

UKOPA Meeting
16 October 2013

Emergency Planning Distances

Rod McConnell

UKOPA/13/040

Presentation Content

- 1 Introduction
- 2 Derivation of Ethylene Planning Distances
- 3 Derivation of Oil Planning Distances
- 4 Proposed Emergency Planning Distances

Introduction

Pipeline Safety Regulations 1996 Regulation 25

(4) The operator of a major accident hazard pipeline shall ensure that every local authority through whose area the pipeline will pass is furnished promptly with such information as it may reasonably require in preparing [the emergency plan]

Guidance

137 Full liaison and effective two-way flow of information is required between the pipeline operator and the local authority.....

138 The pipeline operator should provide information about the type and consequences of possible major accidents and the likely effects...

Introduction

UKOPA Document UKOPA/97/07

Hazard range does not, however, take into account the likelihood of an event occurring, and is not appropriate for determining the distance to be used for detailed emergency planning. Emergency planning distances therefore differ from hazard range.

Based on an individual risk of 1 cpm (chances per million) for rural pipelines and an individual risk of 0.3 cpm for suburban areas, and for vulnerable or large populations, the following table gives examples of worst case emergency planning distances for rural and suburban pipelines.

Introduction

UKOPA Document UKOPA/97/07

Emergency Planning Distances for Gas Pipeline

Diameter (mm)	RURAL		SUBURBAN
	Normal Localities	Sensitive Localities	All Types Of Location
168	75	85	60
324	75	105	60
457	108	117	60
610	150	170	60
762	195	260	60
914	220	265	60
1,067	230	275	60
1,219	250	340	60

Introduction

~ 2006 – new concept introduced:-

The Emergency Planning Distance
and
The Maximum Thermal Hazard Range

for example:-

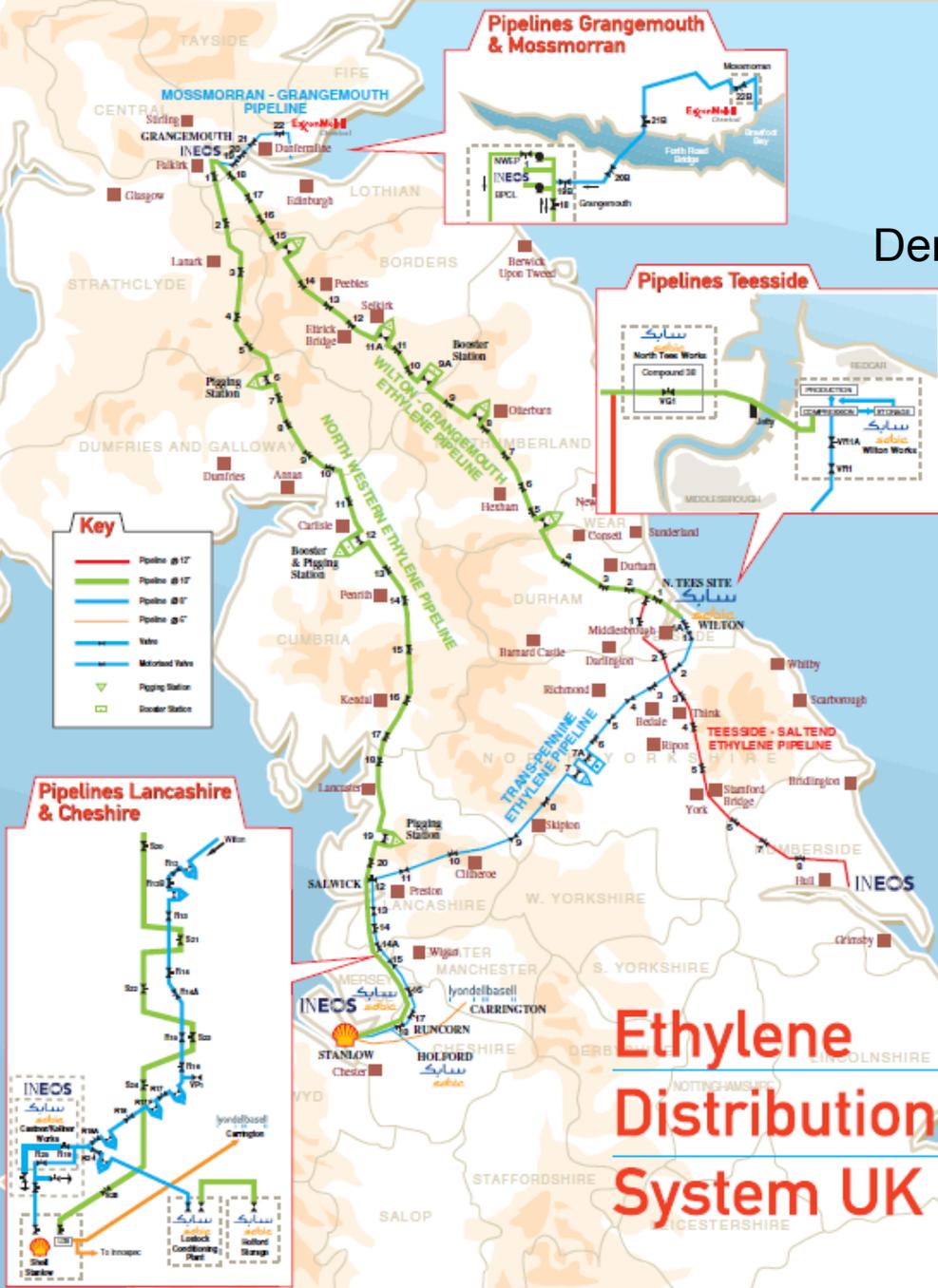
Emergency Planning Distance	340m
Maximum Thermal Hazard Range	872m

- Difficulty with this approach is that Local Authority Emergency Planners tend to default to highest value shown irrespective of logic of diameter / pressure / hole size explanation in guidance documents
- Therefore propose a one-distance EPD for ethylene and oil products

Derivation of Ethylene Planning Distances

- UK dense-phase ethylene pipeline network
– diameter range 168 mm-324 mm
- MAOP all in range 98-100 bar
- For UKOPA presentation by Mark Harrison on the UK Ethylene network see:-

<http://www.ukopa.co.uk/pdfs/UKOPA-09-0016.pdf>



Derivation of Ethylene Planning Distances

Ethylene Hazard Distances for Pipeline Rupture - at 99 bar

note – actual pressure at release point likely to be lower

Fireball - Probability 0.2

Pipeline Diameter	Fireball Hazard Distance
219 mm (8 inch)	120 m
273 mm (10 inch)	165 m
324 mm (12 inch)	200 m

Jet Fire - Probability 0.5
(under discussion!)
calculated for release rate
after 30 seconds

Pipeline Diameter	Jet Fire Escape Distance
219 mm (8 inch)	80 m
273 mm (10 inch)	110 m
324 mm (12 inch)	140 m

Flash Fire - Probability
-Daytime 0.1
-Nighttime 0.025
(under discussion!)

Was calculated for release rate
after 30 seconds –
Distances – 300- 500 m daytime
700m – 1000 m nighttime

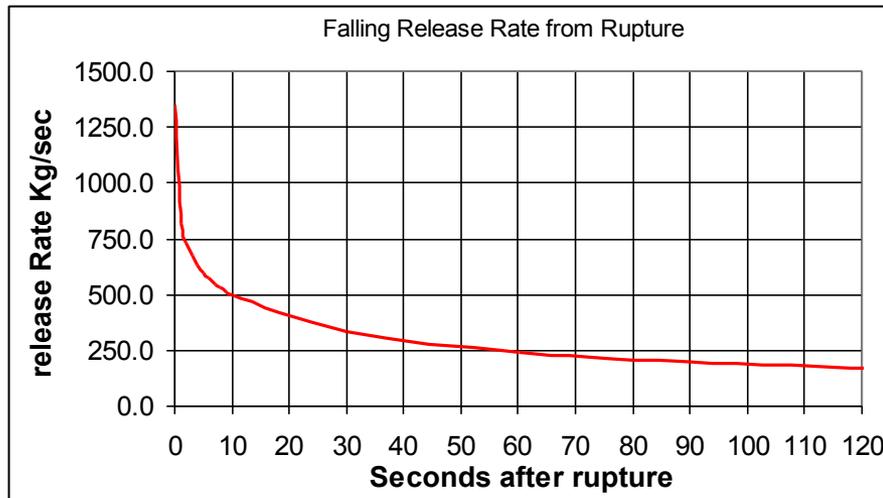
Derivation of Ethylene Planning Distances

Ethylene Flash Fire Distances – re-assessed

1. Assumes ignition at further point from release – most pessimistic (unrealistic?) assumption
2. Distances based on outdated dispersion models – more up-to-date models (e.g. PHAST) give lower distances
3. Using 30 second release rate is flawed – size of flammable gas cloud for 30 second rate – not enough gas has been released after 30 seconds

Derivation of Ethylene Planning Distances

Ethylene Flash Fire Distances – release rate

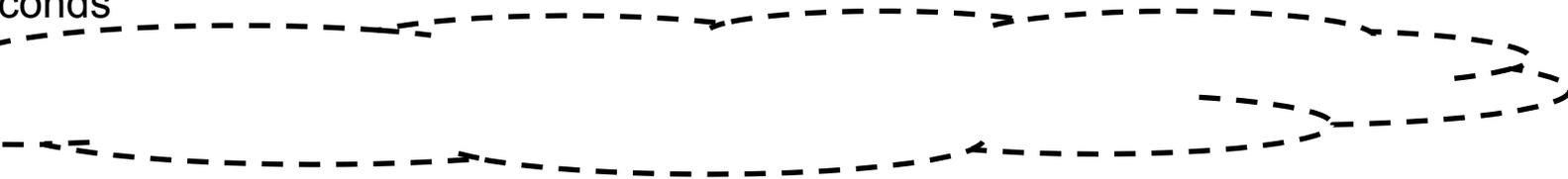


Time after Rupture seconds	Release Rate Kg/sec	Quantity released tonnes	Flammable cloud size for current release rate tonnes
0	1351	0.0	189.4
1	809	1.4	164.5
2	721	2.2	151.4
3	667	2.9	141.6
4	627	3.5	133.7
5	596	4.2	127.0
6	570	4.8	121.3
7	548	5.3	116.2
8	529	5.9	111.6
9	512	6.4	107.5
10	497	6.9	103.7
15	439	9.3	88.8
20	398	11.4	77.9
25	366	13.3	69.6
26	361	13.7	68.1
30	341	15.1	62.8
60	251	23.9	39.3
85	210	29.6	29.4

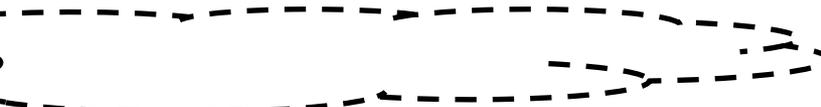
Derivation of Ethylene Planning Distances

Ethylene Flash Fire Distances – amount in cloud

e.g. 5 seconds



e.g. 30 seconds



e.g. 60 seconds



e.g. 85 seconds



Derivation of Ethylene Planning Distances

Re-assessment of Ethylene Flash Fire Distances shows that

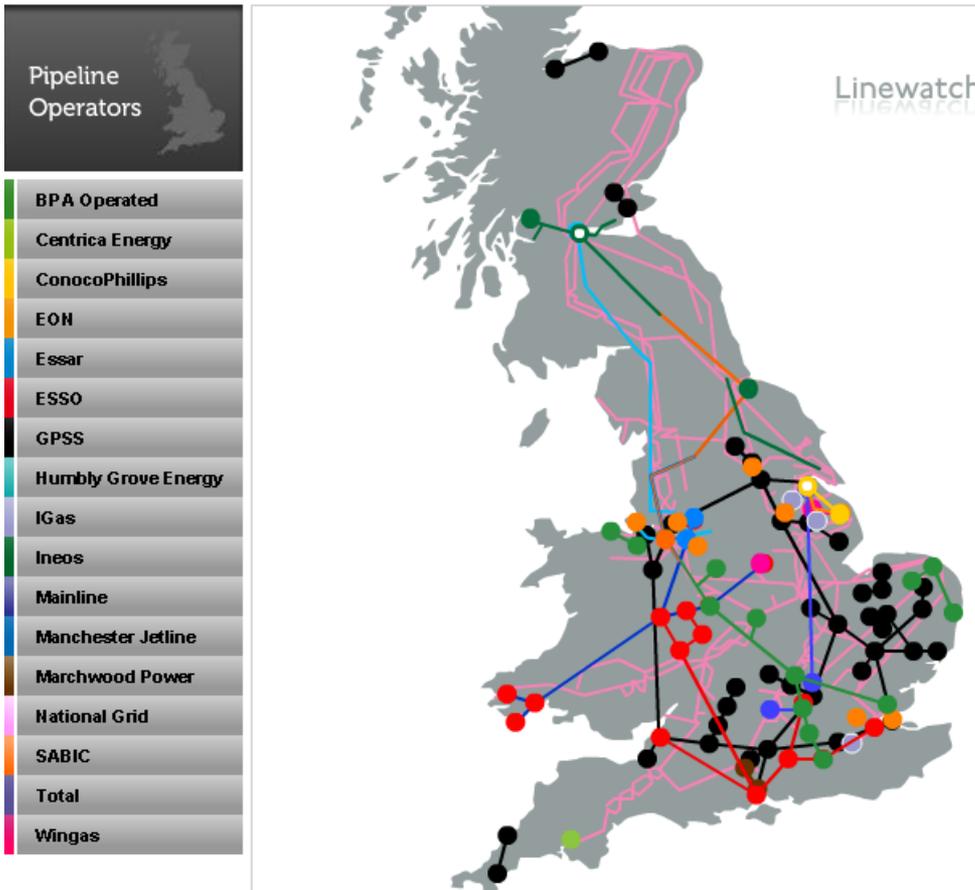
- Maximum flash fire distances reduce significantly
- Hazard distances greater than 250m are transient – they exist for 30 seconds – 3 minutes only
- The probability of a flash fire beyond 250m is 10^{-7} to 10^{-8}
- Therefore well below the ALARP level and are therefore considered “non-credible” for the purposes of defining Emergency Planning Distance

- Therefore define Emergency Planning Distance for UK Ethylene pipelines as

250 metres

Derivation of Oil Planning Distances

PIPELINE NETWORK



- UK oil pipeline networks
- 3 products considered:-
 - Multi-product = gasoline for assessing EPD
 - Aviation fuel / diesel
 - Crude oil (dead)
- diameter ranges generally 168 mm-508 mm
- throughput typically in range 200-800 m³/hour
- MAOPs typically in range 70-100 bar

Derivation of Oil Planning Distances

Three hazard scenarios considered:-

1 Immediate pool fire

-Dependent on flow rate through pipeline, equilibrium pool fire diameter calculated such that pool burning rate = flow rate through pipeline

$$D_{\max} = 2 \cdot \sqrt{\frac{m_r}{\pi \cdot m_f}}$$

where D = maximum diameter of pool fire, metres

m_r = release rate of gasoline into pool kg/sec

m_f = burning rate of fuel kg/sec.m²

Then calculate thermal radiation distance from edge of pool fire to obtain hazard distance

2 Delayed pool fire – dependent on how long to shut off pipeline flow (pumps)
– for 5 minutes shutoff time, pool size similar to immediate ignition pool fire

3 Spray fire – maximum hazard distance estimated to be 2 times pressure
- so typically 140-200m hazard distance - BUT
very low probability ($< 10^{-7}$), so considered “non-credible” for EPD

Derivation of Oil Planning Distances

Immediate Pool Fire Results

Gasoline Emergency Planning Distances (EPD)	
Pipeline diameter and flowrate	EPD metres
6" - 168mm - 200 m3/hour	20
8" - 219mm - 300 m3/hour	27
10" - 273mm - 400 m3/hour	33
12" - 323mm - 500 m3/hour	38
14" - 355mm - 600 m3/hour	43
18" - 457mm - 700 m3/hour	47
20" - 508mm - 800 m3/hour	51

Kerosene - Diesel - Jet Fuel Emergency Planning Distances (EPD)	
Pipeline diameter and flowrate	EPD metres
6" - 168mm - 200 m3/hour	18
8" - 219mm - 300 m3/hour	22
10" - 273mm - 400 m3/hour	25
12" - 323mm - 500 m3/hour	28
14" - 355mm - 600 m3/hour	30
18" - 457mm - 700 m3/hour	32
20" - 508mm - 800 m3/hour	34

Crude Oil Emergency Planning Distances (EPD)	
Pipeline diameter and flowrate	EPD metres
6" - 168mm - 200 m3/hour	27
8" - 219mm - 300 m3/hour	35
10" - 273mm - 400 m3/hour	43
12" - 323mm - 500 m3/hour	50
14" - 355mm - 600 m3/hour	56
18" - 457mm - 700 m3/hour	61
20" - 508mm - 800 m3/hour	66

So recommended EPDs are:-

Multi-Product - 50m

Aviation fuel/diesel – 35m

Crude oil – 70m

Proposed Emergency Planning Distances

So recommended Emergency Planning Distances are:-

Ethylene	250 metres
----------	------------

Multi-Product	50 metres
---------------	-----------

Aviation fuel/diesel	35 metres
----------------------	-----------

Crude oil	70 metres
-----------	-----------