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Hazardous Area Classification of Low Pressure Natural Gas Systems using CFD Predictions

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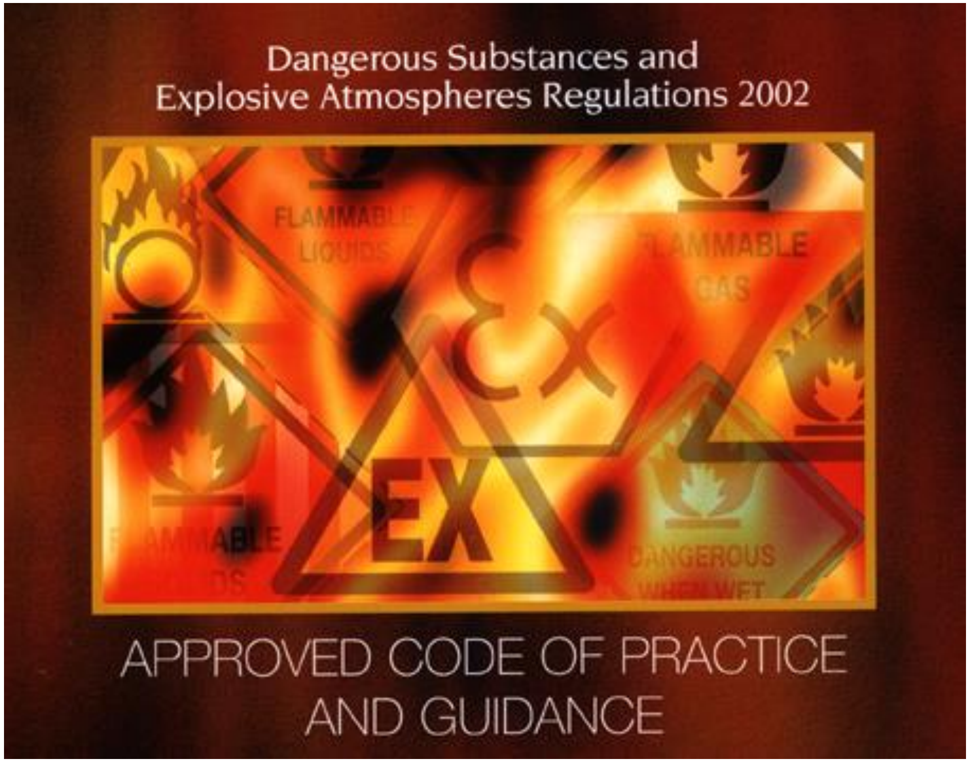
- Background: DSEAR
- BS EN 60079-10:2003
- Computational Modelling
- Results
- Discussion & Conclusions

BACKGROUND: DSEAR

- Dangerous Substances and Explosives Regulations, 2002.



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BACKGROUND: DSEAR

- Dangerous Substances and Explosives Regulations, 2002.
- Responsibility of employers to control or eliminate risks from explosive atmospheres in the workplace.
- Puts into effect EU Directive 99/92/EC (ATEX)
- http://www.hse.gov.uk/fireandexplosion/dsear.htm

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DSEAR ZONING

- Classification of hazardous areas according to ***zones***.

- Control & mitigation measures: appropriate equipment and/or ventilation for zoned areas.

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APPLICATION OF DSEAR

- To whom does it apply?
  - ***All*** workplaces where dangerous substances are present, used, or produced.
  - Excluding domestic premises (provided people are not working there).

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TIMESCALES OF DSEAR

- When do the regulations come into force?
  - July 2003 for new premises
  - July 2006 for ***all*** premises (both old and new)

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DSEAR: NATURAL GAS SYSTEMS

- Estimated ~600,000 businesses potentially affected.
- Required to carry out risk assessment, classify areas into zones and adopt appropriate control/mitigation measures.

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ZONING: BS EN 60079-10:2003

- To provide guidance on zoning, DSEAR suggests that BS EN 60079 is used.
- BS EN introduces concept of a ‘Vz’ gas cloud volume to quantify the hazardous zones.

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Vz DEFINITION

- Volume of gas in which mean gas concentration is 25 or 50% of the Lower Explosive Limit (LEL).
- If Vz < 0.1 m^3, ventilation can be described as ‘high’, and the gas cloud is of ‘Negligible Extent’

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BS EN 60079-10:2003

- Calculation method:

$$\left(\frac{dV}{dt}\right)_{\min} = \frac{(dG/dt)_{\max}}{k.LEL_m}\frac{T}{293} \qquad Vz = \frac{f(dV/dt)_{\min}}{0.03}$$

- Origin of method unknown
- Overly conservative?

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AIMS

- To compare predictions of Vz using:
  - BS EN 60079-10:2003
  - Computational Fluid Dynamics (CFD)

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CASES CONSIDERED

- Outdoor unobstructed release
- Pressures: 0.5 – 5.0 barg
- Hole Sizes: 0.25 – 5.0 mm^2
- Methane, propane, butane and natural gas

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COMPUTATIONAL FLUID DYNAMICS (CFD)

- Numerical solution of conservation equations governing transport of mass, momentum and energy.
- Values of velocity, pressure, temperature and gas concentration found at mesh points.

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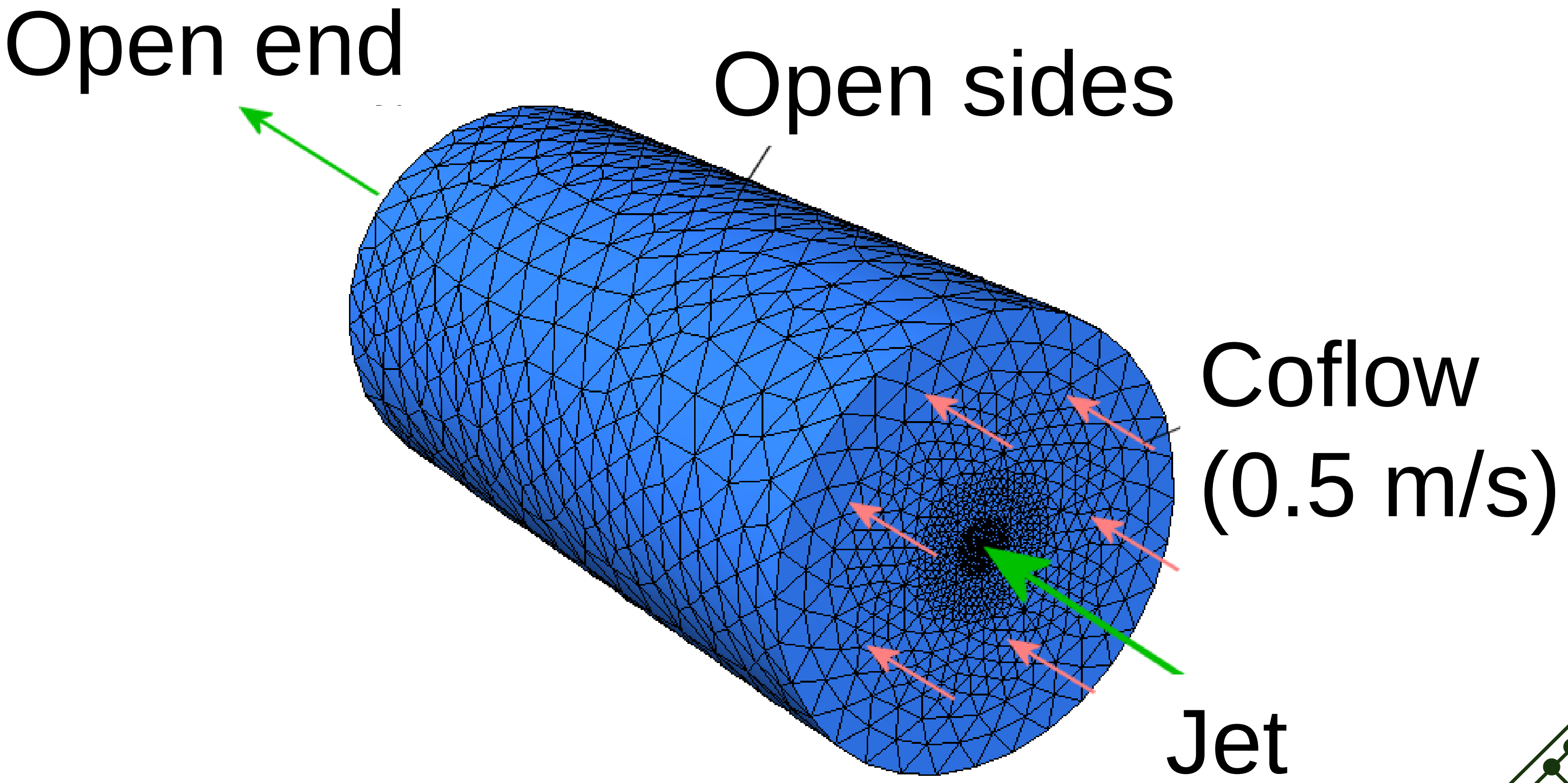
COMPUTATIONAL FLUID DYNAMICS (CFD)



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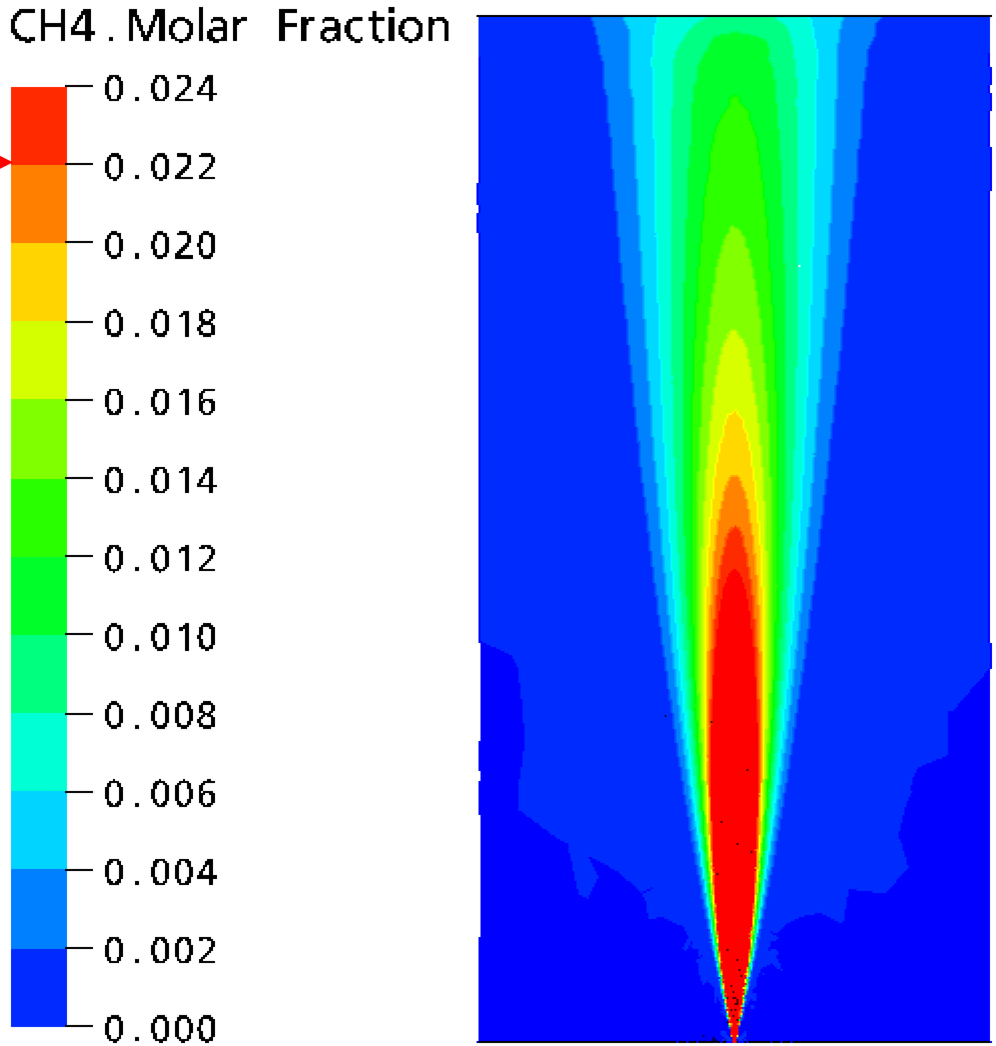
COMPUTATIONAL FLUID DYNAMICS (CFD)

2.2%

Methane
50% LEL



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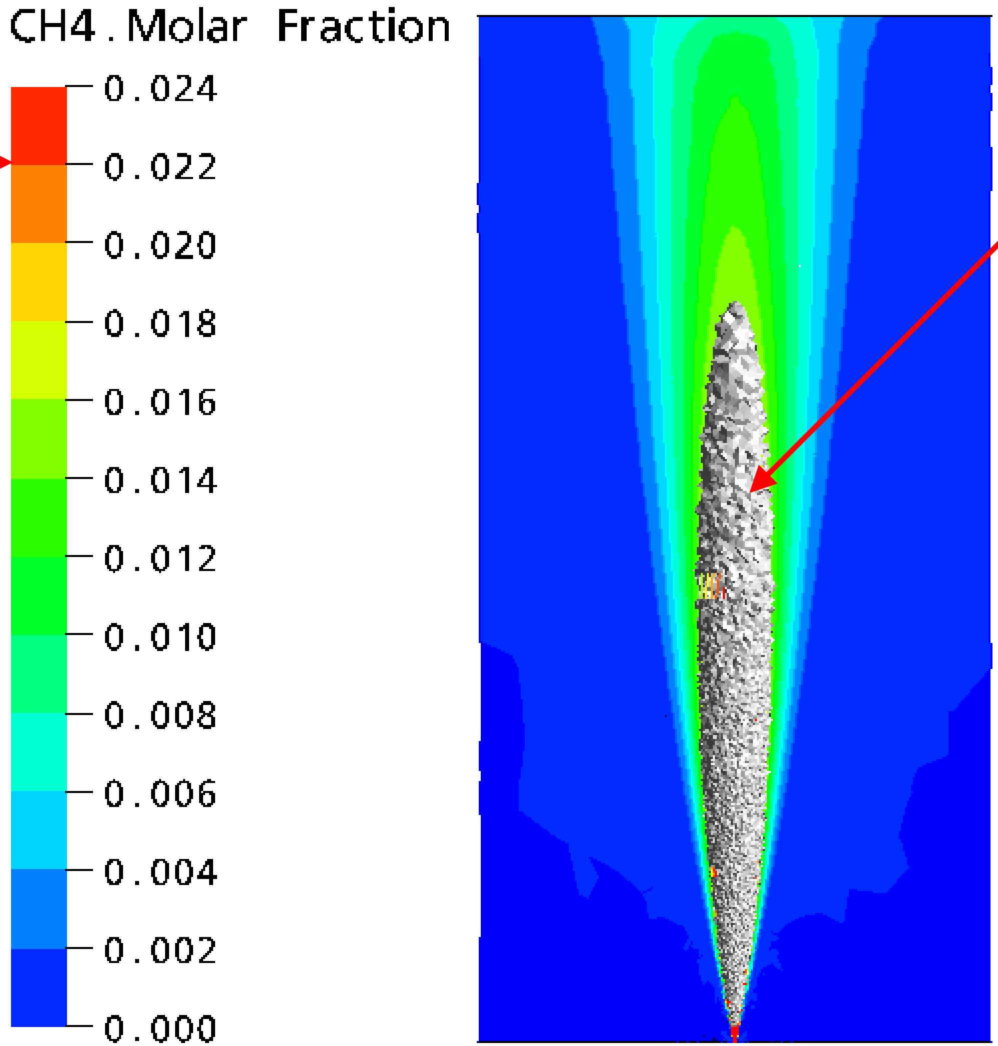

Vz volume

(Mean concentration 50% LEL)

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RESULTS: METHANE

Leak Conditions		50% LEL Vz Volumes (m^3)	
Pressure (barg)	Area (mm^2)	CFD	BS EN 60079
5.0	2.5	0.0326	6.17 – 30.8
2.5	2.5	0.0148	3.60 – 18.0
0.5	2.5	0.0054	1.73 – 8.63

BS EN is 2 – 3 orders of magnitude larger

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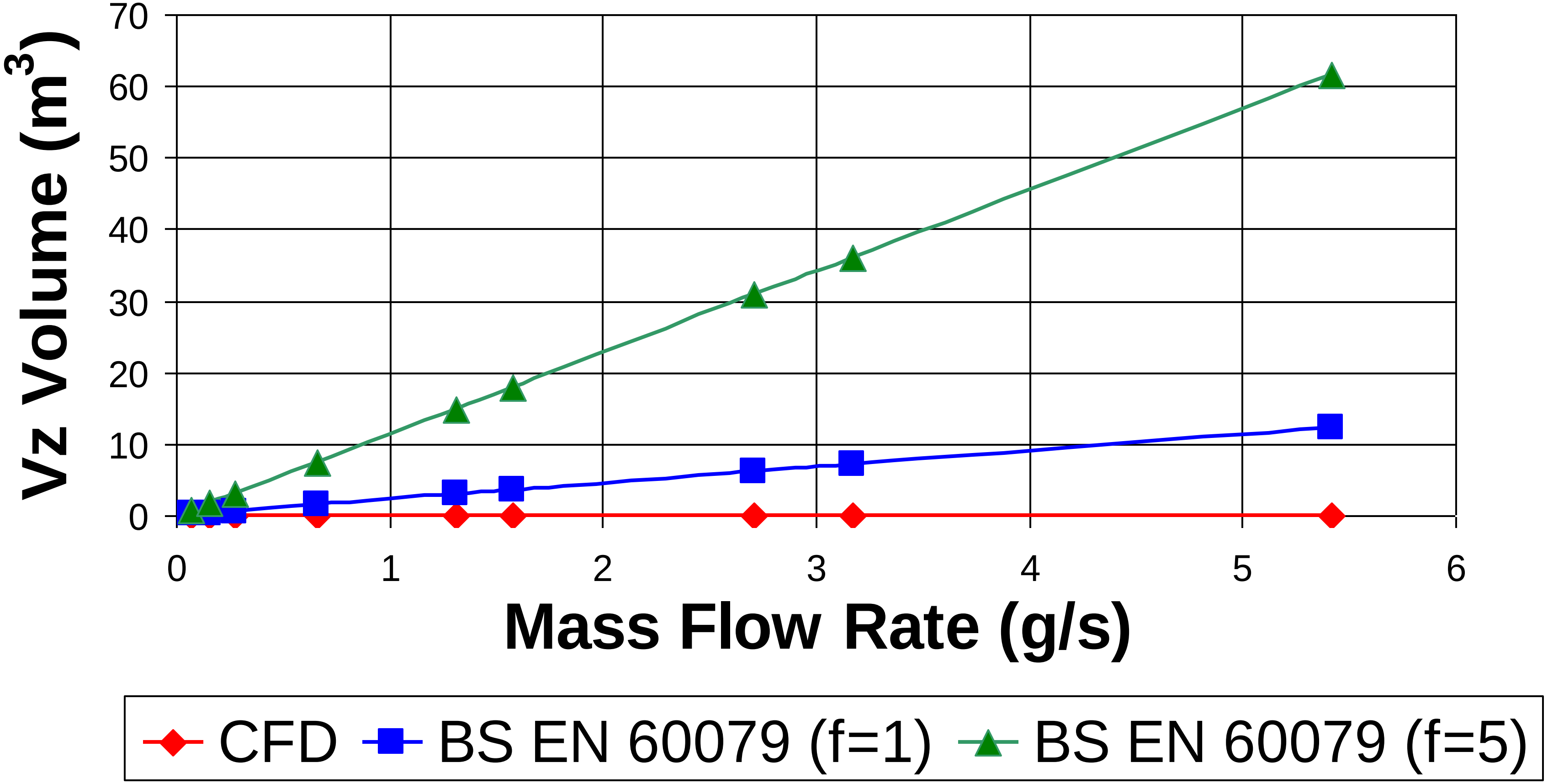
RESULTS: METHANE



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RESULTS SUMMARY

- Over the range of cases considered, BS EN estimates Vz to be 2 – 3 orders of magnitude larger than the CFD.
- Predictions for propane, butane and natural gas show similar trends to methane.

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CONCLUSIONS

- There is a high level of conservatism in BS EN 60079 for low-pressure releases.
- Present CFD results may help to prepare risk assessments and area classification.
- Need to study obstructed spaces.

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JOINT-INDUSTRY PROJECT ON AREA CLASSIFICATION

- To experimentally validate the concept of Vz and ‘negligible extent’.
- To examine gas dispersion and ventilation in indoor plant areas
- To define area classification rules for low-pressure secondary leaks of natural gas for indoor plant areas based on provision of ventilation.
- http://www.hsl.gov.uk/news/index.htm#gas

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THANK YOU

Any questions?

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