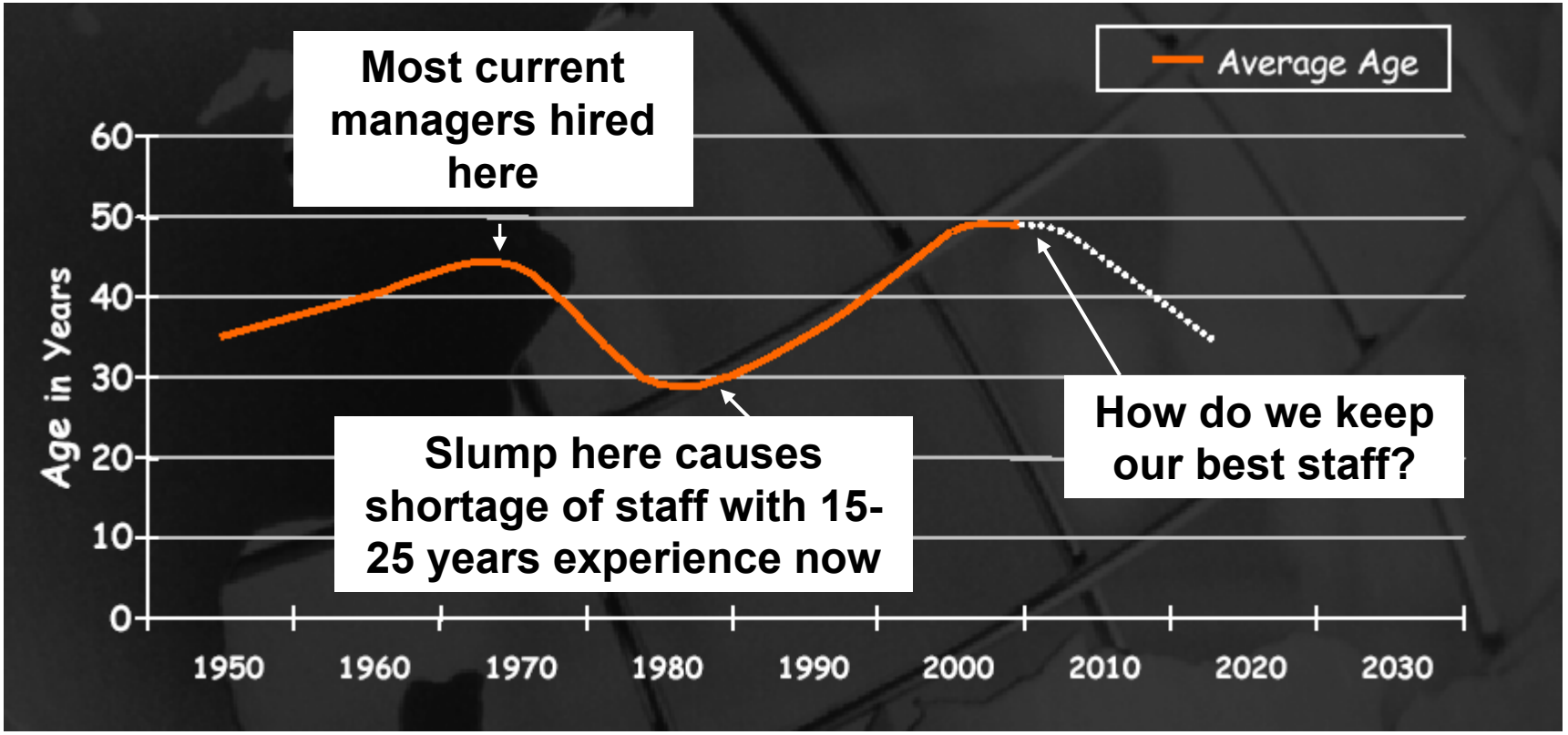
Publication Date:
August 8, 2006

Presentation

- Why do Pipelines Fail?
- Inspection of Pipelines
- Defect Limits/Standards
- User Competency.

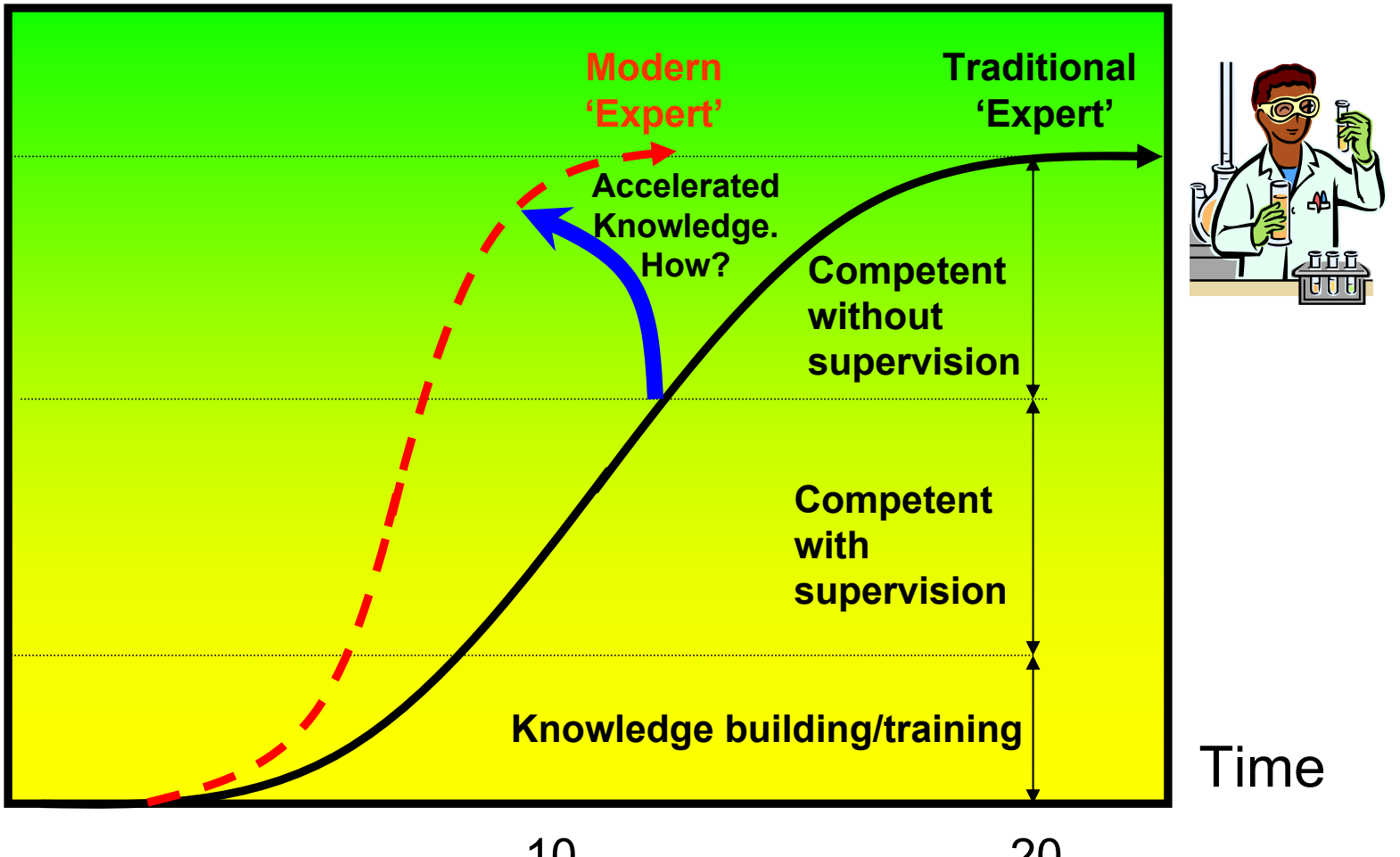
Age Profile

- Three quarters of companies in the oil and gas business are having difficulty recruiting staff
- In the UK, 25,000 engineers retire annually and only 12,000 graduates replace them.



Competency… changing!

- Price for a mile of 36” pipeline in the USA has risen from $US1.5million/mile in 2003 to $US2.5million/mile in 2005, primarily due to the increase in price of steel, and a scarcity of qualified workers.



Competency… UK's EC Skills

Knowledge and understanding	
Application to practice	
Leadership and management	
Interpersonal skills	

Competency… UKOPA Requirements

Health, Safety and Environment	✓
Operations	✓
Mechanical Maintenance	✓
E&I Maintenance	✓
Specialist Services	✓

Competency… How? Four stages?

Educated	e.g. accredited qualification	✓
Trained	e.g. CEng/IEng & CPD	✓
Experienced	structured, with mentoring	✓
Ready!	with QA and support	✓

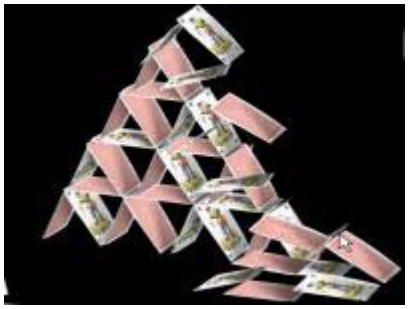
Competency… what to do?

- To improve competency levels, and accelerate development:
  - Undergraduate engineers should be offered both oil and gas, or pipeline, engineering options in their final year of study.
  - Post graduate courses in pipeline engineering are needed
  - Engineers need ‘life-long learning’.
    - Structured modular training courses are needed.
    - Distance learning is the best route

What Next?

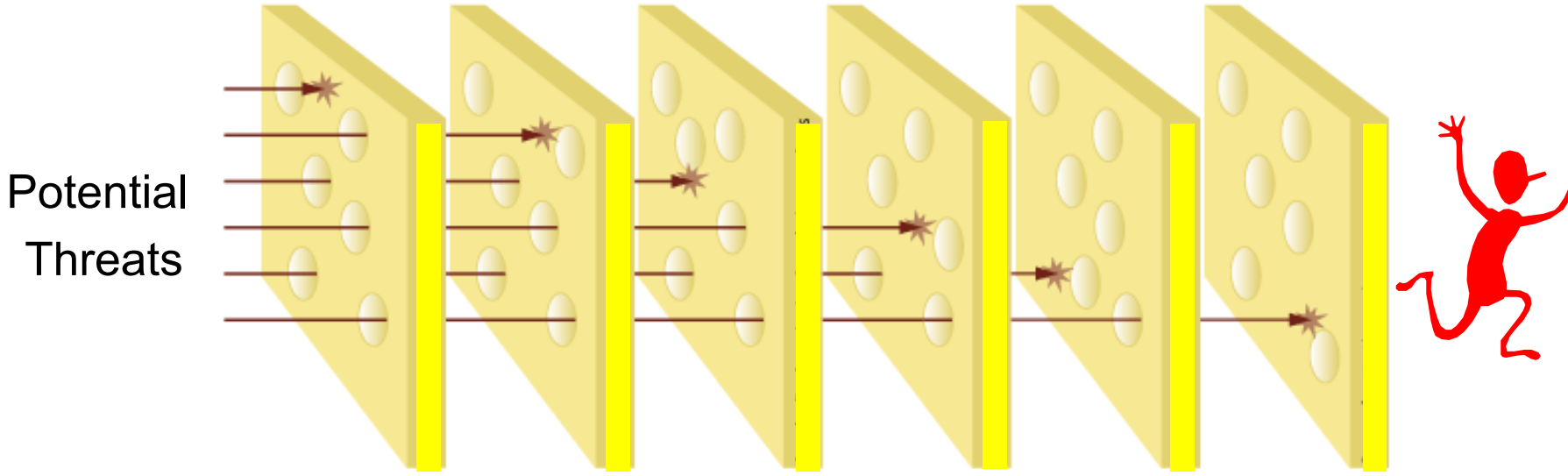
Competency… + ignorance

- Management must be careful…
- Incidents, and the resulting crises, are sometimes attributed to a combination of:
  - An accumulation of flaws in an organisation that provide the process for an incident (e.g. the 'Swiss cheese' model);
  - The development of managerial ignorance or unawareness that leaves managers blind to this accumulation.
- 'Ignorance' has been defined as a manager's (unintentional) inability to notice, and take into consideration, this cumulating effect of an organisations imperfections.



Failures… systems… illustration

- In the ‘Swiss Cheese’ model, an organisation's defences against failure are modelled as a series of barriers, represented as slices of Swiss cheese.
- The holes in the cheese slices represent individual weaknesses in individual parts of the system, and are continually varying in size and position in all slices.



Oil & Gas Majors: 2006

- We need to invest in education and training.

	Company	Revenue ($1000m)	Profit ($1000m)
1	ExxonMobil	378	39.5
2	Shell	319	26.3
3	BP	274	22.3
4	Total	207	16.9
5	Chevron	205	17.1
6	ConocoPhillips	189	15.6

Over to you!

Summary

- Defects fail pipelines
  - Most of these defects can be detected/prevented
  - Most of these defects can be detected/assessed
  - Good, accepted, practical assessment methods exist
  - Repair guidelines exist
- The pipeline business has lost skills, and needs to urgently address competency levels

Close

- Thank you for you attention