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# Pipelines Risk Assessment and LUP in HSE

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HID CI5G

# HSE involvement in LUP

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- Extends back to the early 1970s
- Flixborough (1974) and Seveso (1976)
- Advisory Committee on Major Hazards
- Planning Legislation and HSE as a Statutory Consultee
- Advice given through PADHI

# Legislation

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## HSE

Notification of  
Installations Handling  
Hazardous Substances  
Regulations 1982

COMAH

Pipeline Safety  
Regulations 1996

## LPAs

Planning (Hazardous  
Substances) Act 1990

Planning (Hazardous  
Substances)  
Regulations 1992

General Development  
Procedure Order 1995  
(GDPO)

# Developments on Land Use Planning

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## Current system

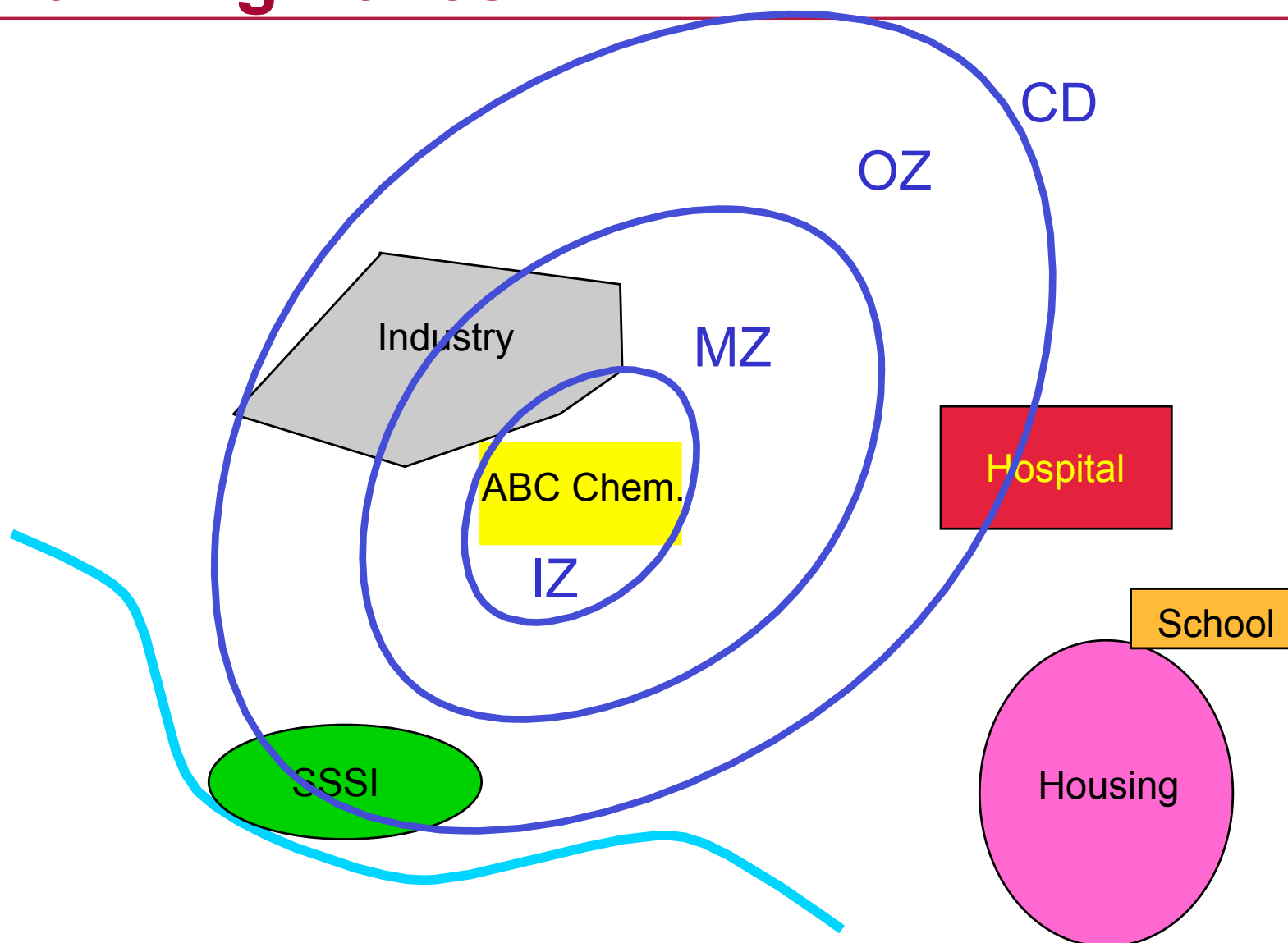
- HSE's role is two fold but both advisory -
  - setting consultation distances
  - advising on proposed developments in vicinity of hazardous installations

# Land Use Planning

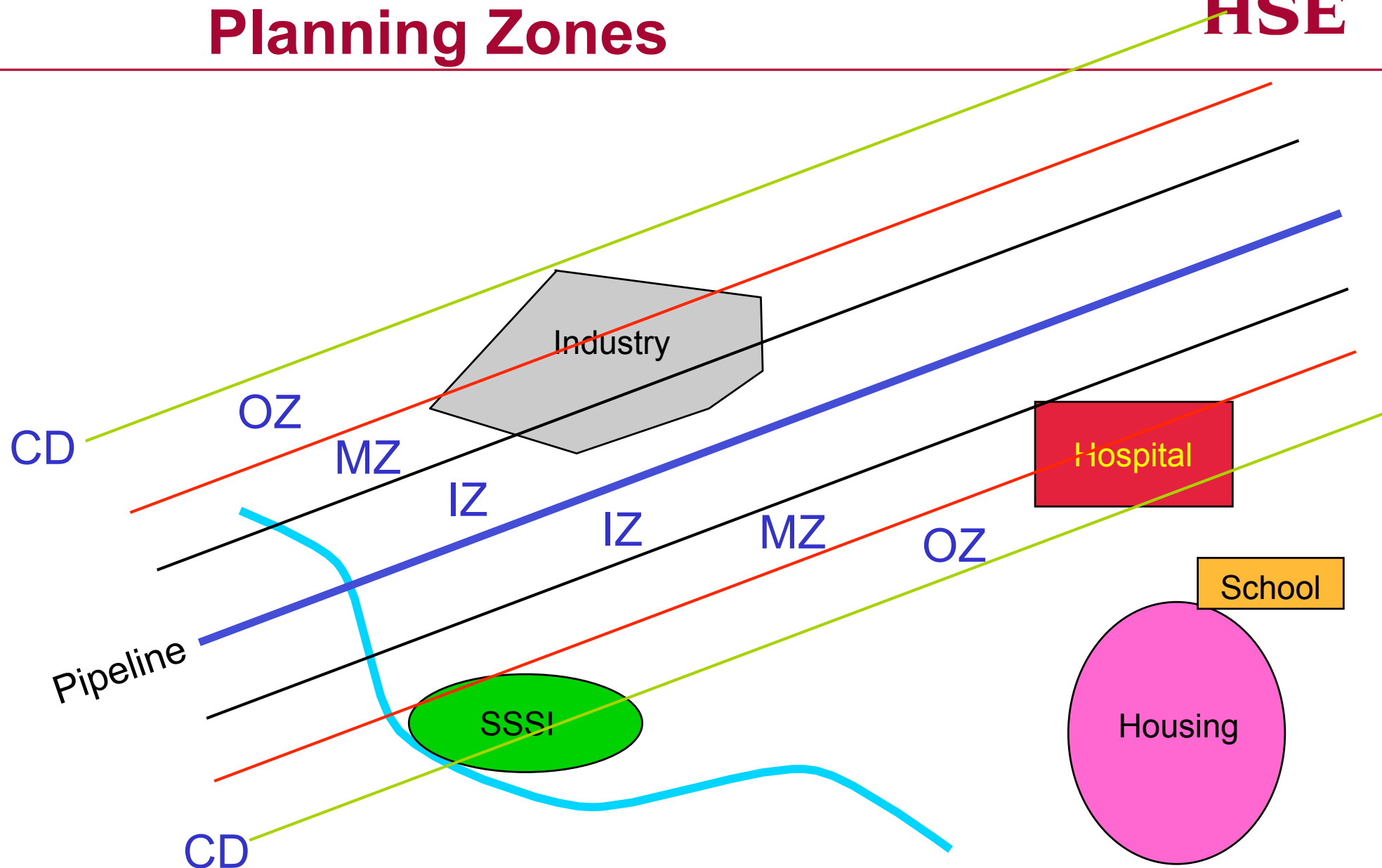
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- Zones define areas of particular concern
- Consultation Zone is limit of HSE interest
- Within CD there are:
  - Inner Zone (10 cpm)
  - Middle Zone (1 cpm)
  - Outer Zone (0.3 cpm)
- Chances per million (cpm) per year of receiving a Dangerous Dose
- Consequence based zones (mainly for flammables)

# Planning Zones



# Planning Zones



## Societal risk – cross-Gov't work

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- HSE LUP advice largely based on individual risk - cumulative affect of developments is not considered
- Population levels/density around sites can increase over time
- Cross-government Task Group
- Not a new concept

# Risk Assessment

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- Risk from steady state operation of pipeline
- (Not construction, etc.)

# Pipeline Risk Assessment Process

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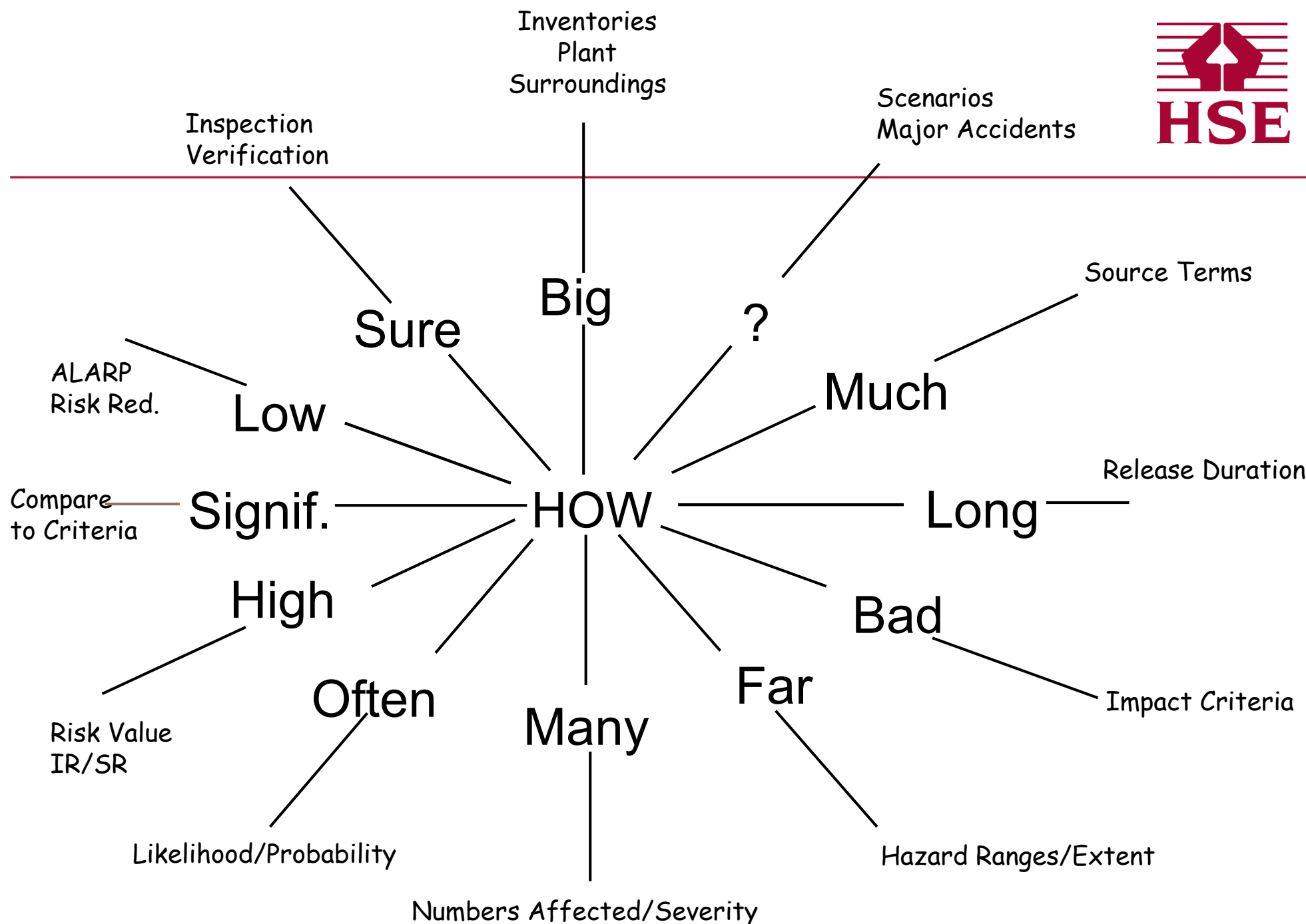


**Inputs to MISHAP**

**Event likelihood**

**Consequence calculations**

**Risk outputs**



# General inputs

**MISHAP01 Version A.8e - General Inputs (untitled)**

Assessment description:

Weather station:

Atmos temperature (\*K):

Humidity (%):

**Substance details**

State: ☒ Gas ☐ Liquid

Name:

**Pipeline Details**

Pressure (bar g):

Temperature (\*K):

Outer Diameter (mm):  (standard size)

Length (km):

Orientation (\*):

Wall thickness (mm):

Depth (m):

**Release size (mm)**

Release 1:

Release 2 (Large):

Release 3 (Small):

Release 4 (Pin):

# Event likelihood –Failure frequency

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- Third Party Activity
  - Predictive model
  - Based on structural reliability
  - Uses BG damage data
  - Validated and verified against operational data
  - Similar to model used by Advantica

# Event likelihood – Failure frequency

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- Other failure modes
  - Mechanical, corrosion, natural causes and other
  - Previously based on EGIG data
  - Now based on UKOPA data
  - Main difference are in “mechanical” and “natural causes”

# Event likelihood – Failure frequency



**MISHAP01 - ExtFail Run (Test Run)**

General Inputs (Not Editable Here)

Pipeline diameter (mm):

Pipeline depth (m):

Specific Inputs (Not Editable Here)

Base failure frequency (events per year per m of pipeline):

**Results - Events per year per m of pipeline**

Release 1 (Rupture):

Release 2 (Large):

Release 3 (Small):

Release 4 (Pin):

Pipeline Nominal Size

☒ Use for Failure Rates

Value (mm):

☐ Pipeline slabbed

☐ Allow for depth of cover (Depth is less than 1m)

# Event likelihood –Event probability

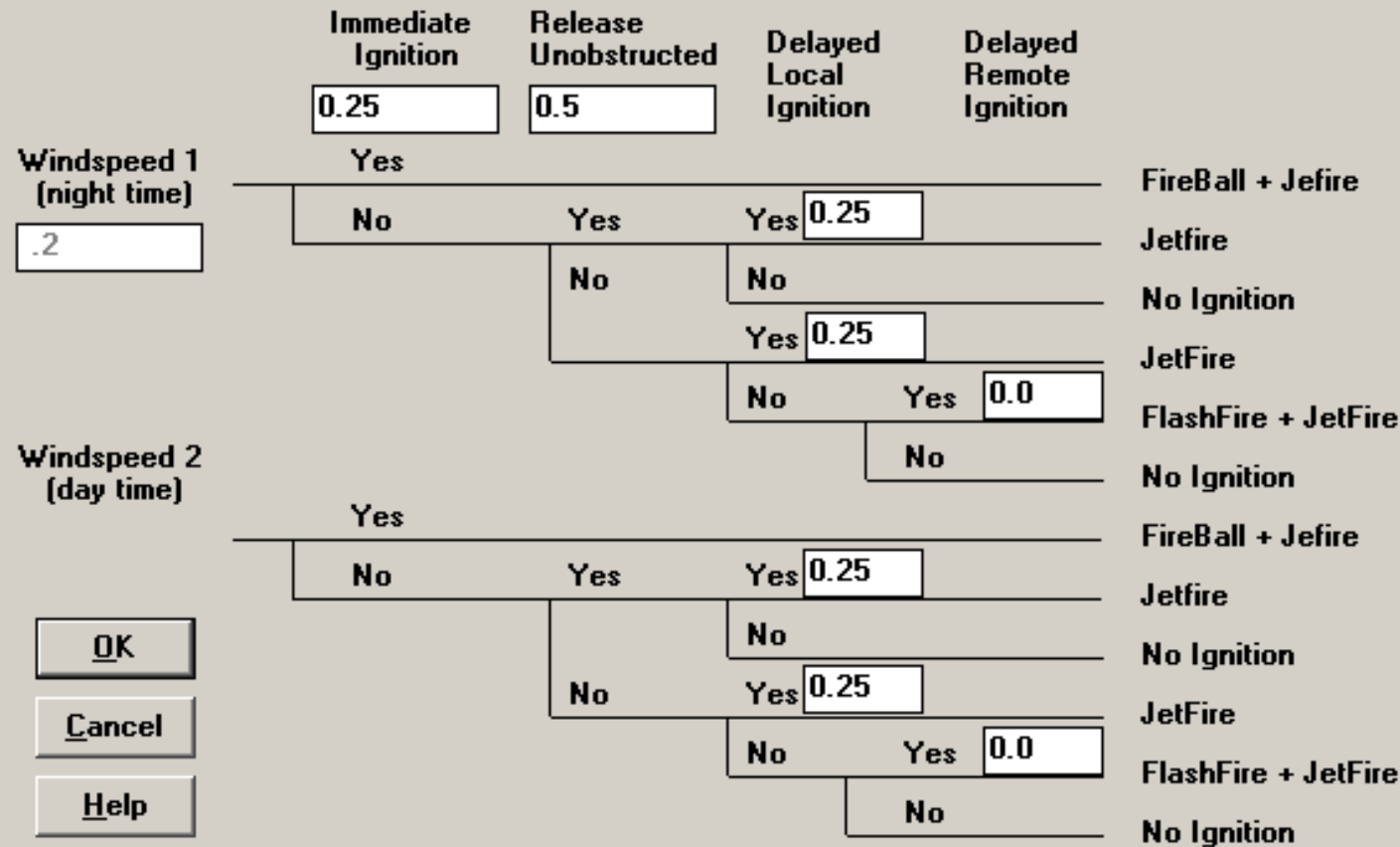


## MISHAP01 - Event Tree Edit (Test Run)

### Specific Inputs for EVENTTREE

Windspeed probabilities from:

☒ Weather station ☐ Other



# Consequences – release rates

**MISHAP01 - LOSSP Release 1 Run (untitled)**

**Substance Properties for methane**

Mol Wt (kg/kg mole):	16.04	Viscosity (Pa.s):	1.087e-5
Critical Press (Pa):	4580000	Sp Heat (J/kg°K):	2197
Critical Temp (°K):	190.4	Sp Heat Ratio:	1.31

**LOSSP Results**

**Initial Conditions**

Mass in pipeline (kg):	702294	Fireball mass (kg):	195091.1
Release rate (kg/s):	17247.87	Fireball duration (s):	20.7
Compressibility:	0.839	Release rate (kg/s) at 30 s:	4013.12

☒ Use substance specific A value for fireball calculations

☒ Use FLAMCALC correlation for fireball duration

Calculate release rate at:

☒ 30 s.

☐ Other time

**View Results**

**Graph**

**OK**

**Help**

**Cancel**

**Print Window**

## Consequences – impact models

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- Fireball – FLAMCALC
- Jetfire – PIPEFIRE
- Flashfire – not used for natural gas
- Models have been compared to experimental and incident data (RR036, CRR294/2000)

# Consequences – impact models

**MISHAP01 - FBALL Fireball 1 Run (Test Run)**

Fireball mass calculated by release model (te):	195.091
Fireball mass for calculations (te):	195.091
Fireball duration (s):	20.7
Fireball radius (m):	176.3
Distance to 500tdu (m):	549.0
Distance to 1000 tdu (m):	409.0
Distance to 1800 tdu (m):	307.0
Distance to spontaneous ignition (m):	229.0

☒ Restrict fireball mass to 300 te for calculations

☒ Restrict fireball duration to 30 s for calculation

☒ Use substance specific A value for calculations

☒ Use FLAMCALC correlation for fireball duration

**View Results** **Print Window** **Graph** **OK** **Cancel** **Help**

# Consequences – impact model

**MISHAP01 - PIPEFIRE Jetfire 1 Run (Test Run)**

Surface emissivity (kW/m<sup>2</sup>):

Flow Rate (kg/s):

**Flame Shape**

Flame length (m):

Flame Width (m):

**PIPEFIRE Results**

☐ Include Fireball

Distance (m) to 500 tdu:

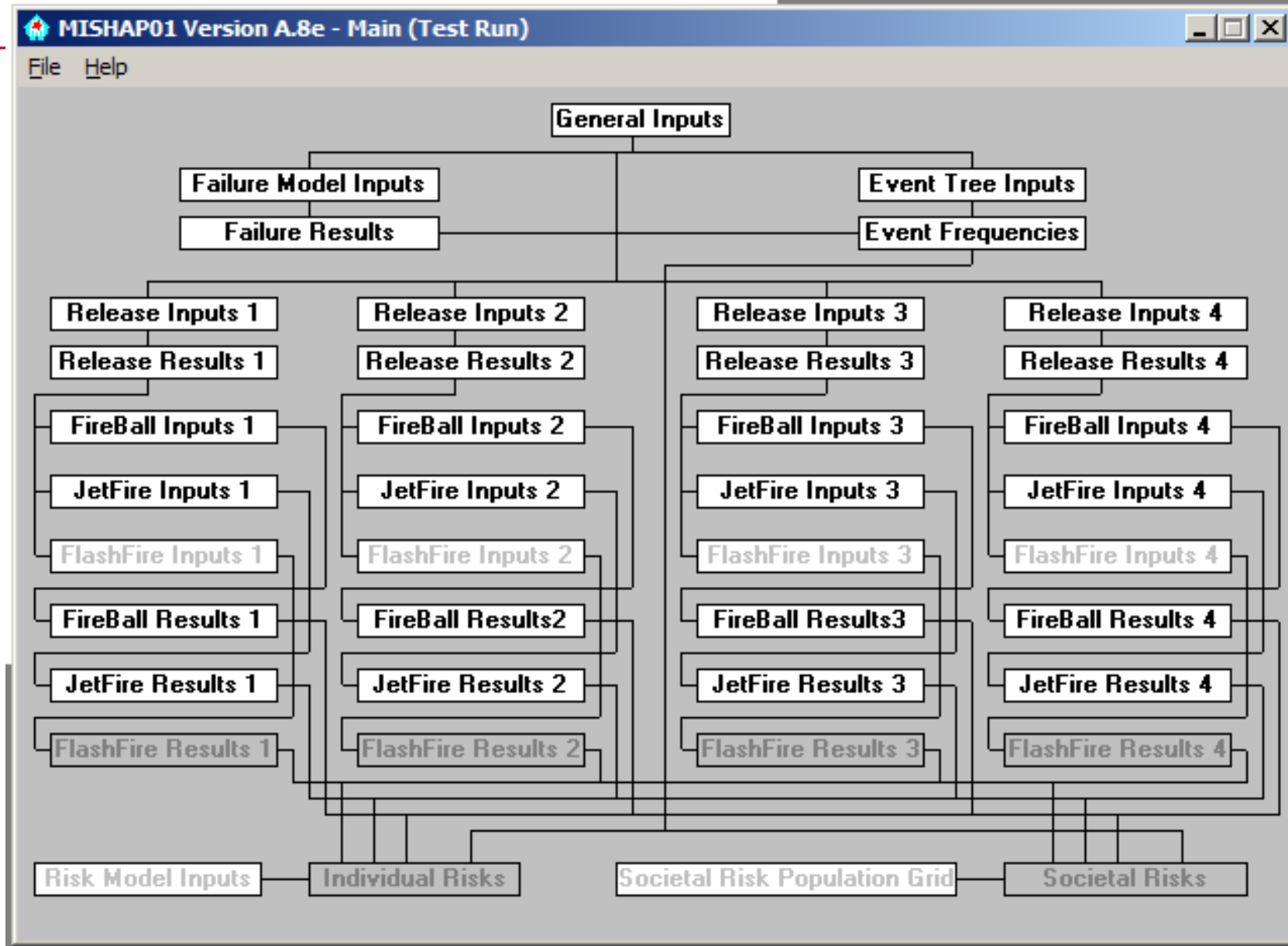
Distance (m) to 1000 tdu:

Distance (m) to 1800 tdu:

Distance (m) to 25.6kW/m<sup>2</sup>:

Distance (m) to 14.7kW/m<sup>2</sup>:

# MISHAP structure



# Risk outputs – Individual Risk

**MISHAP01 - RISKS Run (Test Run)**

File

**RISKS Results - Chances Per Million Per Year**

	1	2	3	4	Total
Fireball followed by jetfire:	0.357	1.537	0.000	0.000	1.894
Jetfire:	0.265	1.062	0.000	0.000	1.327
Flashfire followed by jetfire:	0.000	0.000	0.000	0.000	0.000
Total:	0.622	2.599	0.000	0.000	3.221

Distances to Risks: 1e-5  1e-6  281 3e-7  290

Calculate risks of:   
☒ Dangerous dose ☐ Probit Death

Risk options:   
☒ Uniform Wind Rose ☐ Wind sector   
☐ Wind Always towards target

Target position relative to pipeline:   
☐ East ☐ West

☒ No fireball dose for escaping indoor occupants

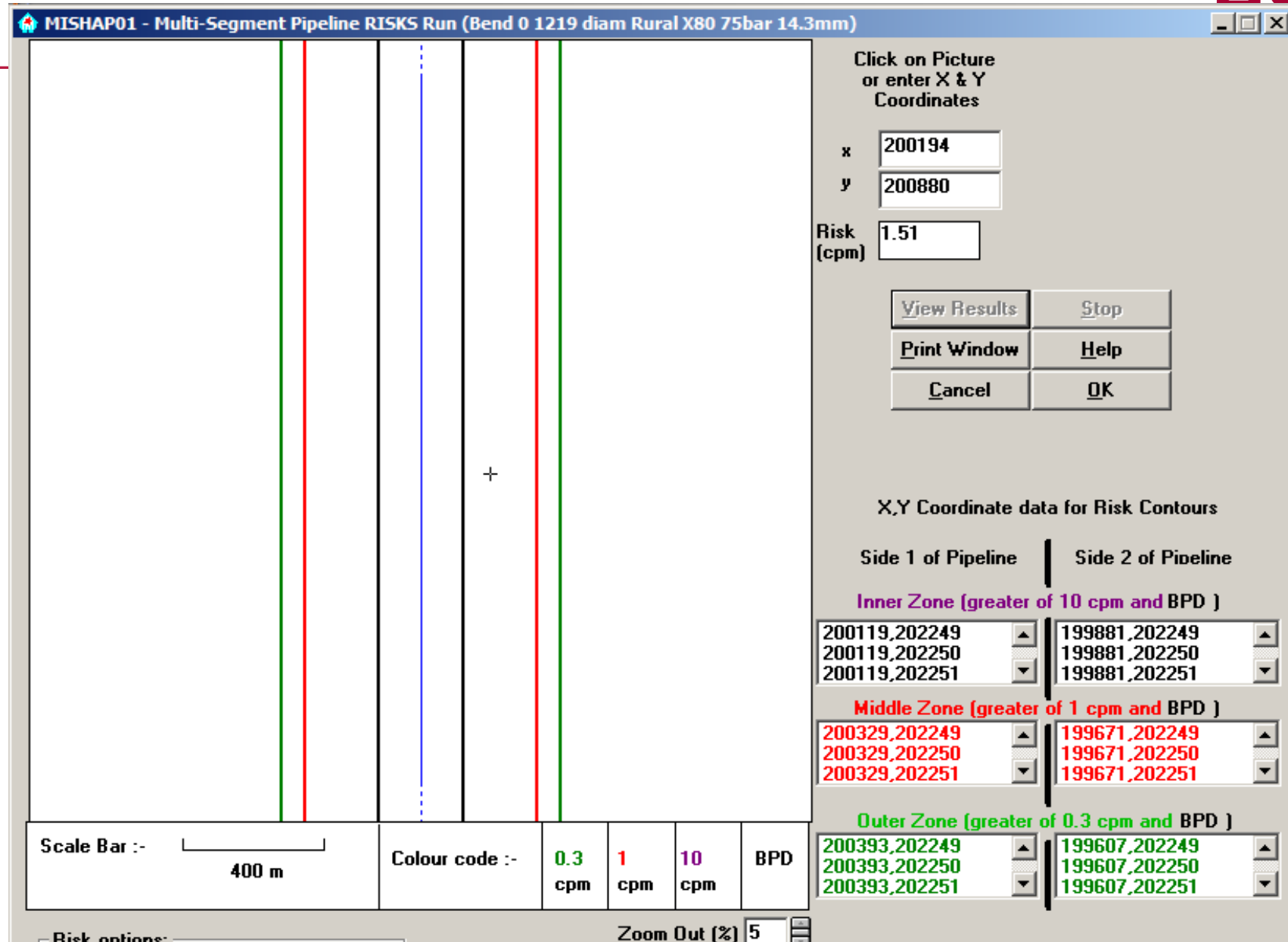
**View Results** **Print Window** **Graph** **OK** **Cancel** **Help**

Display results for:   
☒ All releases   
☐ Release 1 ☐ Release 2   
☐ Release 3 ☐ Release 4

14 Distances   
Distance (m):  100   
(standard)

**Add** **Delete**

# Risk outputs – Individual Risk



# Risk outputs – Societal Risk

**MISHAP01 - SRISKS Edit (Test Run)**

Grid Square Size - Click on a Button to Change

25 50 100 100

14					2	2	2	2				
13						2	2	2	2			
12								2				
11												
10	10	10	10	10	10	10	10	10	10	10	10	10
9			2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		
8			2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		
7			2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		
	10	11	12	13	14	15	16	17	18	19	20	21

OK  
Cancel  
Help

**Population**

☒ No change  
☐ Normal  
☐ Industrial  
☐ Special  
☐ None

Value: 2.5

**Occupancy percentages**

		Normal		Industrial		Special	
		In	Out	In	Out	In	Out
Windspeed 1:	(night-time)	99	1	.00	.00	.00	.00
Windspeed 2:	(day-time)	90	10	.00	.00	.00	.00
Windspeed 3:		.00	.00	.00	.00	.00	.00
Windspeed 4:		.00	.00	.00	.00	.00	.00

# Risk outputs – Societal Risk

**MISHAP01 - SRISKS Run (Test Run)**

File

**Societal Risk**

No. of Casualties		Frequency (yr-1)	No. of Casualties		Frequency (yr-1)
		n      n or more			n      n or more
>100000	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	201 - 501	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>
75001 - 100000	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	101 - 201	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>
50001 - 75001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	76 - 101	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>
20001 - 50001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	51 - 76	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>
10001 - 20001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	21 - 51	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>
7501 - 10001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	11 - 21	<input type="text" value="6.50E-07"/>	<input type="text" value="6.50E-07"/>
5001 - 7501	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	8 - 11	<input type="text" value="1.36E-06"/>	<input type="text" value="2.01E-06"/>
2001 - 5001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	5 - 8	<input type="text" value="2.45E-06"/>	<input type="text" value="4.45E-06"/>
1001 - 2001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	2 - 5	<input type="text" value="1.01E-06"/>	<input type="text" value="5.47E-06"/>
751 - 1001	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	1	<input type="text" value="0.00E+00"/>	<input type="text" value="5.47E-06"/>
501 - 751	<input type="text" value="0.00E+00"/>	<input type="text" value="0.00E+00"/>	0	<input type="text" value="2.19E-07"/>	<input type="text" value="5.69E-06"/>

Set calculation steps:

Risk options:

☐ Uniform Wind Rose ☒ Wind sector

☐ Wind Always towards target

Calculate risks of:

☐ Dangerous dose ☒ Probit Death

☒ No fireball dose for escaping indoor occupants

Nmax

F(Nmax)

Risk Integral

## Other substances

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- Propane
- Ethylene
- Hydrogen
- Crude Oil
- Ethane
- VCM
- Gasoline (PIPERS)
- Ammonia (Toxic PRAM)

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# **Planning Advice for Developments near Hazardous Installations**

# Introduction



PADHI (**P**lanning **A**dvice for **D**evelopments near **H**azardous **I**nstallations) is the name of the procedure used to give a response and advice on consultations involving land use planning proposals.

PADHI+ is the software used by Planning Authorities to generate the advice themselves.

Extranet contains maps of fixed site LUP zones and LUP distances for pipelines.

# Why PADHI ?



- Use specialist resource for assessing Seveso reports
- Fundamental review of HSE role in land use planning
  - Recommended advice codified and an IT tool provided to planners to generate HSE advice themselves.

# PADHI - Basic System

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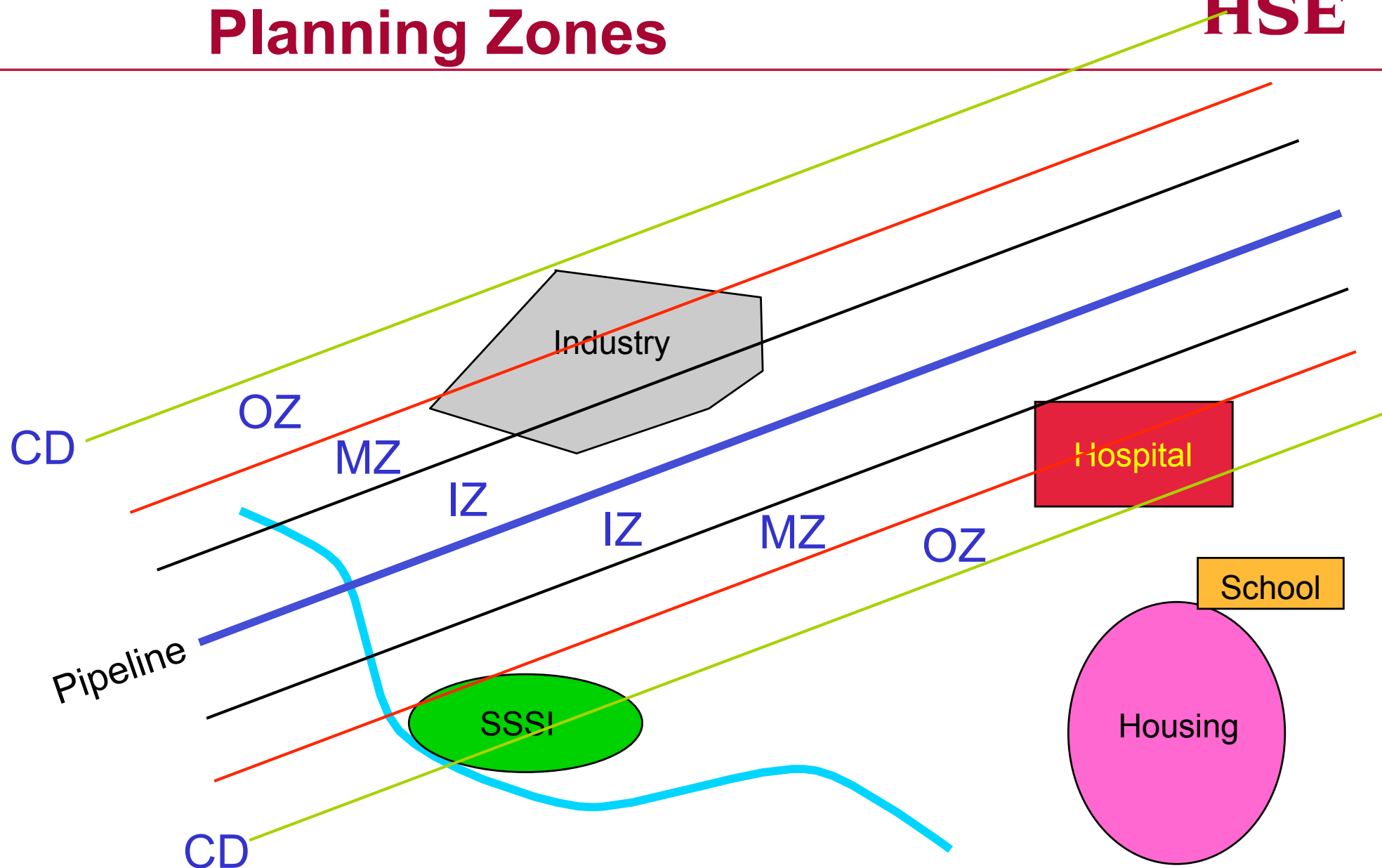
2 inputs to decision matrix:

- Where the development is
  - **What is the development?**
- What it is
  - **What is the impact?**

Generate either:

- 'Advise Against' – (**AA**)
- 'Don't Advise Against' – (**DAA**)

# Planning Zones



## Sensitivity Levels

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- SL 1 – people at work, parking
- SL 2 – use by the general public
- SL 3 – use by vulnerable people
- SL 4 – very large and sensitive developments

[www.hse.gov.uk/landuseplanning](http://www.hse.gov.uk/landuseplanning)

# Decision Matrix



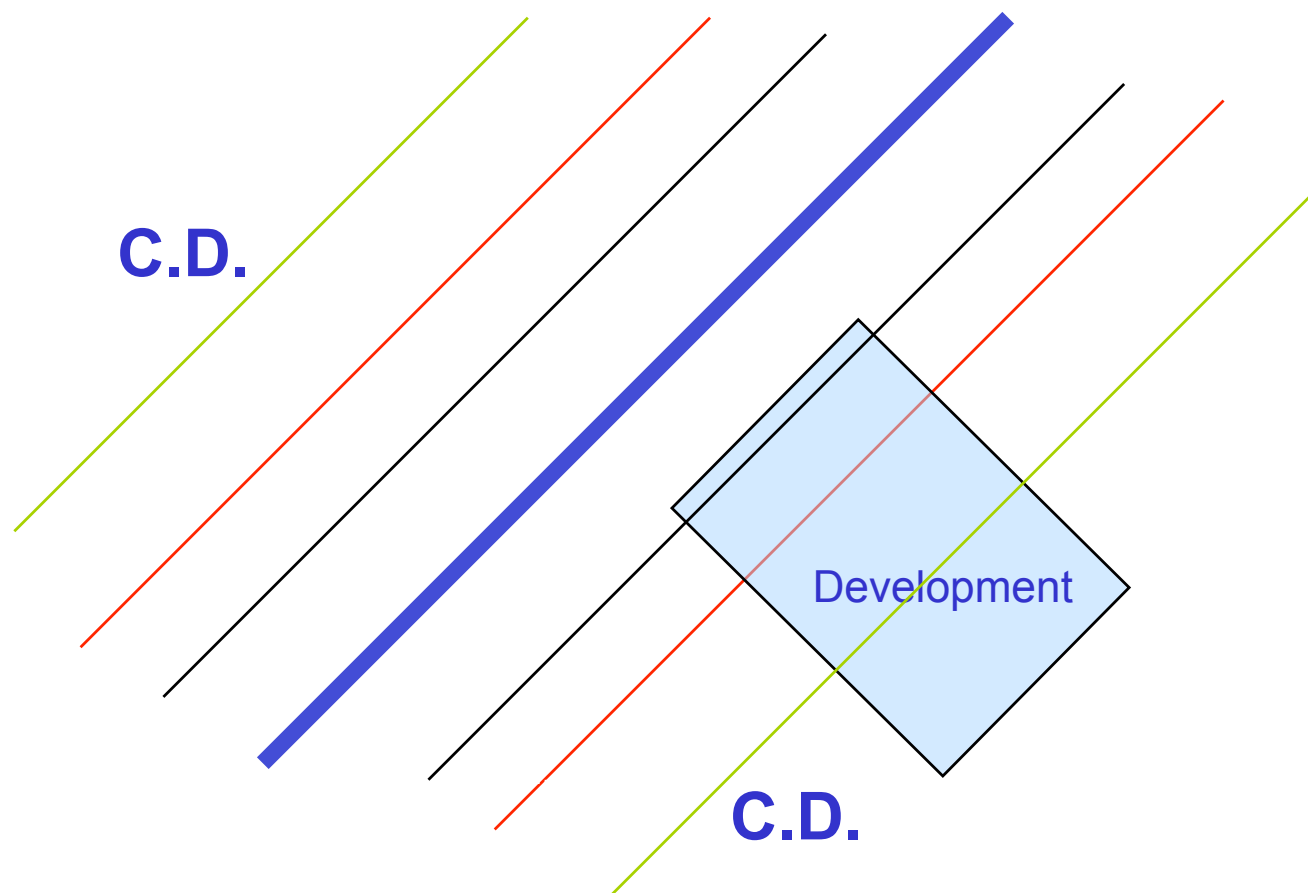
Sensitivity Level	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
3	AA	AA	DAA
4	AA	AA	AA

# Rules



- 
- Rules for:
    - Zone boundaries being straddled
    - More than one hazard
    - More than one land use
    - Extension to existing development facility

# 'Straddling'

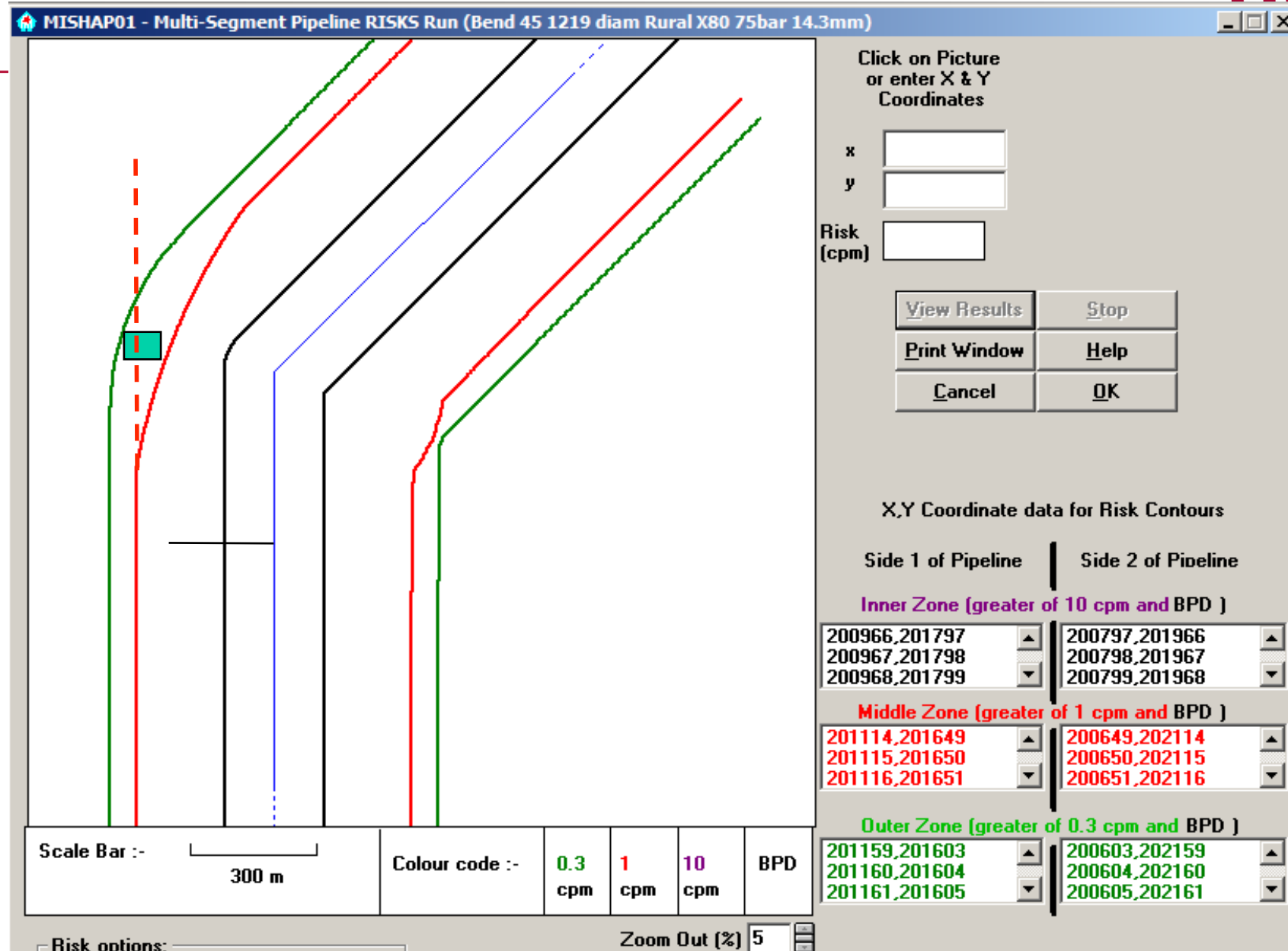


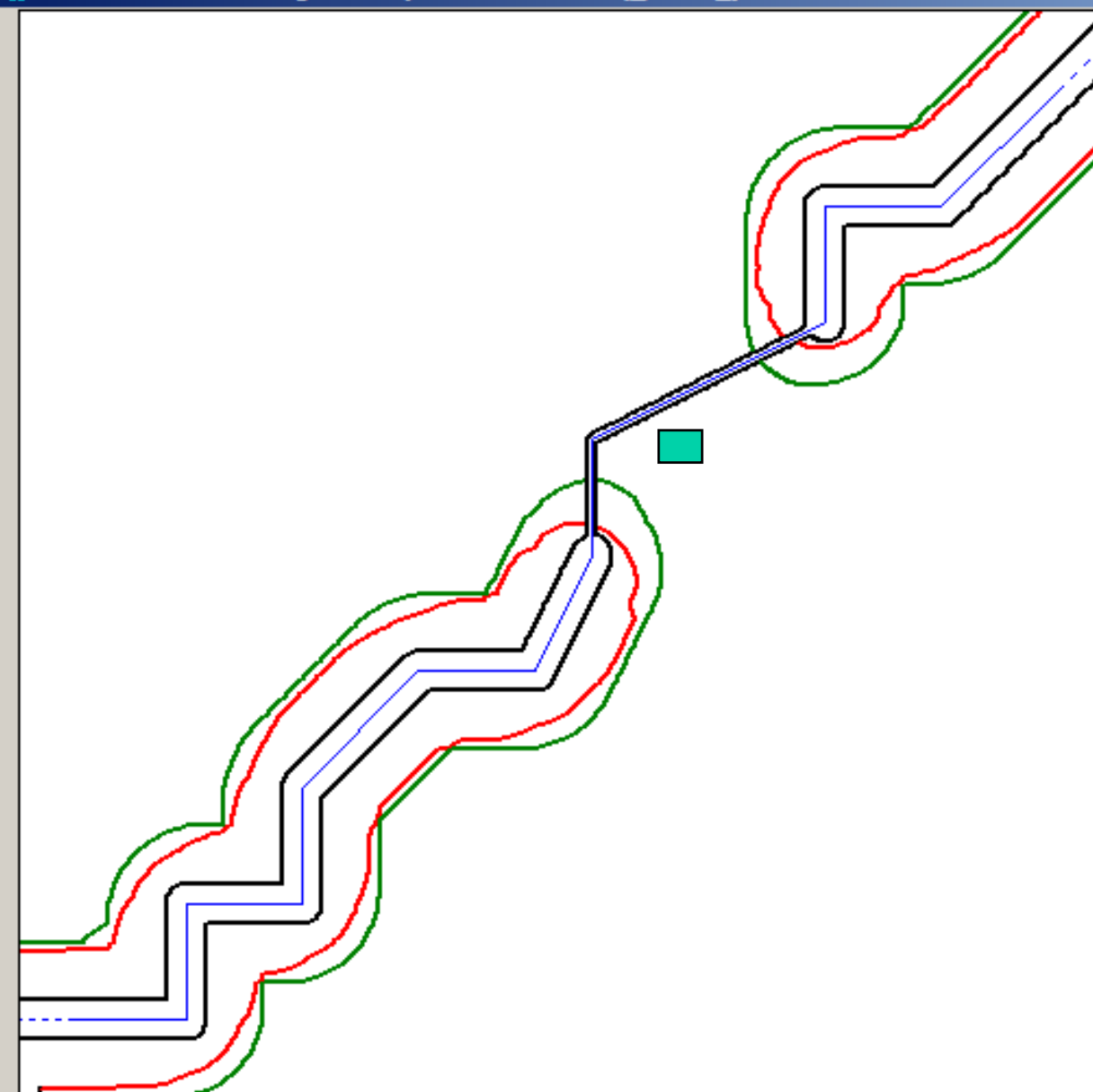
## **‘Multiple major hazards’**

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- More than 1 installation or pipeline
  - Must consider all
  - PADHI decision for each
  - Any AA decision dominates

# Second Bite Cases





Click on Picture  
or enter X & Y  
Coordinates

x

y

Risk  
(cpm)

View Results

Stop

Print Window

Help

Cancel

OK

X,Y Coordinate data for Risk Contours

Side 1 of Pipeline

Side 2 of Pipeline

Inner Zone (greater of 10 cpm and BPD )

351587,367962  
351588,367963  
351589,367964

351562,367987  
351563,367988  
351564,367989

Middle Zone (greater of 1 cpm and BPD )

351615,367933  
351616,367934  
351617,367935

351533,368015  
351534,368016  
351535,368017

Outer Zone (greater of 0.3 cpm and BPD )

351621,367927  
351622,367928  
351623,367929

351527,368021  
351528,368022  
351529,368023

Scale Bar :-

100 m

Colour code :-

0.3  
cpm

1  
cpm

10  
cpm

BPD

Risk options:

Zoom Out (%)

5

© Uniform Wind Rose, © Wind contour