

# Practical Application of Code Supplements

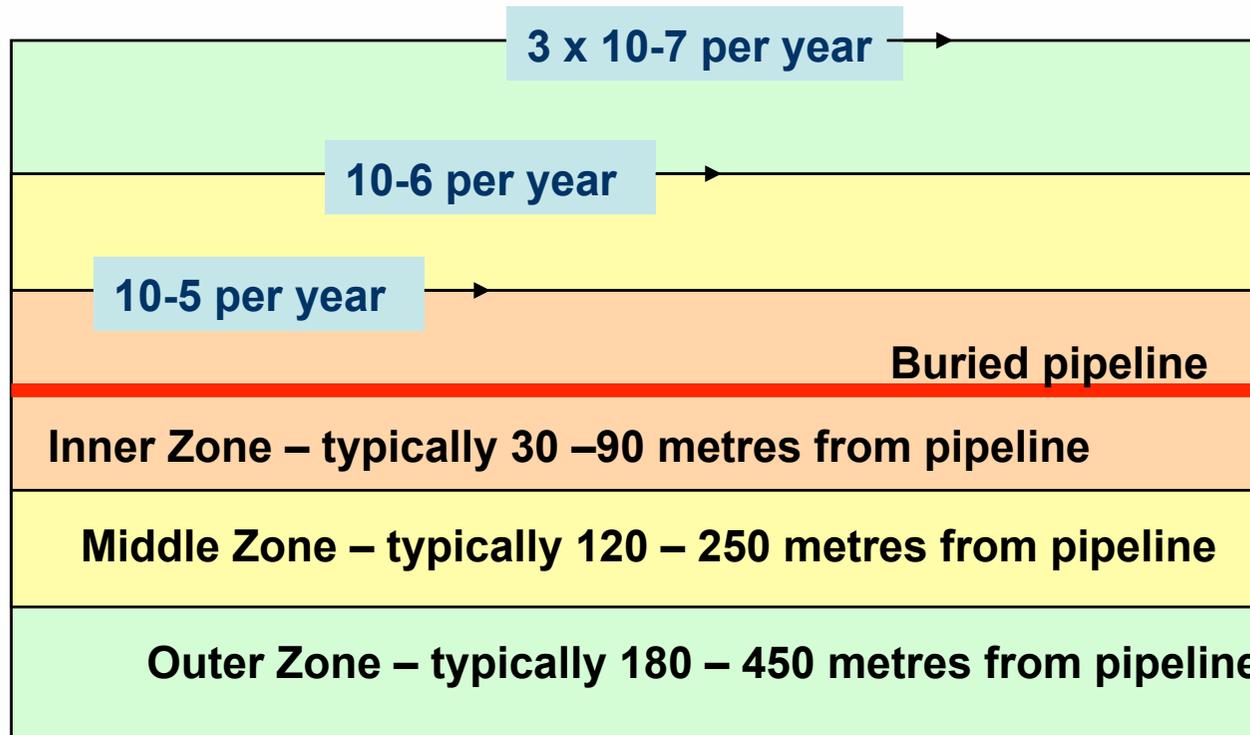
## A Hypothetic Example

**Rod McConnell**

**UKOPA/06/0044**

# Land Use Planning in Britain

- 3 zone Land Use Planning zones applied to Major Hazard Pipelines in late 1980s / early 1990s



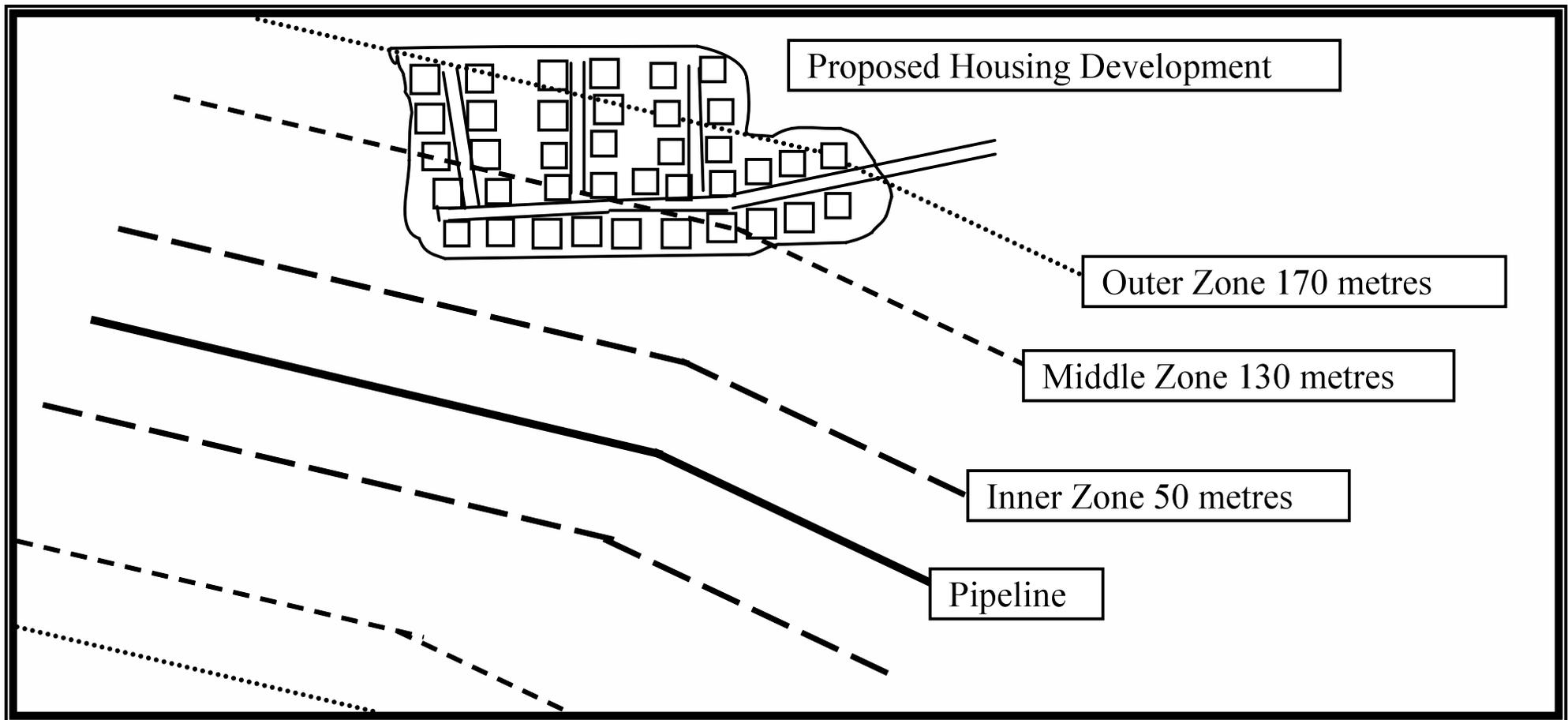
- Permitted developments in each zone described in HSE document PADHI – Planning Advice for Developments near Hazardous Installations

**David Eves, Deputy Director General of the HSE  
to British Gas, 24 August 1995:-**

**“Let me assure you that HSE  
remains committed to the development  
of a risk-based approach  
for the provision of  
land-use planning advice”.**

## Proposed Hypothetical Example in Code Supplements

- Planning Application lodged for a new housing estate
- 38 houses in a green field rural area
- local Planning Authority records show a high pressure gas pipeline
- Land Use Planning Zones as follows:-



## PADHI Guidance

DT2.1 - HOUSING	Houses, flats, retirement flats/ bungalows, residential caravans, mobile homes.	Developments up to and including 30 dwelling units and at a density of no more than 40 per hectare – <b>Level 2</b>	Development where people live or are temporarily resident. It may be difficult to organise people in the event of an emergency.
	<b>EXCLUSIONS</b>		
	Infill, backland development.	DT2.1 x1 Developments of 1 or 2 dwelling units - <b>Level 1</b>	Minimal increase in numbers at risk.
	Larger housing developments.	<b>DT2.1 x2 Larger developments for more than 30 dwelling units – Level 3</b>	Substantial increase in numbers at risk.
		DT2.1 x3 Any developments (for more than 2 dwelling units) at a density of more than 40 dwelling units per hectare - <b>Level 3</b>	High-density developments.

Having determined which zone the development falls into and also the Sensitivity Level of the development, the following matrix is used to decide the type of advice.

Level of Sensitivity	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
3	AA	AA	DAA
4	AA	AA	AA

**DAA** = Don't Advise Against development.

**AA** = Advise Against development.

## Rule 4 – Developments on Sites with Existing Permitted Use

- ❑ Single development in this area, so PADHI Rule 4 is applied
- ❑ Development is neither an extension,  
nor a multiple use development,  
nor a change in use,
- ❑ so Rule 4 does not apply.

## Rule 1 – Straddling Developments

- ❑ Development is only partly in the Middle Zone,  
so Rule 1 Straddling Developments is applied.
- ❑ 8 houses are inside the Middle Zone,
- ❑ another 3 straddle the zone boundary,
- ❑ only about 7 houses are outside Outer Zone.
- ❑ Therefore more than 10% are inside Middle Zone,
- ❑ and relatively few outside Consultation Distance (i.e. Outer Zone Boundary),
- ❑ therefore development is in Middle Zone and HSE advice is **Advise Against**

## Letter to Developer:

“The Health and Safety Executive (HSE) is a statutory consultee for certain developments within the Consultation Distance (CD) of major hazard installations / complexes and pipelines.

This consultation, which is for such a development and also within at least one CD, has been considered using the details provided by you and HSE’s assessment methodology.

The assessment indicates that the risk of harm to people at the proposed development is such that **HSE’s advice is that there are sufficient reasons, on safety grounds, for advising against the granting of planning permission in this case.**

As the proposed development is within the CD of a major hazard pipeline **you should consider contacting the pipeline operator before deciding the case.**

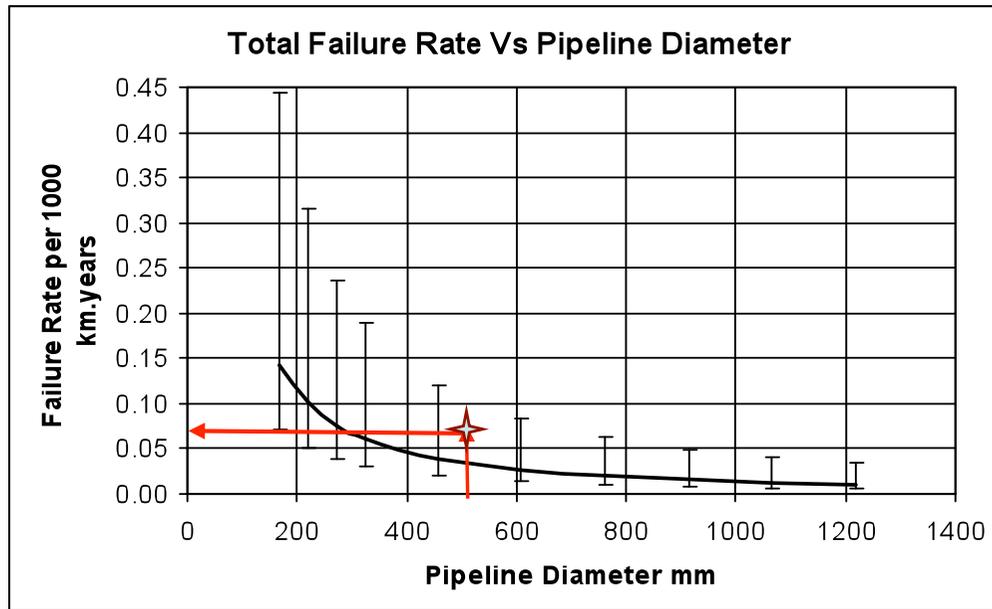
There are two particular reasons for this:

- 1) The operator may have a legal interest (easement, wayleave, etc.) in the vicinity of the pipeline.  
This may restrict certain developments within a certain proximity of the pipeline.
- 2) The standards to which the pipeline is designed and operated may restrict occupied buildings or major traffic routes within a certain proximity of the pipeline.  
Consequently there may be a need for the operator to modify the pipeline, or its operation, if the development proceeds.”

## Then:-

- ❑ Developer contacts pipeline operator who confirms following details:-
  - Material - high pressure natural gas
  - Pipeline diameter - 508 mm
  - Wall thickness - 11.1 mm
  - Steel - X46
  - Maximum Allowable Operating Pressure - 70 bar
  - Depth of Cover - 900 mm
  - Area Classification - Rural – R Area
  - Design factor - 0.51
- ❑ Therefore pipeline design and operation are as notified to HSE
- ❑ LUP Zones are as stated by HSE
- ❑ Only possibility is to consider Mitigating Measures
- ❑ Developer commissions a Risk Assessor to review LUP zones and Possible Mitigation Measures

# Pipeline Failure Rate - from Code Supplement

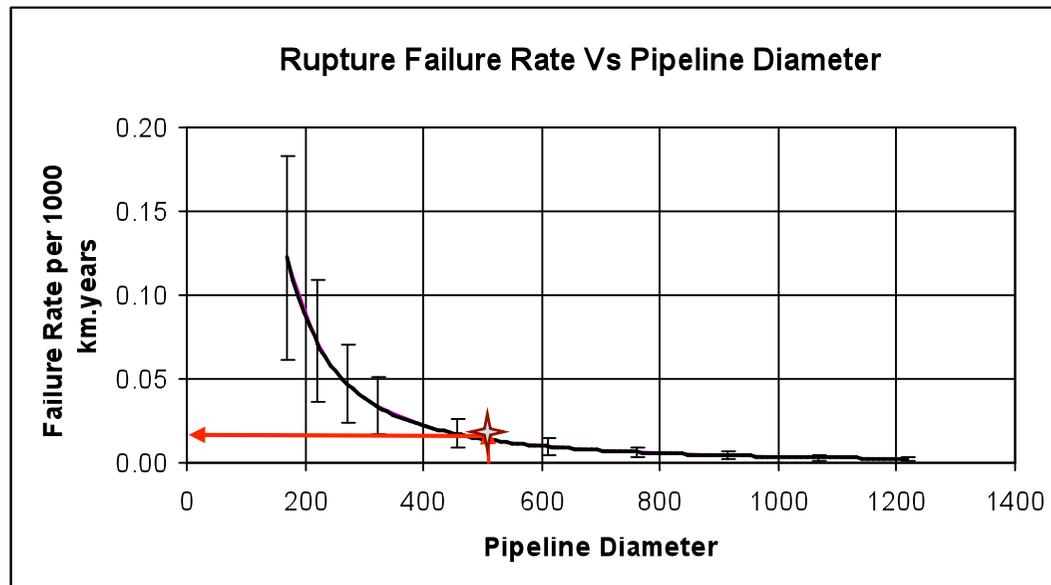


**Design factor 0.51**

**Use mid-range failure rates**

**Total failure rate = 0.065**

**per 1000 km.year  
which is the same as  
per metre X  $10^{-6}$  per year**



**Rupture failure rate = 0.015**

**per 1000 km.year  
which is the same as  
per metre X  $10^{-6}$  per year**

# Risk Calculation

## Code Hypothetical Example - Calculation of LUP Zones

Diameter	508				
MAOP	70				
Wall thickness	11.1				
Steel	X46				
Depth of Cover	900				
Design factor	0.51				
Area Class'n	R	HSE	$10^{-6}$ risk	130	metres
BPD (from TD1)	49	Calculated	$10^{-6}$ risk	130	metres
Rupture Rate	0.015				
Large Hole	0.02	HSE	$3 \times 10^{-7}$	170	metres
Small Hole	0.03	Calculated	$3 \times 10^{-7}$	163	metres
<b>Total Failure Rate</b>	<b>0.065</b>				

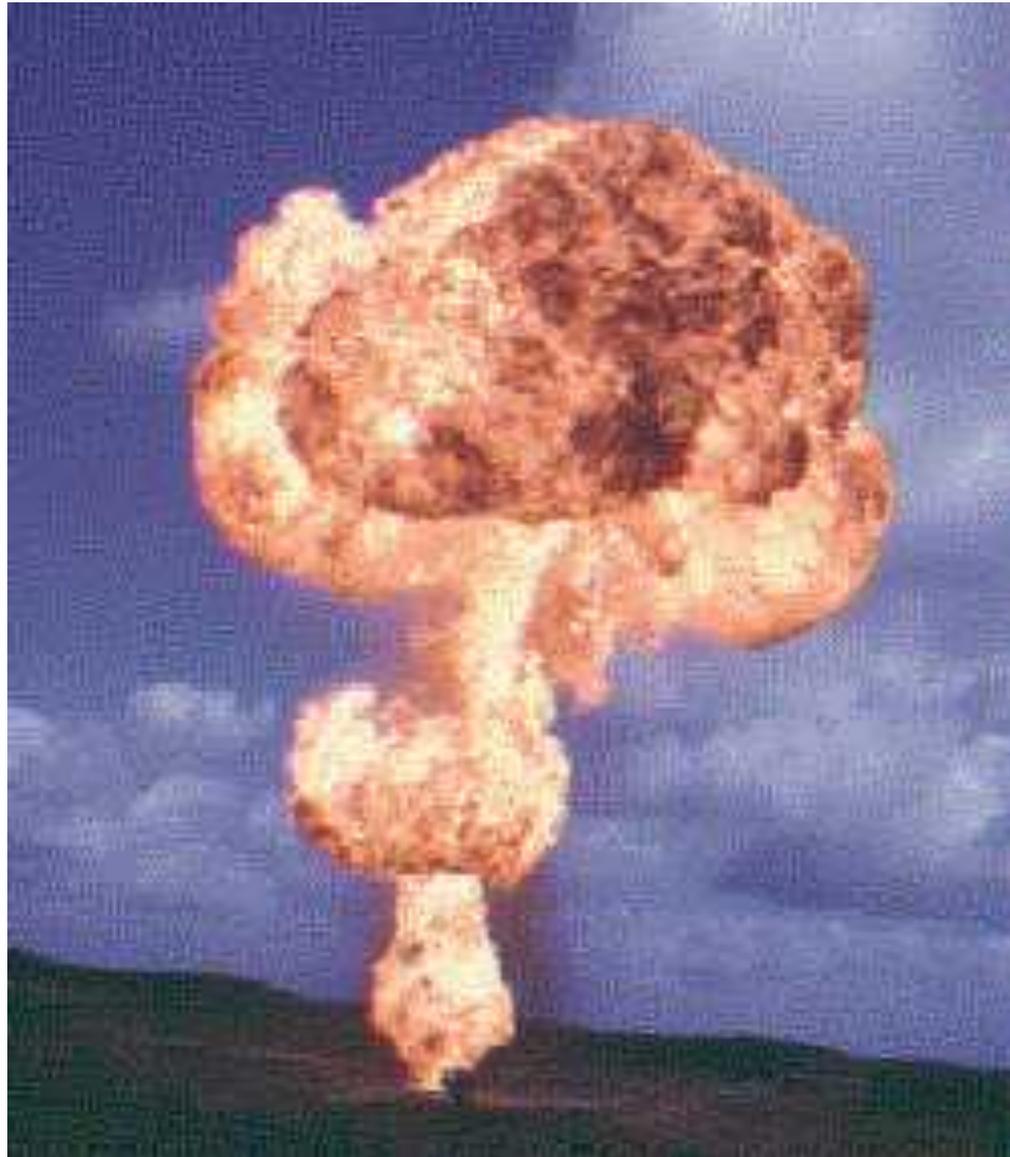
### RESULTS

Fireball spontaneous ignition distance	165
Jetfire escape distance 1000tdu	135
Fireball pilot ignition distance	202

Risk Calculation Input + Results		
Pressure	70	bar
Diameter	508	mm
Rupture	0.0150	
110 mm hole	0.0200	
75 mm hole	0.0300	
<b>Calculate risks</b>		
Distance to		
$10^{-5}$ per year	0	metres
$10^{-6}$ per year	130	metres
$3 \times 10^{-7}$ per year	163	metres

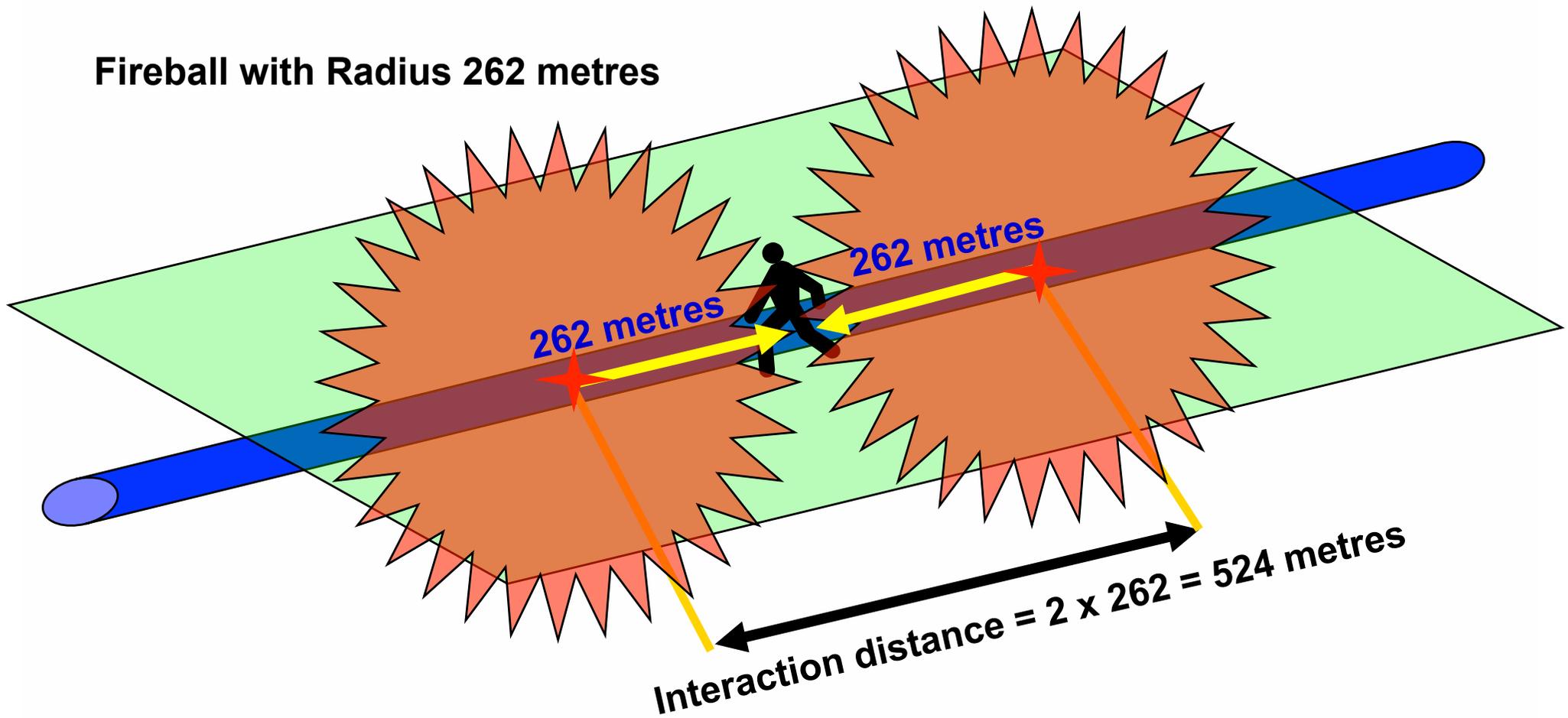
- Good fit to HSE Zone Distances

# Worst Potential Consequence - Fireball



## Individual Risk – how do we calculate Risk Zones?

Fireball with Radius 262 metres



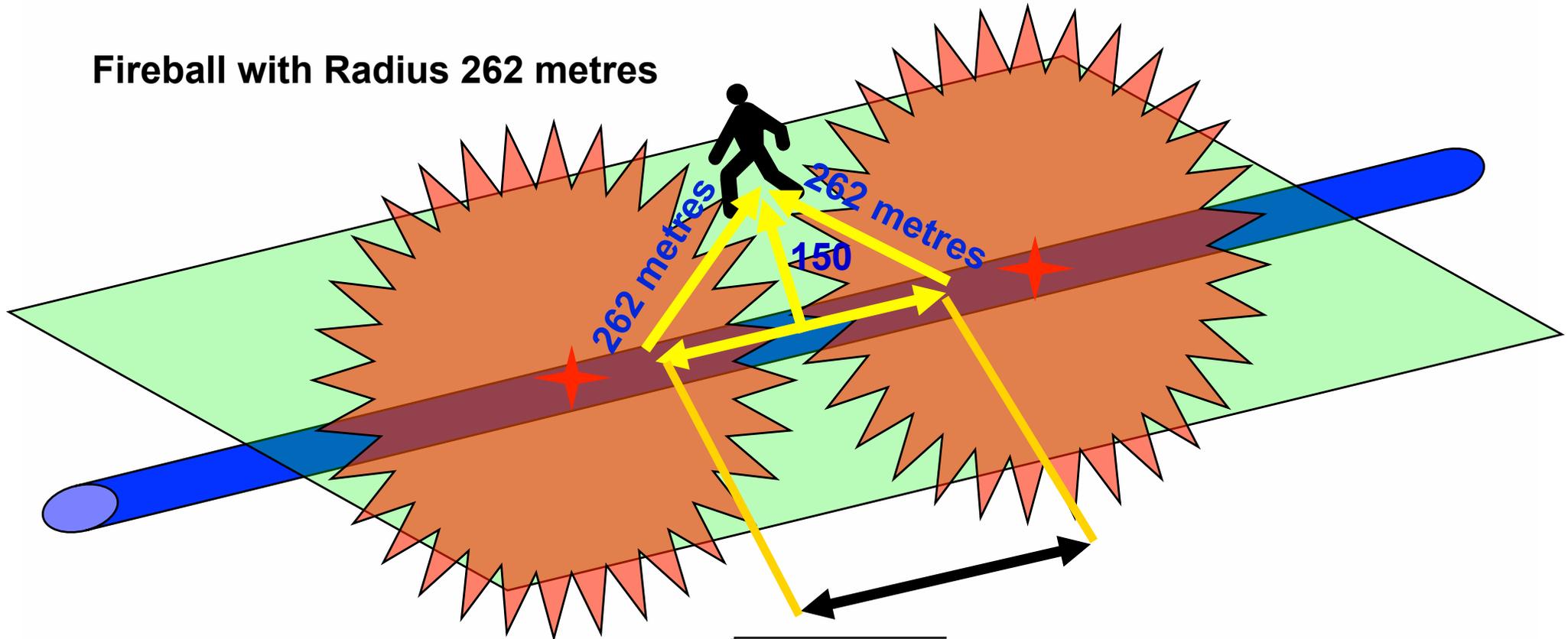
Rupture frequency of pipeline = 0.015 per metre x  $10^{-6}$  per year

Probability of Fireball = 0.25

Individual Risk on pipeline =  $524 \times 0.25 \times 0.015 \times 10^{-6} = 1.97 \times 10^{-6}$  per year

## Individual Risk – how do we calculate Risk Zones?

### Fireball with Radius 262 metres



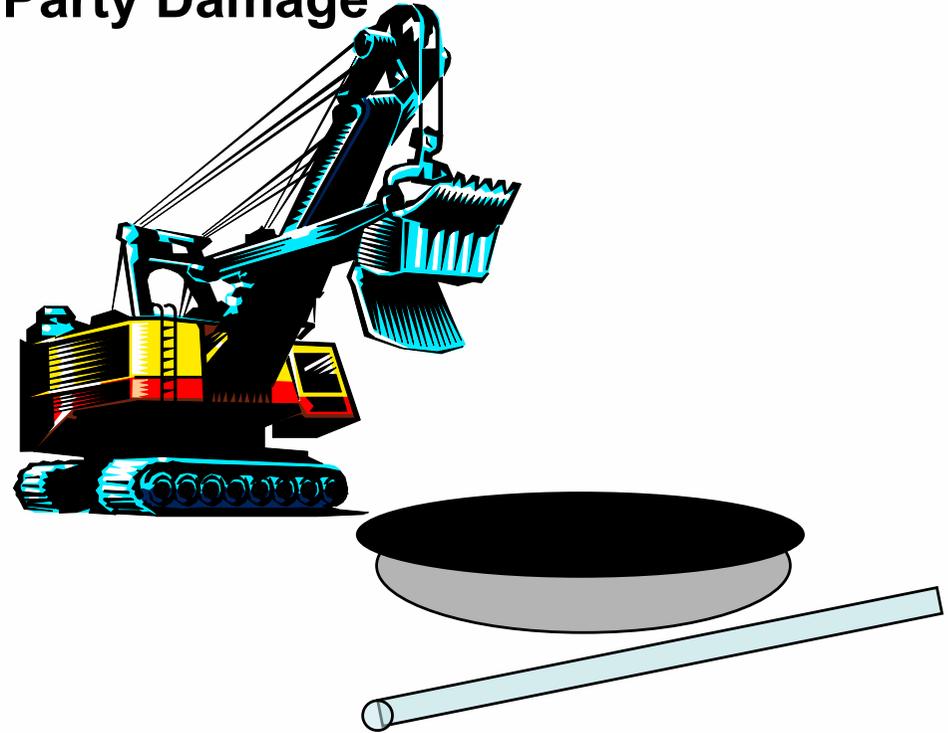
$$\text{Interaction Distance} = 2 \times \sqrt{(262^2 - 150^2)} = 2 \times 215 = 430 \text{ metres}$$

Rupture frequency of pipeline = 0.015 per metre x  $10^{-6}$  per year

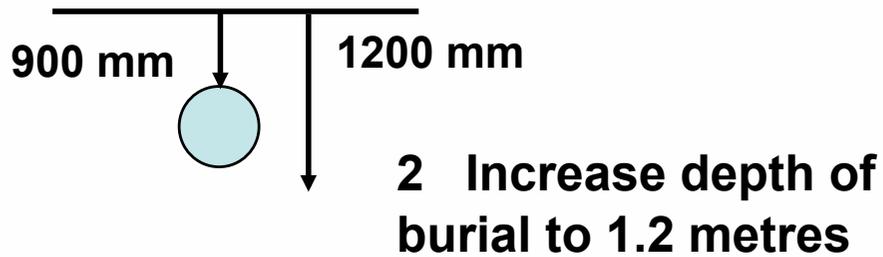
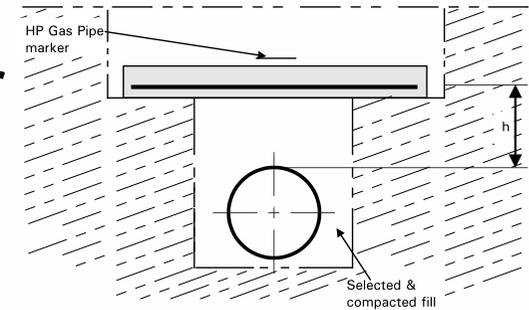
Probability of Fireball = 0.25

Risk 150 metres from pipeline =  $430 \times 0.25 \times 0.015 \times 10^{-6} = 1.61 \times 10^{-6}$  per year  
- so can calculate risk at any distance from pipeline

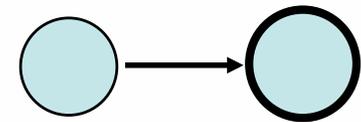
# Mitigation methods – to reduce 3<sup>rd</sup> Party Damage

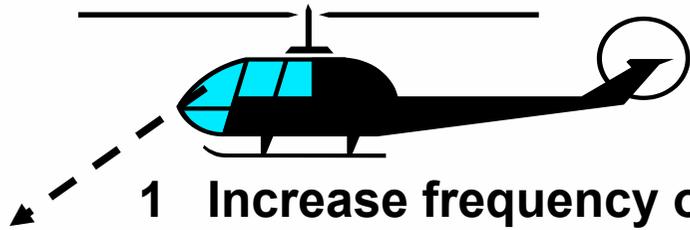


**3 Install concrete slabbing and marker tape to IGE/TD/1 standards**



**4 Replace in thick-wall (14.27 mm) pipe**

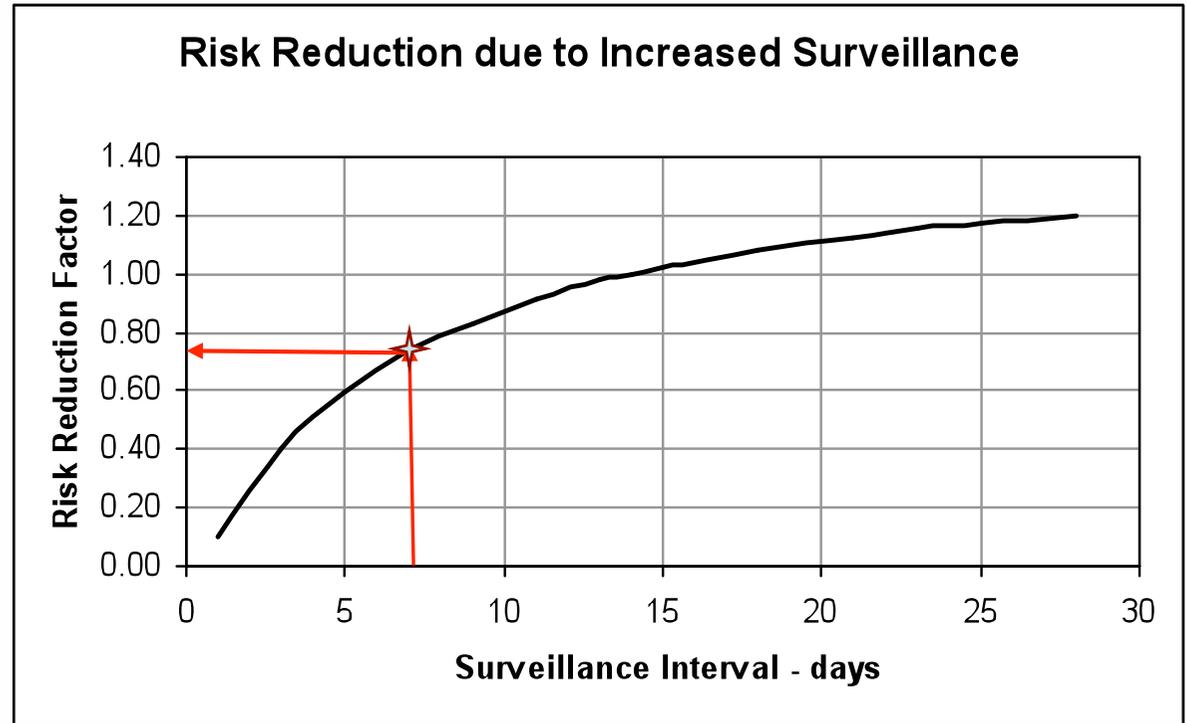




**1 Increase frequency of surveillance to weekly**

**From Code Supplement**

**Risk reduction = 0.75**



**So 3<sup>rd</sup> Party frequencies reduce to 0.75 previous values**

**3<sup>rd</sup> Party frequencies are ~ 65% of total frequency (UKOPA data)**

**Rupture frequency becomes 0.0126 x 10<sup>-6</sup> per metre**

**Risk Calculation re-run with new frequencies =**

RESULTS				
HSE	10 <sup>-6</sup> risk	130	metres	
Calculated	10 <sup>-6</sup> risk	121	metres	
HSE	3 x 10 <sup>-7</sup>	170	metres	
Calculated	3 x 10 <sup>-7</sup>	161	metres	

**Middle Zone reduction to**

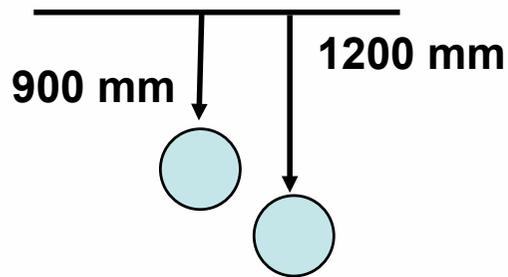
**121 metres still leaves**

**6 houses in Middle Zone**

**- more than 10% of development**

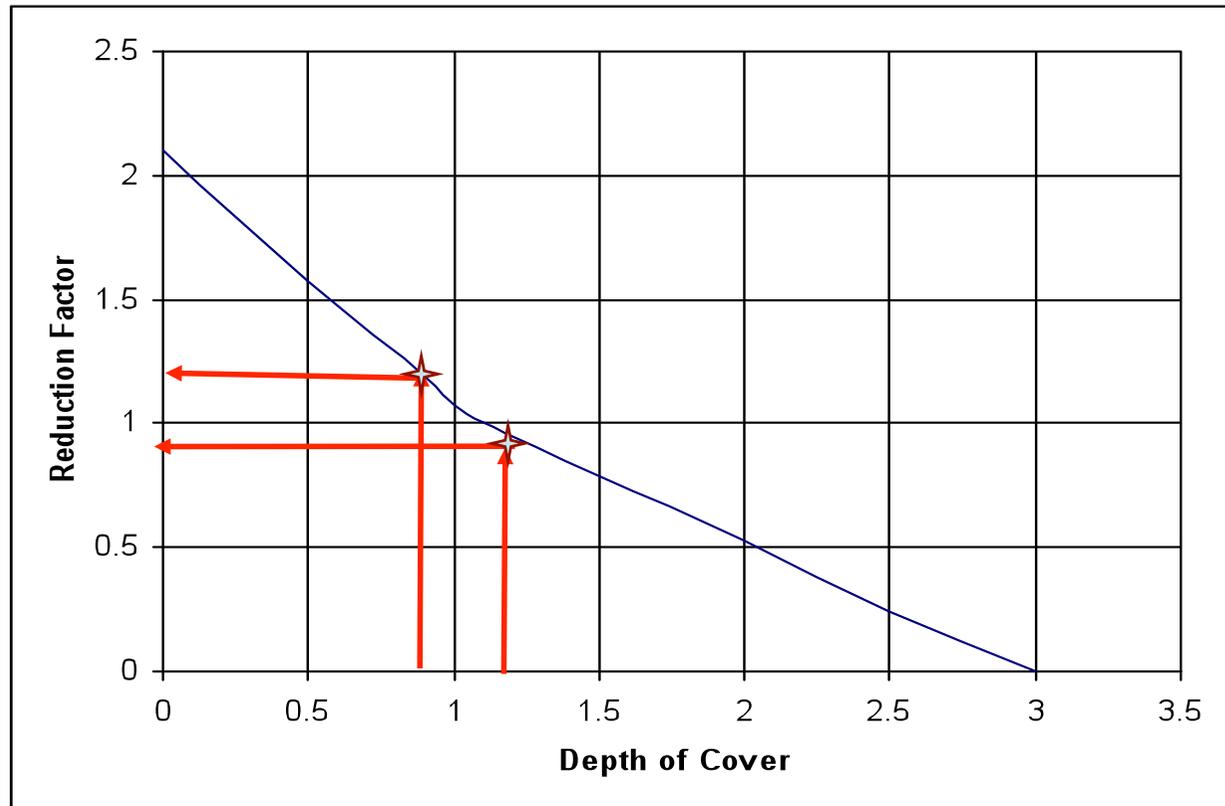
**- still Advise Against**

## 2 Increase depth of burial to 1.2 metres



From Code Supplement  
Standard Depth is  
1.1 metres

Compared to 1.1 metres:-



Existing Depth 0.9 metres gives added risk factor of 1.2 times

Reducing Depth top 1.2 metres reduces risk factor to 0.95 times

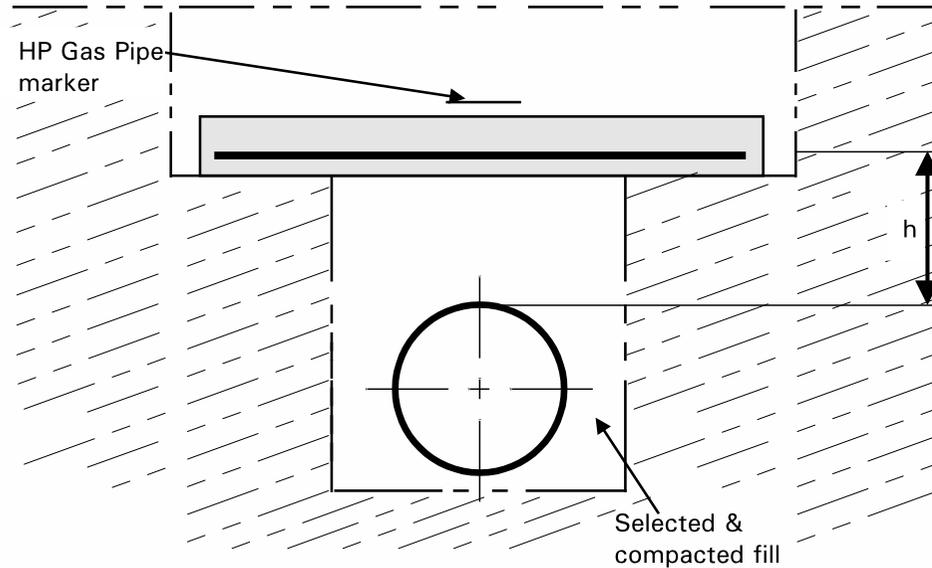
Overall risk reduction from 0.9 to 1.2 metres is therefore  $0.95/1.2 = 0.79$

Less risk reduction than increased surveillance – therefore **Advise Against**

Note that Code advises “Increasing the depth of cover by lowering the pipeline trench or bunding the pipeline is not recommended”

**3 Install concrete slabbing and marker tape to IGE/TD/1 standards**

**Risk Reduction Factor = 0.1**



**So 3rd Party frequencies reduce to 0.75 previous values  
 3rd Party frequencies are ~ 65% of total frequency (UKOPA data)  
 Rupture frequency becomes  $0.0063 \times 10^{-6}$  per metre**

**Risk Calculation re-run with new frequencies =**

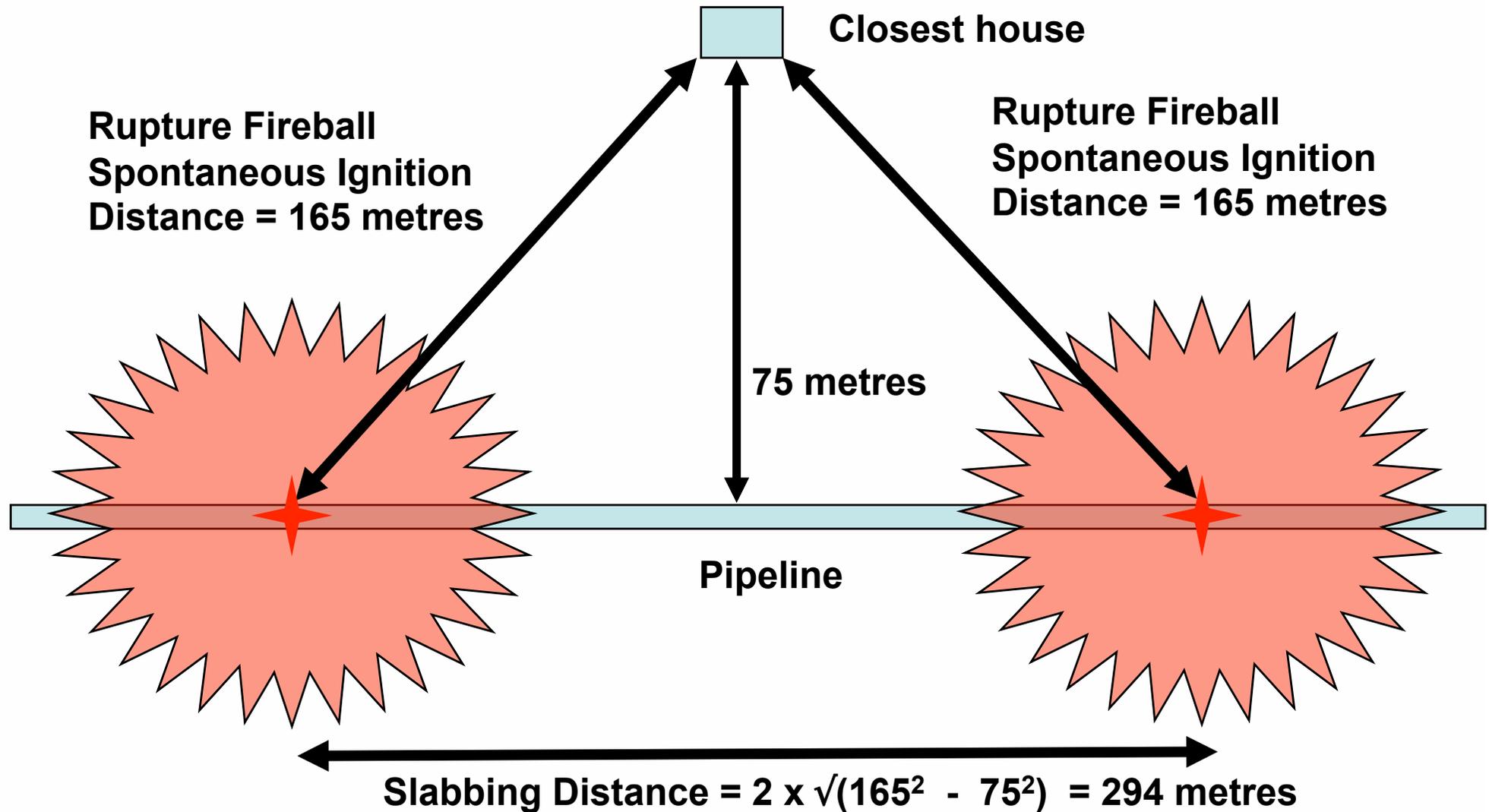
RESULTS				
HSE	$10^{-6}$ risk	130	metres	
Calculated	$10^{-6}$ risk	46	metres	
HSE	$3 \times 10^{-7}$	170	metres	
Calculated	$3 \times 10^{-7}$	138	metres	

**Middle Zone reduction to 46 metres**

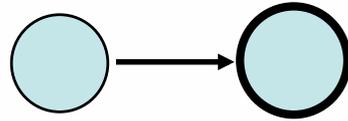
- takes whole development out of Middle Zone
- changes advice to

**Do Not Advise Against**

# How far should concrete slabbing be installed?



4 Replace in thick-wall (14.27 mm) pipe



Design Factor (DF) changes from 0.51 to 0.39

Compared to DF = 0.72:-

DF = 0.51 Reduction Factor = 0.52

DF = 0.39 Reduction Factor = 0.35

Reduction due to Design Factor =  $0.35/0.52 = 0.67$

Wall Thickness (WT) changes from 11.1 mm to 14.27 mm

Compared to WT = 5.35 mm:-

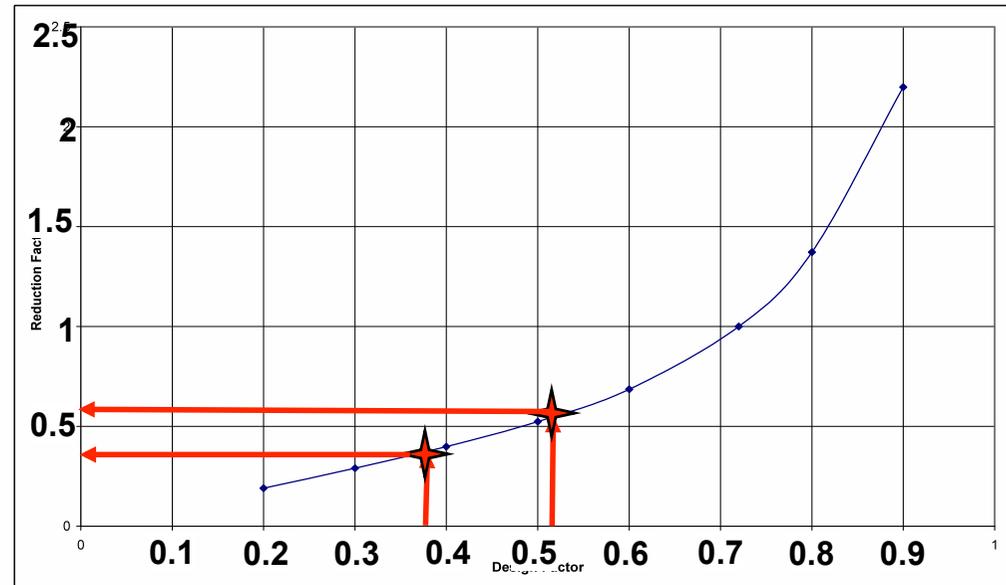
WT = 11.1, Reduction Factor = 0.25

WT = 14.27, Reduction Factor = 0.14

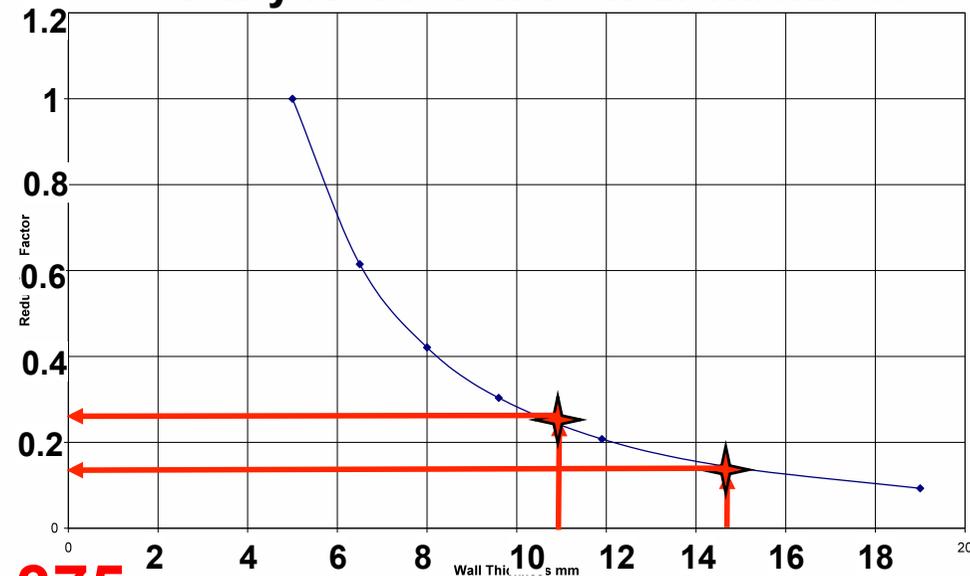
Reduction due to Wall Thickness =  $0.14/0.25 = 0.56$

Overall Reduction =  $0.67 \times 0.56 = 0.375$

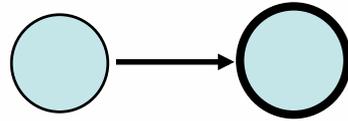
3<sup>rd</sup> Party Reduction Vs Design Factor



3<sup>rd</sup> Party Reduction Vs Wall Thickness



4 Replace in thick-wall (14.27 mm) pipe



Overall Reduction =  $0.67 \times 0.56 = 0.375$

Assume this applies to all failure mechanisms, not just 3<sup>rd</sup> Party

Rupture frequency becomes  $0.0056 \times 10^{-6}$  per metre

Risk Calculation re-run with new frequencies =

RESULTS				
HSE	$10^{-6}$ risk	130	metres	
Calculated	$10^{-6}$ risk	34	metres	
HSE	$3 \times 10^{-7}$	170	metres	
Calculated	$3 \times 10^{-7}$	138	metres	

Middle Zone reduction to

**34 metres**

- takes whole development out of Middle Zone
- changes advice to

**Do Not Advise Against**

What is length of thick-wall pipe required? - 294 metres as for slabbing

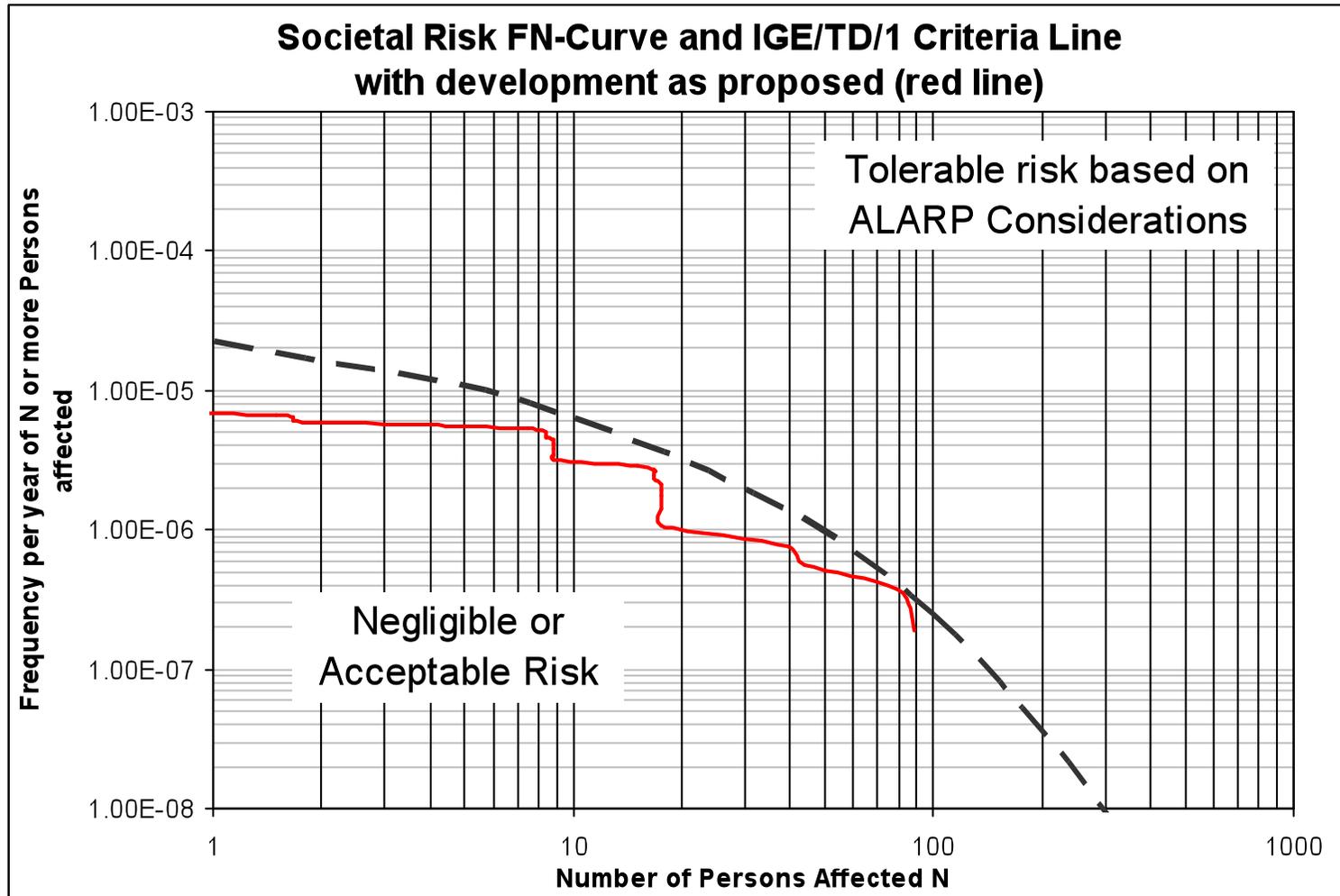
# Assessment of Societal Risk using F–N plot

Development assumed to contain:-

2 persons per house +10% outside during daytime = 84 people total

4 persons per house + 10% outside during nighttime = 167 people total

Interaction distance for calculating IGE/TD1 Criteria curve = 502 metres





# However if additional population added up to maximum allowed by IGE Code

= 2.5 persons per hectare:-

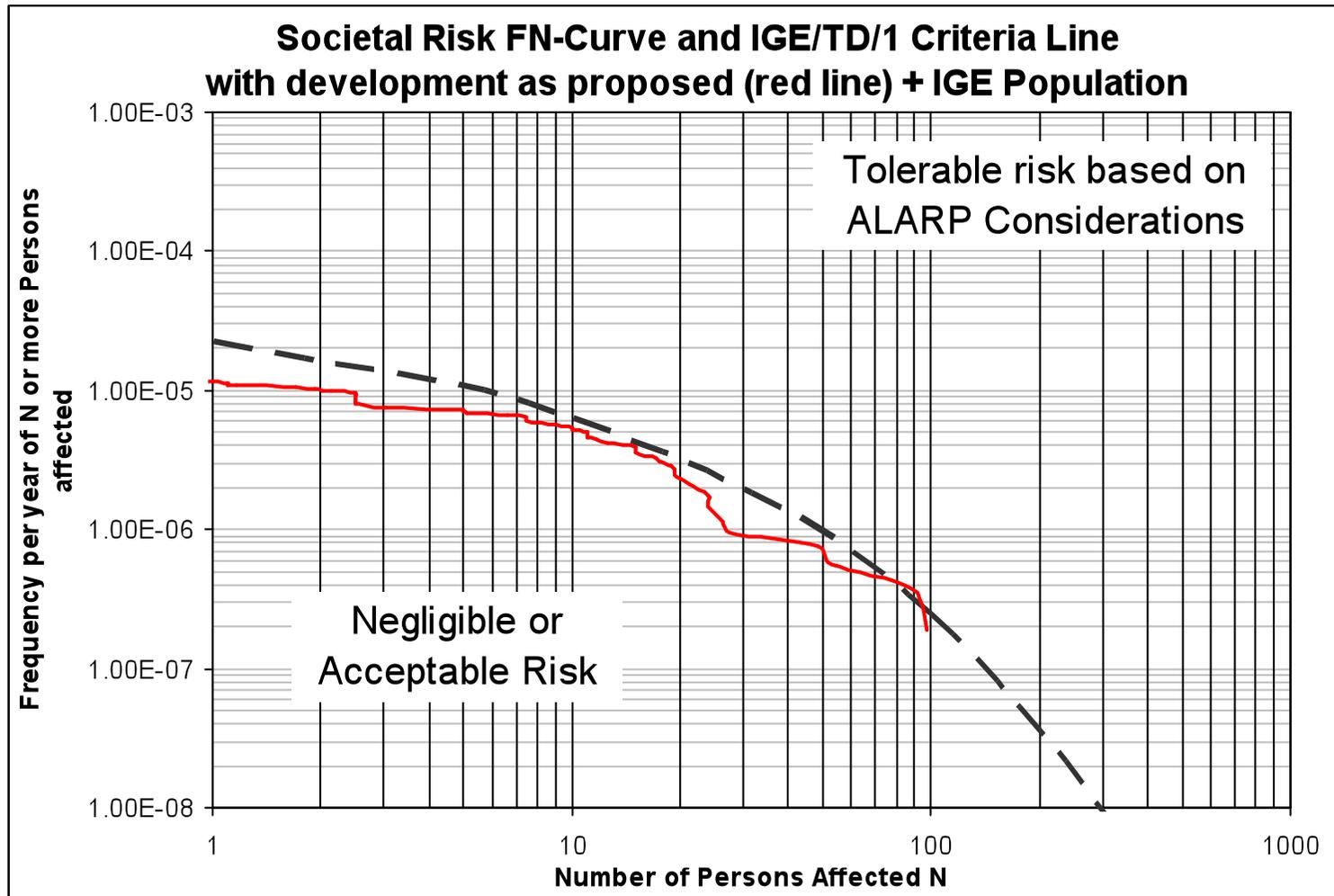
Daytime

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	2.5	30.8	35.2	8.8	2.5	0	0	0	0
0	0	0	0	0	0	1.25	8.8	1.25	1.25	1.25	0	0	0	0
0	0	0	0	0	0	1.25	1.25	1.25	1.25	1.25	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Nighttime

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	2.5	61.6	70.4	17.6	2.5	0	0	0	0
0	0	0	0	0	0	1.25	17.6	1.25	1.25	1.25	0	0	0	0
0	0	0	0	0	0	1.25	1.25	1.25	1.25	1.25	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

## F-N Curve begins to exceed criteria:-



Criteria derived from high Design Factor standard population cases