Multi-Product Pipeline Network
Quantified Risk Assessment

- Original requirement for gasoline QRA to classify gasoline as MAHP for amendments to PSR 96
- HSE approach – concerns with pinhole dominating risks and non-logical PIPIN failure rate data
- Methodology based on Atkins 1998 report and now applied to several UK pipelines

HSE/UKOPA Meeting 10 November 2006

KEY PARAMETERS AFFECTING SAFETY RISK ASSESSMENT

- Pipeline failure mechanisms and size
- Release rate
- Amount released during shutdown, depressurisation and drain down
- Hole size to cause spray
- Ignition probability – spray fire, immediate or delayed pool fire, no ignition
- Probability of escape
- Fire and thermal radiation effects

Table 2 - Failure Rates per 1000 kilometre-years – Product Oil Pipelines in the UK

Spillage Cause	Pinhole	Hole	Rupture	Total
Mechanical	0.025	0.022	0.012	0.059
Corrosion	0.012	0.049	0.002	0.063
Natural	0.002	0.008	0.004	0.014
Third Party	0.026	0.054	0.022	0.102
Total	0.065	0.133	0.040	0.238

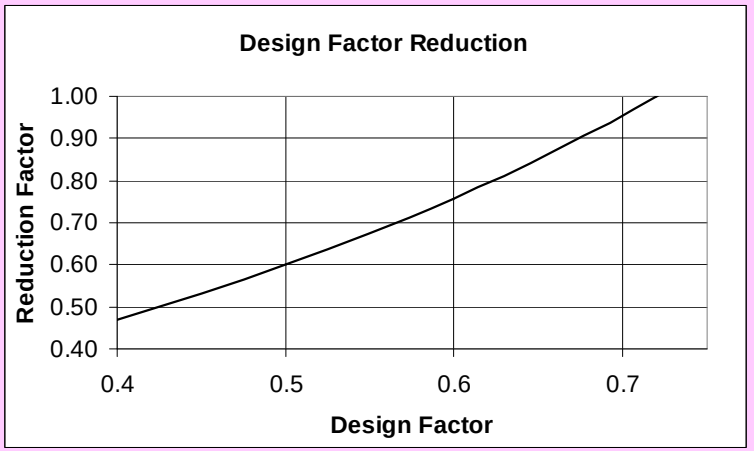
Allow for:-

> Management Systems, in-line inspection, corrosion monitoring

> Pipeline diameter and thicker wall

> Higher 3rd party rates - At road crossings x 2 - Suburban areas x 4 (with increased surveillance)

Figure 3 – Reduction in Failure Rate with Design factor



GENERIC FAILURE MECHANISMS

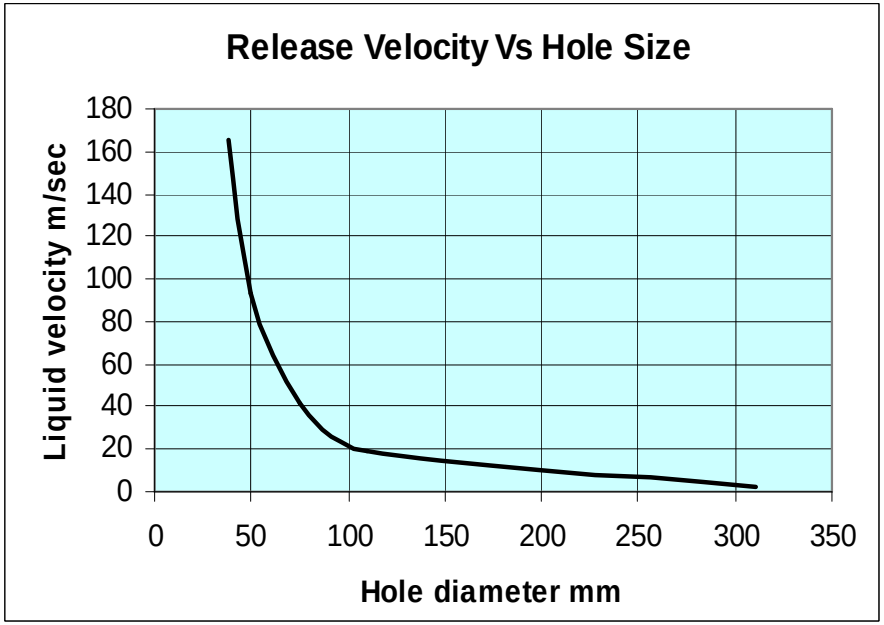
- 3rd Party interference / excavation
- Corrosion – internal and external
- Mechanical Defect – original or construction
- Natural Failure – earth movement / landslide etc.

OPERATIONAL FAILURE MECHANISMS

- Overpressure - e.g. due to multiple pump operation
- Thermal Expansion
- Overpressure due to surge
- Fatigue due to pressure cycling

CAUSES OF SPRAYS AND EFFECTS

- Atkins analysis of nearly 300 incidents worldwide showed ~ 16% caused sprays
- Velocity through hole indicates medium-sized holes cause serious risks from sprays
- Atkins suggest 2 x pressure in bar as maximum range
- Modelled as 4 ellipses with length 100%, 75%, 50% and 25% max. range and width 80% length



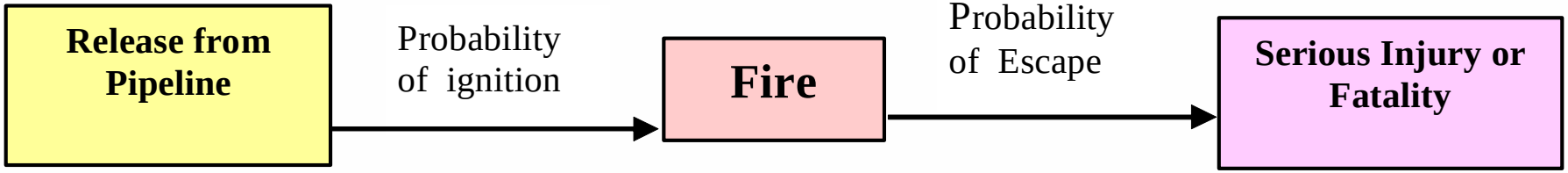
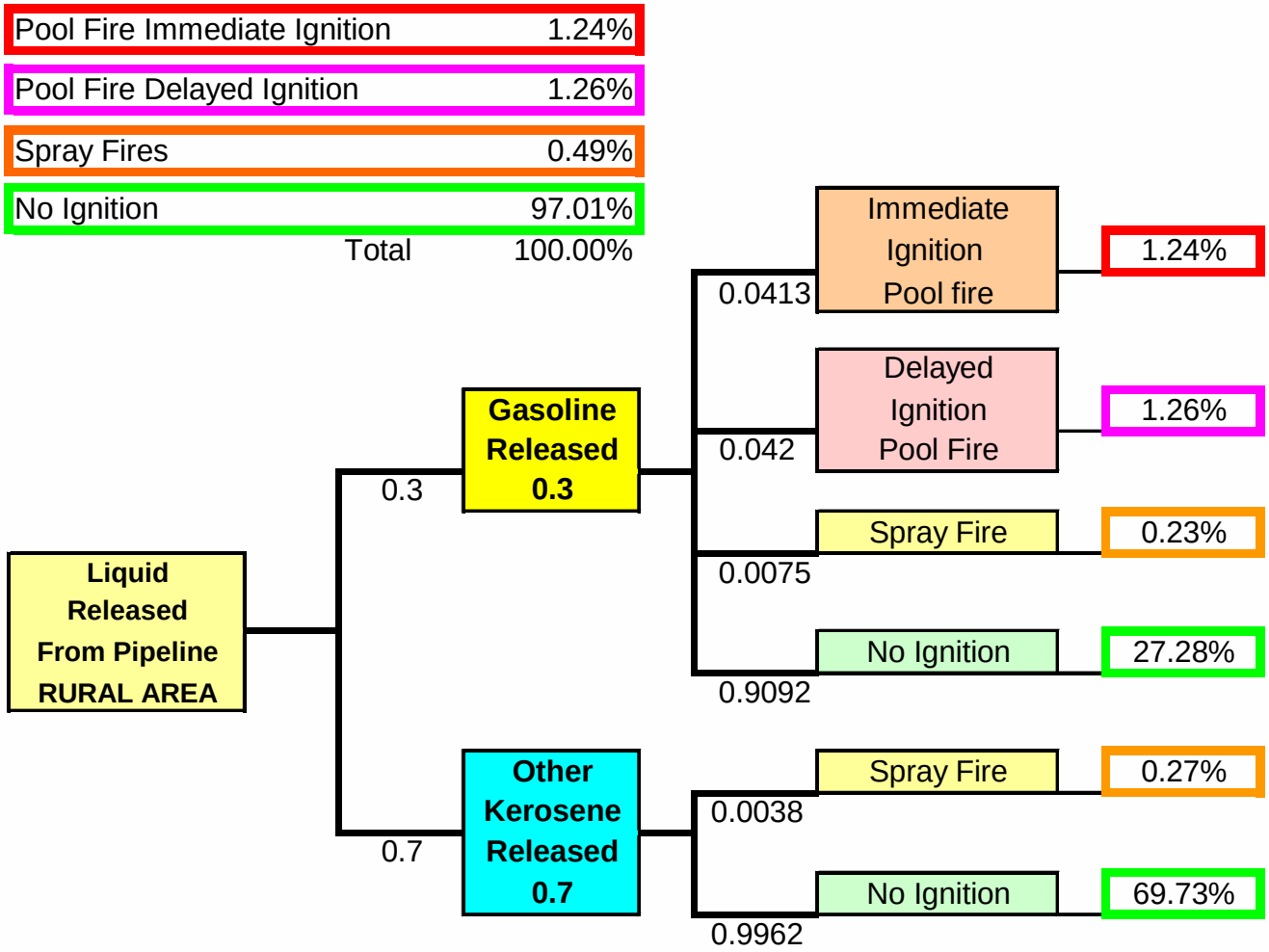


Table 12 – Ignition Probabilities for Rural Areas

Rural Locations			
Scenario	**Probability of Ignition**	**Probability of Escape**	**Comments**
Gasoline spray fire caused by 3rd party excavation	**0.1**	**0.1**	People in the vicinity carrying out excavation may cause ignition, and unlikely to be able to escape
Gasoline spray fire caused by other failures	**0.01**	**0.25**	Very unlikely for spray release to ignite, and unlikely for anyone to be present, higher probability of escape
Kerosene / others spray fire caused by 3rd party excavation	**0.05**	**0.1**	Lower probability (50%) of igniting kerosene / diesel spray / gasoil, same escape probability as gasoline
Kerosene / others spray fire caused by other failures	**0.005**	**0.25**	Lower probability (50%) of igniting kerosene / diesel spray / gasoil, same escape probability as gasoline
Gasoline immediate ignition pool fire caused by 3rd party excavation	**0.1**	**0.5**	People in the vicinity carrying out excavation may cause ignition, may be able to escape from slow-growing pool fire in the open air

Multi-Product Pipeline - Probability of Ignition - Rural Area



CONCLUSIONS from the Safety Study

1. QRA of several pipelines completed

2. Failure rate data for generic causes – adjusted CONCAWE data,

3. Four consequences analysed based on W S Atkins 1998

4. Low incident frequency + low ignition probability indicates very low risk levels for gasoline pipelines

5. In a few notable cases consequences can be potentially very serious

6. General approach suggests that the levels of risk are low compared to other substances, and marginal for inclusion as MAHP under PSR 96