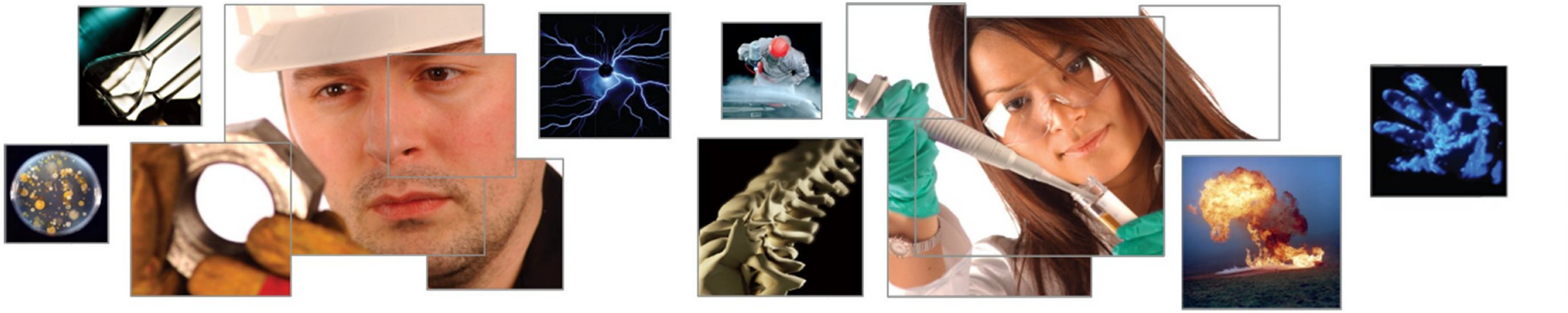
# Pipeline technical meeting

9 November 2009



# Agenda

- Introductions and purpose
- Slabbing
- Depth of cover
- Use of UKOPA data for ethylene pipelines
- Updated operational failure rates
- PIPIN TPA model
- Event tree constants in MISHAP
- Other UKOPA briefing notes
- AOB

# Purpose

- Update UKOPA on progress made with various tasks
- Discuss preliminary findings
- Discuss next steps

# Slabbing (1)

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- RAWG/08/013
- UKOPA requested that HSE consider slabbing as a measure that could be implemented to reduce likelihood of third party interference for buried pipelines
- UKOPA proposed reduction factors for probability slab breached based on Advantica report R8904
  - Rural, slab only – 0.158
  - Rural, slab, tapes and stripes – 0.053

# Slabbing (2)

HEALTH & SAFETY LABORATORY

- HSE asked HSL to consider the justification for these factors
  - Based on British Gas field tests and Advantica reports (R8904 and R6249)
- HSL have considered Advantica work and requested further clarification on the conclusions of these reports
- Advantica agreed to carry out further work looking at the full range of possible machinery in Feb 09
- No further information received

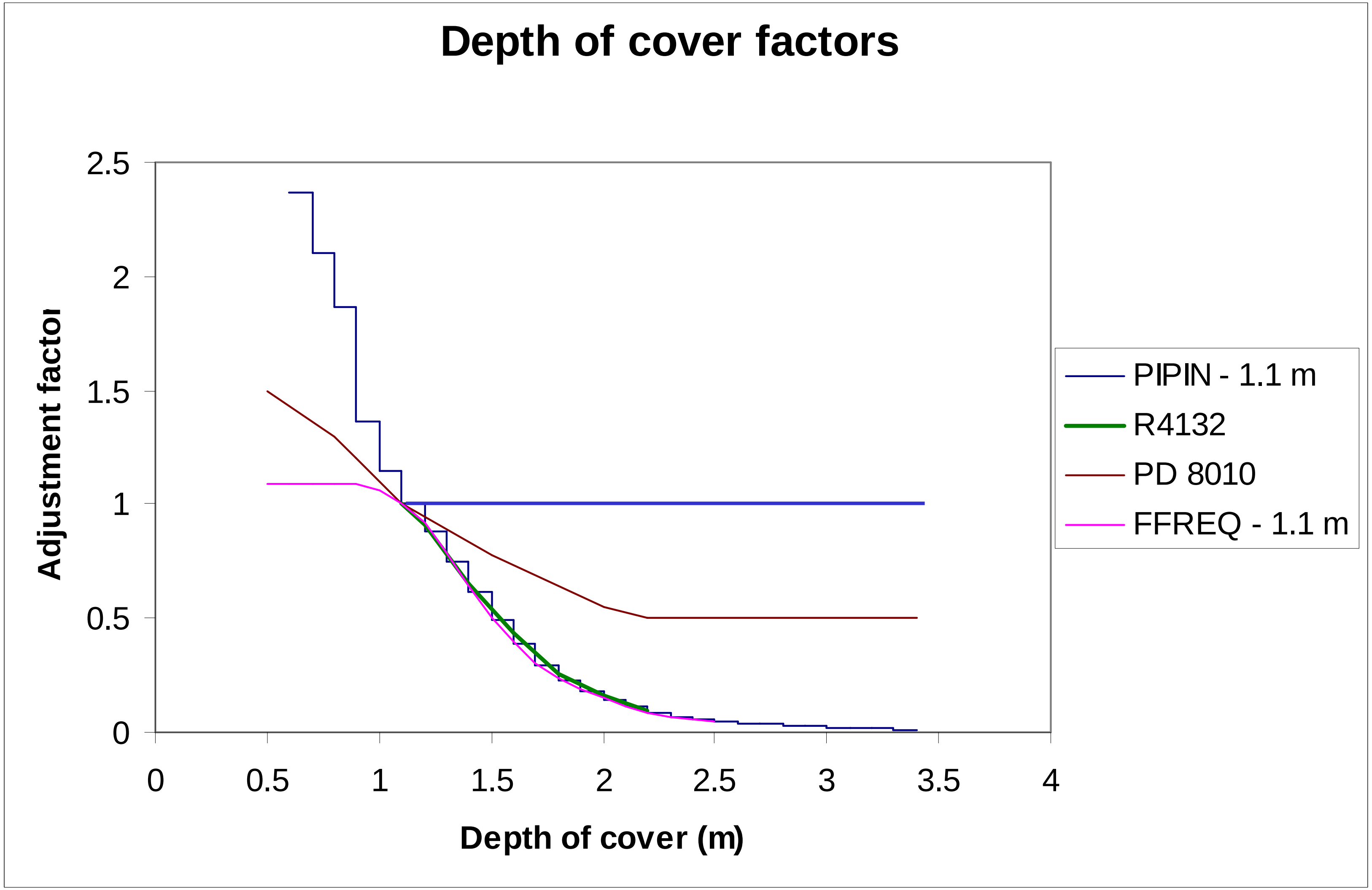
# Depth of cover (1)

- UKOPA briefing note 6 (RAWG/08/017)
- Compares depth of cover factors from various sources
  - Jones & Gye, 1991
  - Corder, 1995
  - WS Atkins (EGIG and Transco data)
  - PIPIN
  - PD8010 supplement
- Recommends HSE apply reduction factors at depths greater than 1.1 m

# Depth of cover (2)

- Current policy in HSE takes no benefit from depth of cover below 1.1 m
- PIPIN has factors up to 3 m
  - From BG Transco?
- BG Transco report calculates factors from 1.1 m to 2.2 m
- These are very similar to those in PIPIN
  - When the latter is renormalised to use a factor of 1 between 1.1 m and 1.2 m
- Below 1.1 m, the values in FFREQ also appear to be the same

# Depth of cover (3)



# Depth of cover (4)

- Supplement to PD 8010-1:2004 is a ‘middle, conservative course’
  - Between those in PCAS Chapter 6O and those used in FFREQ for depths of cover less than 1.1 m
  - Between HSE’s cut-off at 1.1 m and the FFREQ values at depths of cover of 1.1 m or more
- EGIG data gives a factor of 5.1 at depths of cover below 0.8 m
  - In closer agreement with PIPIN than PD 8010 or FFREQ at these depths

# Depth of cover (5)

- Average depth of cover
  - The average depth of cover across the network has been calculated as 1.075 m
    - Rounded to 1.1 m
    - From HSE's Corporate Operational Information System (COIN)
  - UKOPA's fault database gave an average depth of 1.041 m
    - This data is just a subset of COIN
    - An average depth of 1.1 m is recommended

# Depth of cover (6)

- Conclusions and results
  - HSL recommended
    - PD 8010 supplement values be used at depths of cover greater than 1.1 m
    - At depths above this, the existing values be retained
    - The factors should be modified to allow for an average depth of cover of 1.1 m
  - Result
    - Rejected by Panel due to lack of data to support the PD 8010 position

# Ethylene pipelines (1)

- UKOPA briefing note 3 (RAWG/08/014)
- Use of CONCAWE data is overly conservative leading to large zones in land-use planning cases
- CONCAWE data does not contain specific information on ethylene pipelines
- UKOPA data does contain such information although it is relatively sparse
- Increasing pipeline diameter should lower corrosion and mechanical failure rates
- This does not happen with current HSE practice (CONCAWE)

# Ethylene pipelines (2)

- Reviewed work carried out for UKOPA
  - Evidence that construction and maintenance of ethylene pipelines are as good as for natural gas pipelines
  - Analysing the UKOPA database to show fault data for ethylene pipelines is statistically similar to fault data for natural gas pipelines
- UKOPA failure data used to derive failure rates for ethylene pipelines

# Ethylene pipelines (3)

- Comments on the work
  - There appeared to be some inaccuracies in the statistical method
  - Overall results after corrections appear the same
    - With lower confidence levels
    - These confidence levels are still well within the acceptance level

# Ethylene pipelines (4)

- Conclusions
  - The work and the results appeared reasonable
  - HSL proposed to HSE that UKOPA data is used in the future for ethylene pipelines
- Accepted by Panel

# Operational failure rates (1)

- UKOPA briefing note 4 (RAWG/08/015)
  - HSE CONCAWE corrosion data failure rate does not vary with pipeline thickness
  - Recommended
    - HSE reduce corrosion failure rate for non-natural gas pipelines when applied to thicker walled pipelines, similar to natural gas
- UKOPA briefing note 8 (RAWG/08/019)
  - UKOPA noted discrepancies in the WS Atkins analysis used in PIPIN
  - Recommended
    - A more up-to-date assessment of CONCAWE failure data
    - Recognise that CONCAWE data as applying to European experience

# Operational failure rates (2)

- PIPIN currently uses various failure data
  - EGIG
  - CONCAWE
  - UKOPA
- Calculates failure rates for four failure modes
  - Mechanical
  - Corrosion
  - Natural failures (and other)
  - TPA
    - Normally not used as TPA predictive model used in PIPIN

# Operational failure rates (3)



| *Substance* | *TPA* | *Mechanical* | *Natural* | *Corrosion & other* |
|---|---|---|---|---|
| **Natural gas** | **TPA model** (EGIG) | **UKOPA** No variation | **UKOPA** No variation | **EGIG** f(thickness) |
| **Ethylene** | **TPA model** (EGIG) | **CONCAWE PRODUCTS** f(diameter) | **UKOPA** No variation | **CONCAWE PRODUCTS** f(diameter) |
| **Spiked crude** | **TPA model** (EGIG) | **CONCAWE CRUDE** f(diameter) | **UKOPA** No variation | **CONCAWE CRUDE** f(diameter) |
| **Vinyl chloride** | **TPA model** (EGIG) | **CONCAWE PRODUCTS** f(diameter) | **UKOPA** No variation | **CONCAWE PRODUCTS** f(diameter) |
| **LPG** | **TPA model** (EGIG) | **EGIG** No variation | **UKOPA** No variation | **EGIG** f(thickness) |

# Operational failure rates (4)

- Purpose of work
  - The data was, in some cases, over 10 years old
  - Review current failure rates
  - Recommend new failure rates
- Various failure data analysed
  - CONCAWE products data (1987 – 2006)
  - CONCAWE crude data (1987 – 2006)
  - UKOPA data (1988 – 2007)
- EGIG data was unavailable so this has not been updated

# Operational failure rates (5)

- Natural gas
  - UKOPA data for all failure modes
  - EGIG was previously used for corrosion and TPA
- Ethylene
  - UKOPA data for all failure modes
  - Previously
    - CONCAWE products for mechanical and corrosion
    - UKOPA for natural
    - EGIG for TPA
- Spiked crude
  - CONCAWE crude data for mechanical and corrosion
  - UKOPA for natural and TPA
  - EGIG previously used for TPA

# Operational failure rates (6)

- Vinyl chloride
  - CONCAWE products for mechanical and corrosion
  - UKOPA for natural and TPA
  - EGIG previously used for TPA
- Gasoline
  - CONCAWE products for mechanical and corrosion
  - UKOPA for natural and TPA
  - EGIG previously used for TPA
- LPG
  - EGIG for mechanical and corrosion
  - UKOPA for natural and TPA
  - EGIG previously used for TPA

# Operational failure rates (7)

| ***Substance*** | ***TPA*** | ***Mechanical*** | ***Natural*** | ***Corrosion & other*** |
|---|---|---|---|---|
| **Natural gas** | **TPA model**<br>(UKOPA) | **UKOPA**<br>f(diameter) | **UKOPA**<br>No variation | **UKOPA**<br>f(thickness) |
| **Ethylene** | **TPA model**<br>(UKOPA) | **UKOPA**<br>f(diameter) | **UKOPA**<br>No variation | **UKOPA**<br>f(thickness) |
| **Spiked crude** | **TPA model**<br>(UKOPA) | **CONCAWE CRUDE**<br>No variation | **UKOPA**<br>No variation | **CONCAWE CRUDE**<br>No variation |
| **Vinyl chloride** | **TPA model**<br>(UKOPA) | **CONCAWE PRODUCTS**<br>No variation | **UKOPA**<br>No variation | **CONCAWE PRODUCTS**<br>f(diameter) |
| **LPG** | **TPA model**<br>(UKOPA) | **EGIG**<br>No variation | **UKOPA**<br>No variation | **EGIG**<br>f(thickness) |
| **Gasoline** | **TPA model**<br>(UKOPA) | **CONCAWE PRODUCTS**<br>No variation | **UKOPA**<br>No variation | **CONCAWE PRODUCTS**<br>f(diameter) |

# Operational failure rates (8)

- Recommendations to HSE
  - Updated failure rates should be used
  - Failure rates should be updated on a regular basis
- Revised failure rates accepted by Panel

# PIPIN TPA model (1)

- UKOPA briefing note 5 (RAWG/08/016)
  - PIPIN TPA model overestimates failure rates for small diameter pipelines
    - Comparison with UKOPA data
    - Comparison with FFREQ
  - Recommendation
    - Take account of the over-prediction for smaller diameter pipelines when re-considering the 3rd party activity model

# PIPIN TPA model (2)

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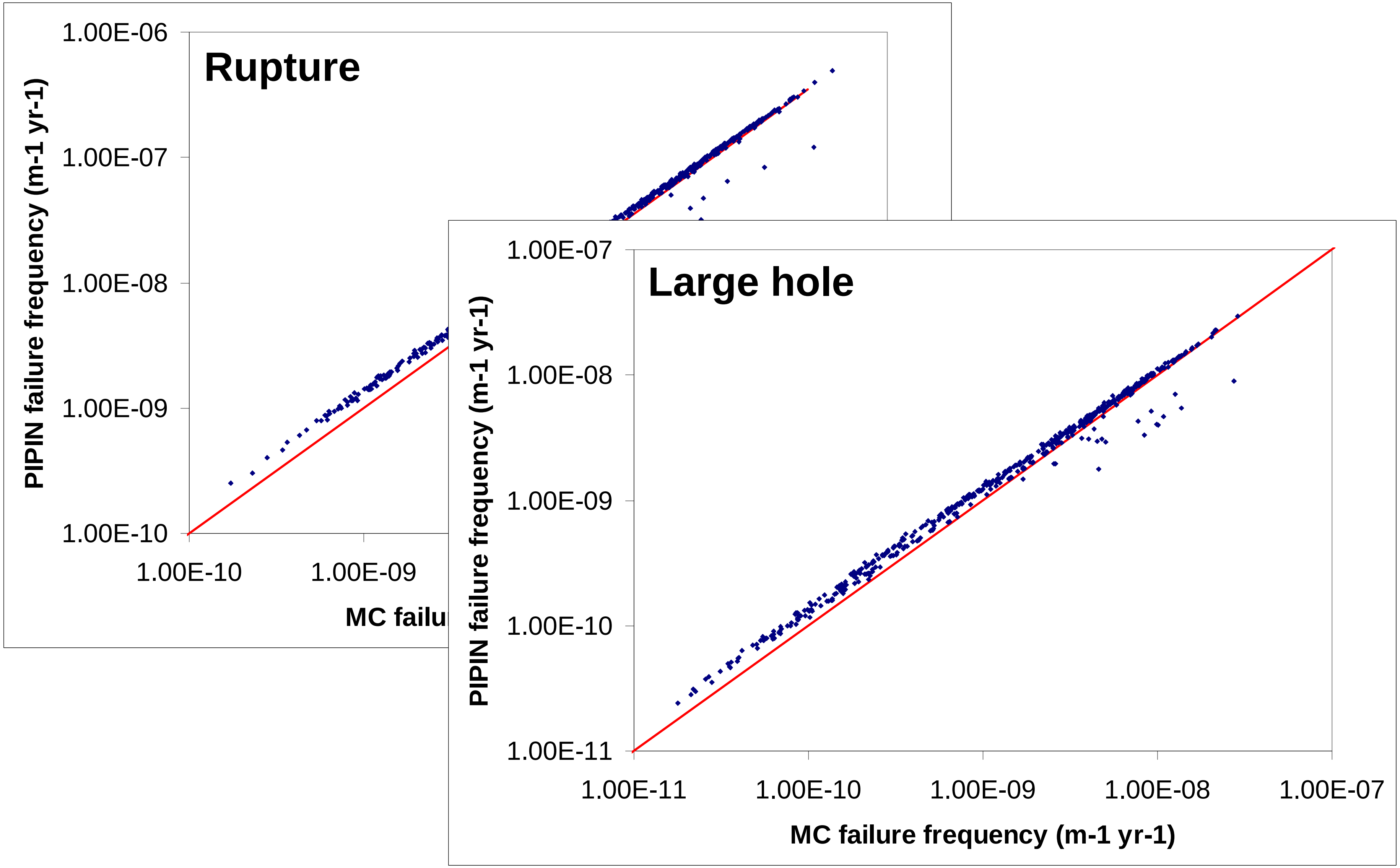
- HSL work
  - Recreate PIPIN TPA model using a Monte Carlo solution technique
  - Examine fracture mechanics
  - Review strike rates
  - Review damage distributions

# PIPIN TPA model (3)

- Monte Carlo solution
  - Successfully implemented
  - Fracture mechanics fully documented
  - Results comparable
  - Some scatter, although judged to be down to differences in solution techniques

# PIPIN TPA model (4)



# PIPIN TPA model (5)

- Review of fracture mechanics
  - Ongoing
  - No fundamental issues identified
  - Key difference (with FFREQ) is the inclusion of micro-cracks at the bottom of a dent-gouge
  - Non-zero micro-crack predicted when no dent is present
  - Charpy Energy – Fracture Toughness Correlation may be over-predicting toughness values
- No plans to move significantly away from this model at present

# PIPIN TPA model (6)

- Strike rates
  - Current incident frequencies for gouges and dent-gouges within PIPIN were calculated some time ago
  - Proposed to use UKOPA data to update these
  - Considered work by Jane Haswell who used the same data
  - Some difficulty in replicating this work
  - Not clear why some records were discarded

# PIPIN TPA model (7)

- Strike rates (cont.)
  - New analysis performed which left 606 records to be considered
    - 543 were gouges
    - 60 were dent-gouges
    - 1 was a crack
    - 2 were unknown
  - Description of the crack implied it was a dent-gouge
  - Unknowns apportioned between gouges and dent-gouges

# PIPIN TPA model (8)

HEALTH & SAFETY LABORATORY

| | Incident frequencies (x10$^{-7}$ per m per yr) | | |
|---|---|---|---|
| | **Gouge** | **Dent-Gouge** | **Both** |
| **Current HSE** | 12.9 | 2.07 | (14.97)<br>(12.13) rural<br>(47.31) suburban |
| **Proposed** | 8.53 | 0.958 | (9.49) |
| **Lyons et al** | | | 8.49 |
| **FFREQ rural** | | | 11.29 |
| **FFREQ suburban** | | | 43.43 |

# PIPIN TPA model (9)

- Strike rates (cont.)
  - Calculated new strike rates for gouges and dent-gouges
  - Gouge incident frequency reduced by approximately 1/3
  - Dent-gouge incident frequency is approximately 1/2 of the current frequency
  - Results from PIPIN indicate that there is approximately a 40% reduction in TPA failure rates
  - Results from PIPIN for all failure modes indicate reductions of between 9% and 33% in the failure rates
  - Preliminary draft work and has not been agreed by HSE

# PIPIN TPA model (10)

- Damage distributions
  - No analysis carried out
  - Waiting for input from UKOPA

# Event tree constants (1)

- UKOPA briefing note 7 (RAWG/08/018)
  - Basis of ignition probabilities used by HSE questioned
  - Recommendation
    - Develop a more rational, logical approach
    - For both natural gas and other substances
    - Event tree logic and probabilities should be more transparent and based on physical parameters and historical incident rates

# Event tree constants (2)

- Objectives of HSL work
  - Review the basis of the event tree structure for non-natural gas
  - Review the probabilities used for non-natural gas
  - Take on-board UKOPA comments
  - Make recommendations for changes (if required) to event tree structure and probabilities for non-natural gas
- Work ongoing

# Event tree constants (3)

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- Preliminary findings
  - MISHAP event tree structure appeared well founded
  - Ignition probabilities in literature very variable
  - Basis of all MISHAP values not clear
  - Some evidence to support changing the non-natural gas event tree probabilities
  - No compelling evidence on what these values should be
  - Further work required before any changes can be proposed

# Other briefing notes

- UKOPA briefing note 9 (RAWG/08/020)
  - Methodology to assess gasoline LUP zones
- UKOPA briefing note 10 (RAWG/08/021)
  - Gas pipeline consequence analysis
- UKOPA briefing notes 1 and 2
  - What are these?