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Gasoline Land Use Planning Zones
Proposed Minimum Distance to Occupied Buildings (MDOB)

1 Introduction

At the UKOPA-HSE meeting on 10 November 2006, HSE confirmed that Gasoline will be included as a Major Accident Hazard substance under PSR 96. As a result they will need to calculate LUP zones for gasoline pipelines, and propose commencing discussions with UKOPA in January 2007. Target date for including gasoline is end 2007.

UKOPA is also currently developing Code supplements for UK pipelines for IGE/TD/1 and PD 8010 covering:-

"Application of Pipeline Risk Assessment to Proposed Developments in the Vicinity of Major Hazard Pipelines"

Recent risk assessment applied to several UK gasoline pipelines indicate that the distance to risk levels of 10^{-6} (Middle Zone) and 3×10^{-7} (Outer Zone) are likely to be 20-80 metres from a pipeline depending on design and operating conditions. However there is no current way of determining Inner Zone (10^{-5} equivalent) because, in common with other MAH pipelines, risk levels do not approach 10^{-5}.

For other gases (and some liquids), HSE have adopted the IGEM Building Proximity Distance (BPD) for natural gas, and are proposing to use the PD 8010 Minimum Distance to Occupied Buildings (MDOB).

MDOB exists for ethylene, LPG and NGL but not for gasoline. This note proposes a possible approach for defining the MDOB for gasoline.

2 Development of the IGE/TD/1 Building Proximity Distance

BPDs published in IGE/TD/1 Edition 4 were derived from research work submitted to the IGE panel to allow development of the Communication 674 (first recommendations for high pressure gas) in 1967 and subsequently the first edition of TD1 1977 through to the consolidated Edition 2 in 1983. Evidence indicates that the BPD distances were based on distances to 10,000 BTU/ft2.h (33 KW/M2) due to jet flames from pipeline rupture. Reasonably good replication of the BPD results across the pressure-diameter range has been obtained using the current HSE PIPEFIRE model which is based on original British Gas equations.

Application of the same approach to ethylene gives MDOBs which are lower for ethylene and similar for LPG than those obtained using the current PD 8010 equations.

3 Development of the IGE/TD/1 Minimum Distance to Occupied Buildings

MDOBs were developed for BS (now PD) 8010 in the early 1990s in the form of an equation. Communication with Roger Hill (of A D Little) and others involved at the time indicate that the distances were based on calculated 10^{-6} risk levels obtained from a limited number of quantified pipeline risk assessments which existed in 1989/90, but evidence of this is not available. The equation is as follows:-

$$\text{Minimum Distance MDOB} = Q\left(\frac{D^2}{32000}+\frac{D}{160}+11\right)\left(\frac{P}{32}+1.4\right)$$

D = pipeline diameter in mm

P = pressure in barg

Q = substance factor (below)

Substance	Substance Factor Q
Ammonia	2.5
Ethylene	0.8
Hydrogen	0.45
Methane	0.55
LPG	1
NGL	1.25
Category C (oxygen etc.)	0.3

MDOBs for methane are slightly greater than TD/1 BPDs for natural gas for some pipeline diameters.

4 Developments of Land Use Planning Inner Zones

Inner zone distance has the most significant effect on HSE advice for Land Use Planning in that no significant residential or other public access developments are permitted in the Inner Zone.

Originally the inner zone applied by HSE was based on the fireball radius based on the burning of the accumulated release from the first 5 – 20 seconds of a gas release. However following lobbying by UKOPA, the re-calculation of the natural gas LUP zones in 2001-2 resulted in the adoption of BPD as the inner zone distance.

There are indications that HSE will also apply this approach when re-calculation of ethylene and other MAH pipeline LUP zones occurs. However no MDOB currently exists for gasoline so this note proposes a way forward.

5 Rationale for Calculating the Gasoline MDOB

Two main hazard scenarios have been developed for gasoline pipelines, a spray fire, and a pool fire. The pool fire may occur immediately after release, or be delayed until the spreading pool finds a source of ignition.

The spray fire (or jet fire) extent is dependent on the hole size and liquid pressure in the pipeline. Only a limited range (historically 16%) of holes cause significant sprays to occur. Pool fires are dependent on hole size, but less on pipeline pressure. For a pipeline at 30 to 100 bar pressure, hole sizes in excess of ~ 50 mm are likely to release the full pumping rate into the pool fire, so the limit on pool fire size is dictated by pumping rate and burning rate of gasoline.

Spray fires are difficult to characterise for a single case – they are dependent on a number of factors including directionality, wind, pressure, hole size etc. The extent and area covered cannot be simply generalised.

Immediate ignition pool fires have a characteristic pool diameter dictated by 2 factors:- release rate (= pipeline pumping rate) and burning rate. For any given pipeline it is possible to characterise these factors into a single set of hazard distances based on typical pipeline pumping rates for 2 metres/second liquid velocity.

For typical UK gasoline pipeline diameters, the immediate ignition pool sizes are as follows:-

Diameter mm	168 mm	219 mm	273 mm	323 mm	355 mm
Release Rate m3/hour	160	270	420	590	710
Pool radius metres	12.5	16.3	20.3	24	26.4

While recognising the limitations of this approach (flat earth, equal spreading of pool, immediate ignition), if a building is within the immediate pool fire, there is a significant hazard to the occupants, so these distances provide the basis of the MDOB for gasoline. However to be consistent with other substances in PD 8010, and to allow some influence of pressure on MDOB, a Substance Factor Q of 0.4 is proposed for gasoline which gives a reasonable approximation to the pool radii calculated above. This suggests that the MDOB for gasoline is greater than Category C substances, but smaller than for methane gas.

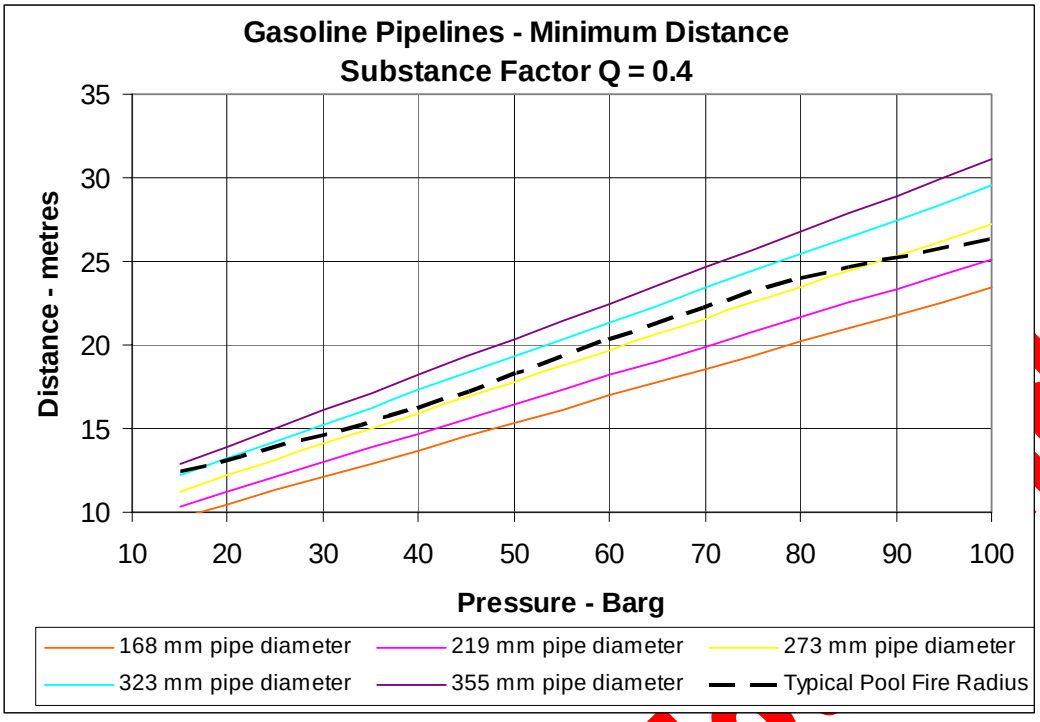
5 Proposed Minimum Distance to Occupied Buildings for Gasoline

The results for gasoline are as follows:-

Pipeline Diameter		Pressure - Barg					
inches	mm	15	30	40	60	80	100
		Minimum Distance to Occupied Buildings - MDOB metres					
18	457	15	19	22	27	32	37
16	406	14	17	20	24	29	34
14	355	13	16	18	22	27	31
12	323	12	15	17	21	25	30
10	273	11	14	16	20	23	27
8	219	10	13	15	18	22	25
6	168	10	12	14	17	20	23

These are based on Substance Factor Q = 0.4 for gasoline.

Plotted as a graph, also showing typical pool fire radii distances potted as though dependent on pressure (shown as a dotted line):-



6 Conclusions and Recommendations

a) Risk assessments carried out on UK gasoline pipelines indicate that risk levels of 10^{-6} and 3×10^{-7} exists adjacent to most pipelines which are likely to result in relatively small Land Use Planning Zones.

b) HSE have indicated that they intend to proceed with inclusion of gasoline as a Major Accident Hazard substance within the PSR 96 regulations so they will be actively seeking views of application of LUP zones to gasoline pipelines.

c) Inner zone distances are likely to have the most significant impact on Land Use Planning advice adjacent to gasoline pipelines. Inner zones will be applied to all gasoline pipelines, whether or not further middle and outer zones are applied as well. If a gasoline pipeline has little or no risk calculated from a risk assessment, HSE always apply the inner zone distance. Therefore it is essential that a robust and acceptable approach is developed to calculate inner zone distances.

d) BPD has been adopted by HSE as the inner zone distance for natural gas pipelines, and it is likely that MDOB will be adopted in a similar way for PD 8010 substances.

e) Gasoline has no MDOB so it is proposed that a Substance Factor of 0.4 is adopted for gasoline and the PD 8010 equation then applied to obtain MDOB distances.

f) Resulting MDOBs (and inner zones distances) of 23 to 37 metres would then apply to typical UK pipelines.

g) Current development of the Code Supplement for PD 8010 would allow this new approach to be included and published in due course.

h) The views of UKOPA gasoline operators are requested for this proposal. Please send your views to Dr J V Haswell by 30 November 2006.

i) This proposal is to be submitted to the RAWG for approval at the meeting to be held on 6th December 2006.

R A McConnell
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