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Hazardous Area Classification For Biomass in the Thermal Generation Industry

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Introduction

- Background
- Traditional Standards
- Objective
- Experimental Testing
  - Methods
  - Results
- Practical Application
- Further Work

Background

- The Large Combustion Plant Directive (LCPD, 2001/80/EC)
    - Driving coal fired thermal PowerStations to find alternative fuels
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
    - Requires employers to carry out a risk assessment of activities where potentially explosive atmospheres can arise.
    - Areas must be classified into zones which dictates the standard of equipment that can be used.

Traditional Approach to Dust Classification

- IEC 60079-10-2
  - Purely qualitative assessment
- Zone 20
  - Inside containment only
- Zone 21
  - Typically 1m radius
- Zone 22
  - Typically 3m radius but if house keeping poor, can be huge.
  - Potentially the entire enclosure.

Flammable Properties - Dusts Vs. Vapours

- Dusts can ignite in either layer or cloud form – one a fire risk the other an explosion risk
- Dusts and vapours behave differently:
  - Dispersion of vapour can be calculated
  - Gas or vapour cloud more easily dispersed by ventilation
- Dust emission creates cloud, settles as layer but can be disturbed as a cloud again
  - Risk assessment and Area classification should take this into account

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Objective of this project

- To establish the LEL and other pertinent explosion data for biomass

- To review standards and other work to suggest a novel approach to the classification of biomass plant and other large, dusty processes.

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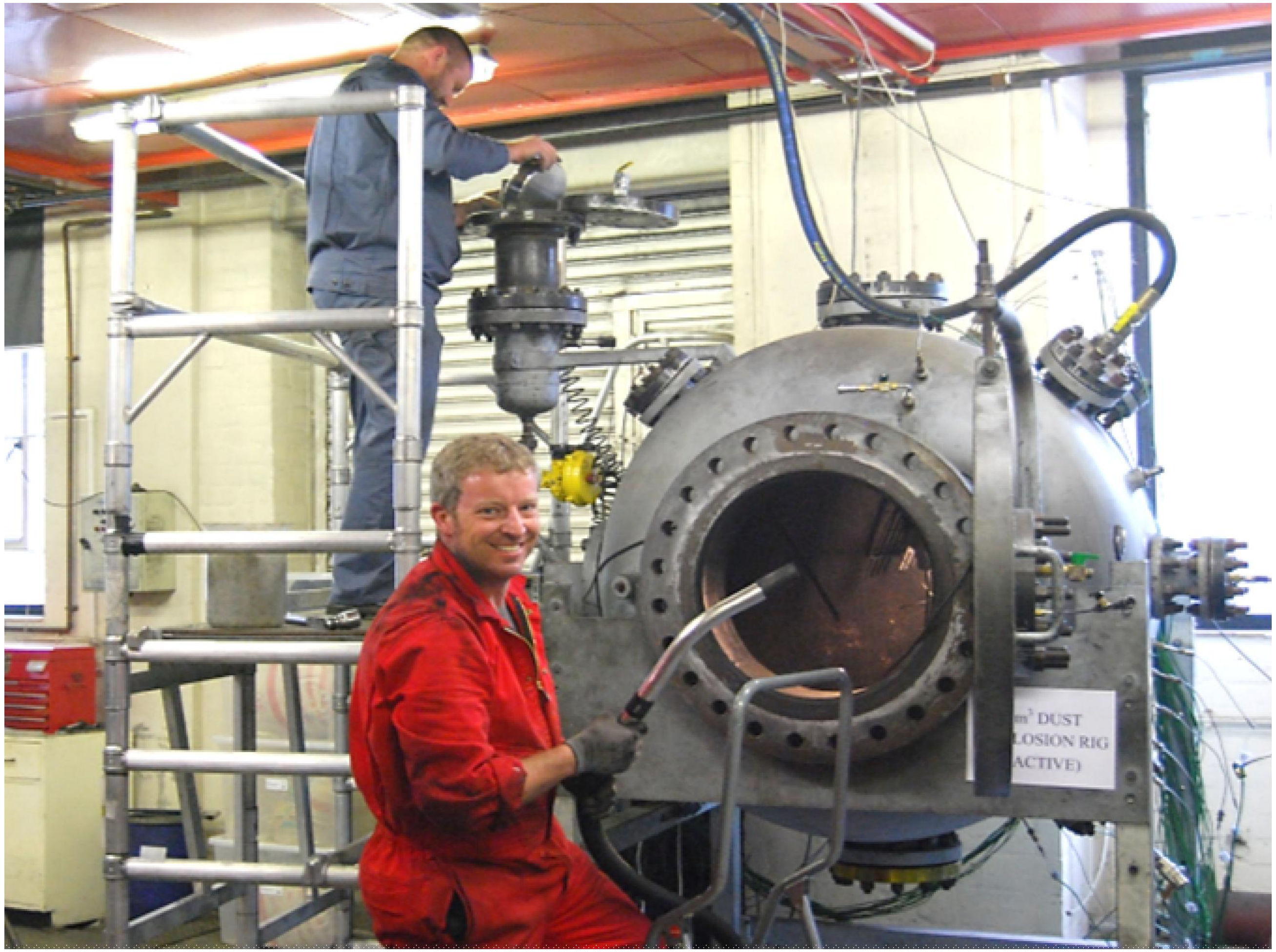
Experimental Testing

- $1m^3$ vessel (actually $1.138m^3$!)
- Following the methods in the BS EN 14034 suite of standards
- Differences for biomass
    - 10L holding pot
    - Biomass dispersion
    - Dispersion pressure halved to 10Barg

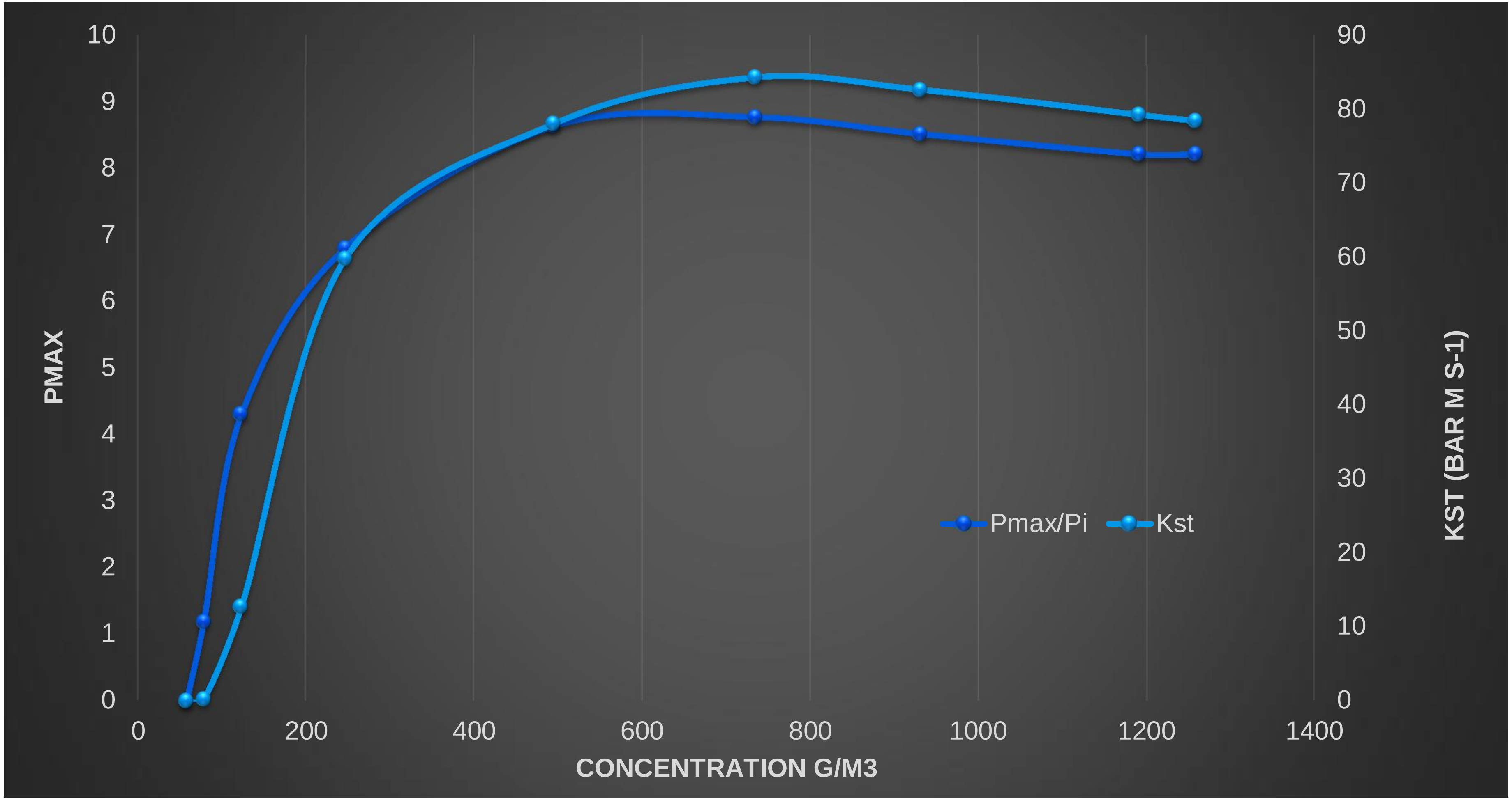
Material Tested

- Spruce wood dust taken from the dust extraction collectors at a PowerStation.
- BS EN 14034-3 does not specify a particle size for testing but ISO 6184-1 states that the particle size should be below 68um
- Material was fibrous and dry.

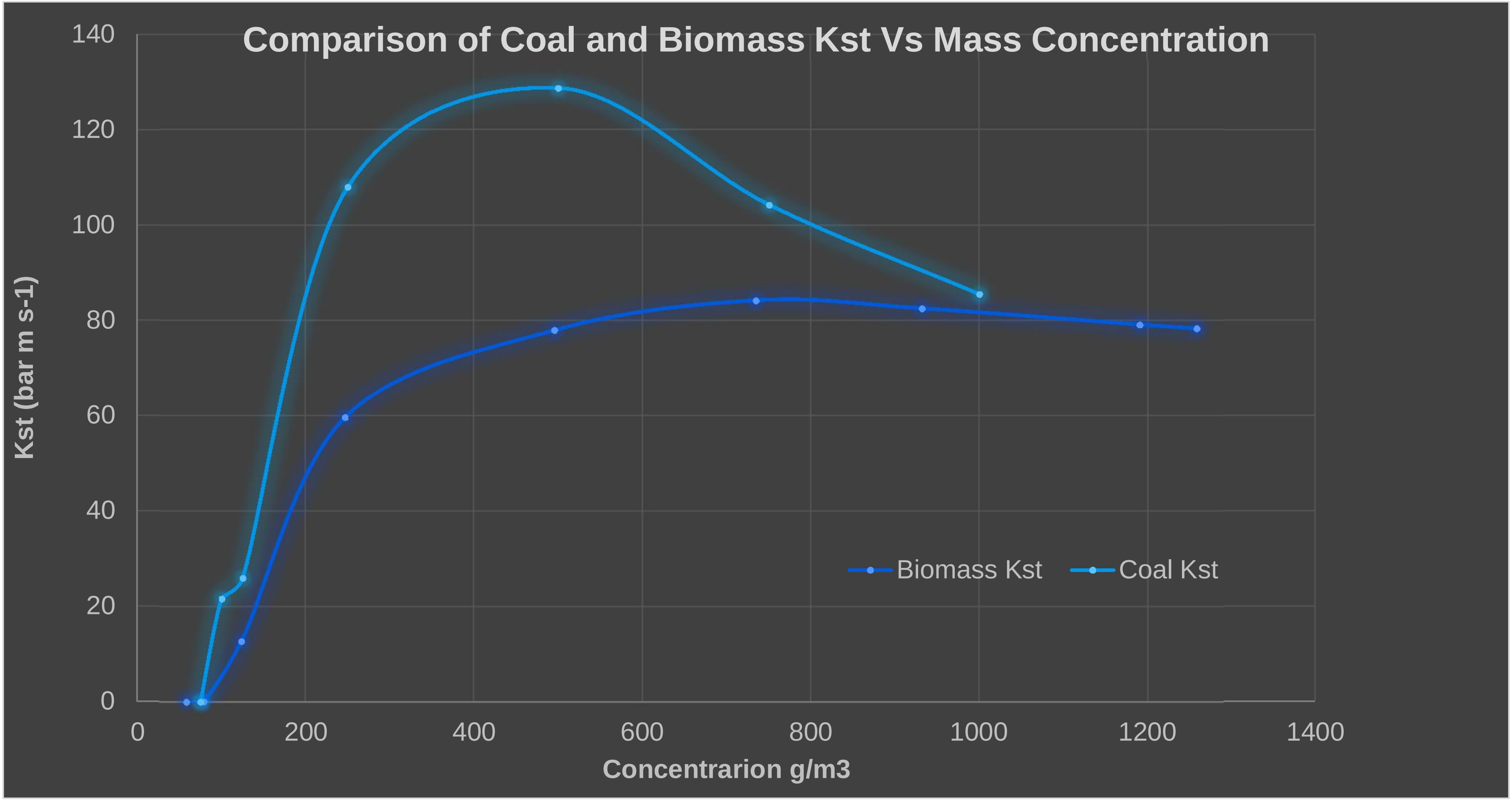
Hard weeks work!



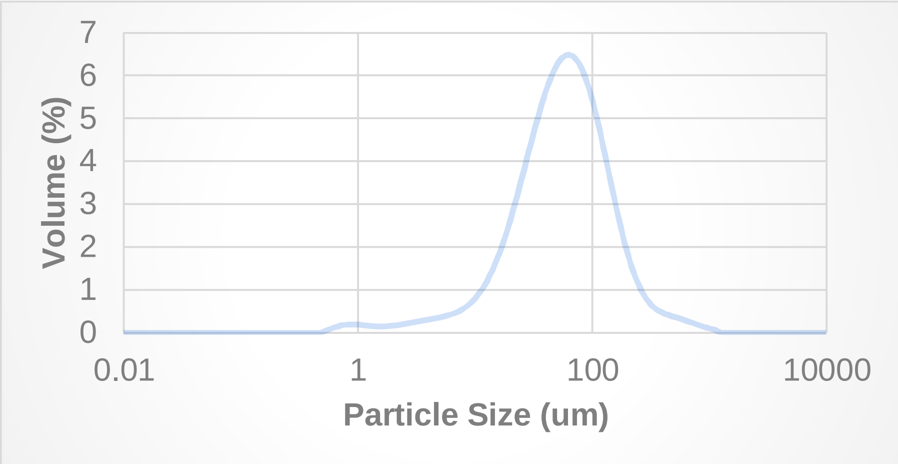
Results - LEL, P_{max} and K_{st}



Results –K_{st} of Biomass Vs. Coal



Results - Material data



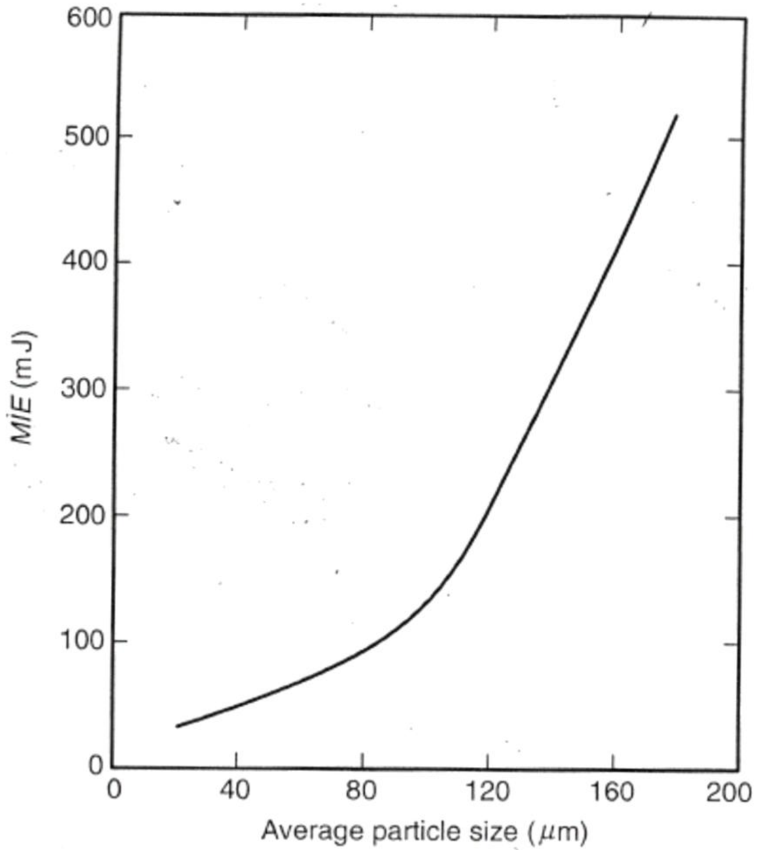


Figure 2-3.4.2.1 Effect of average particle diameter of a typical agricultural dust on the minimum ignition energy. (Unpublished data courtesy of U.S. Mine Safety and Health Administration.)

LEL (g/m^3)	80
Moisture (%)	8.19
Stoich F/A (g/m^3)	181.1
Bulk density (Kg/m^3)	250.9

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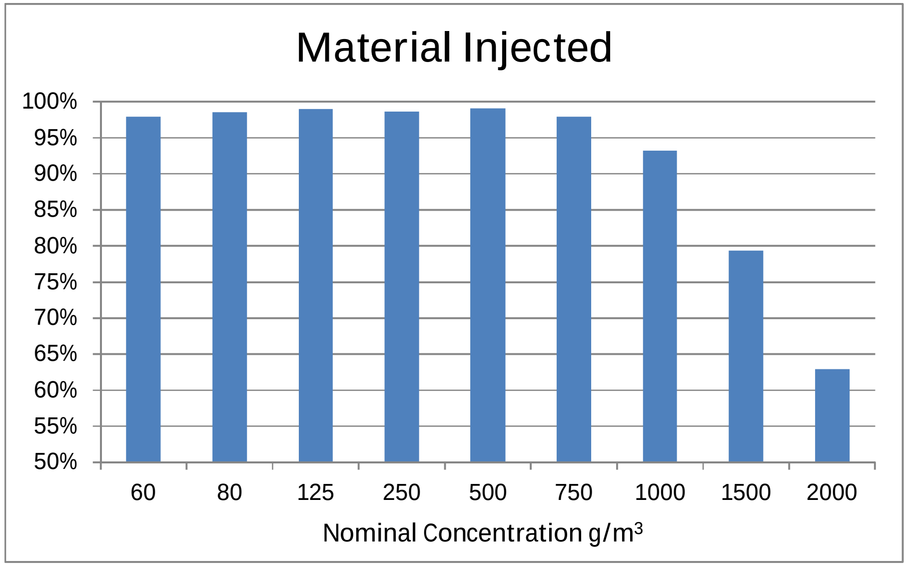
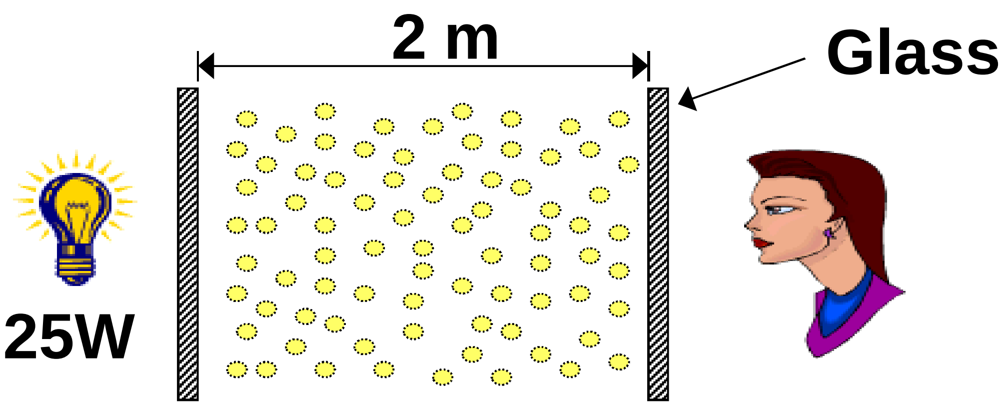
Issues with the results

- Quantities of unburnt material
- Amount of material injected
- Variability of LEL – Huescar (2013) has MEC of 35g/m^3



Application of the results

- LEL of this material is high compared to other dusts
- Worst case tested (fine, dry dust)
- Large deposits of dust needed to enter flammable region in a large building
- Difficult to get a external dust cloud externally without a catastrophic event initiating the cloud.



Area 50 x 50m	2500	m^2
Dust Layer thickness	2	mm
Bulk density	250	Kg/m^3
Floor area covered with dust	10	%
Mass of dust	125	Kg
Height of building	10	m
Volume of building	25000	m^3
Concentration	5	g/m^3

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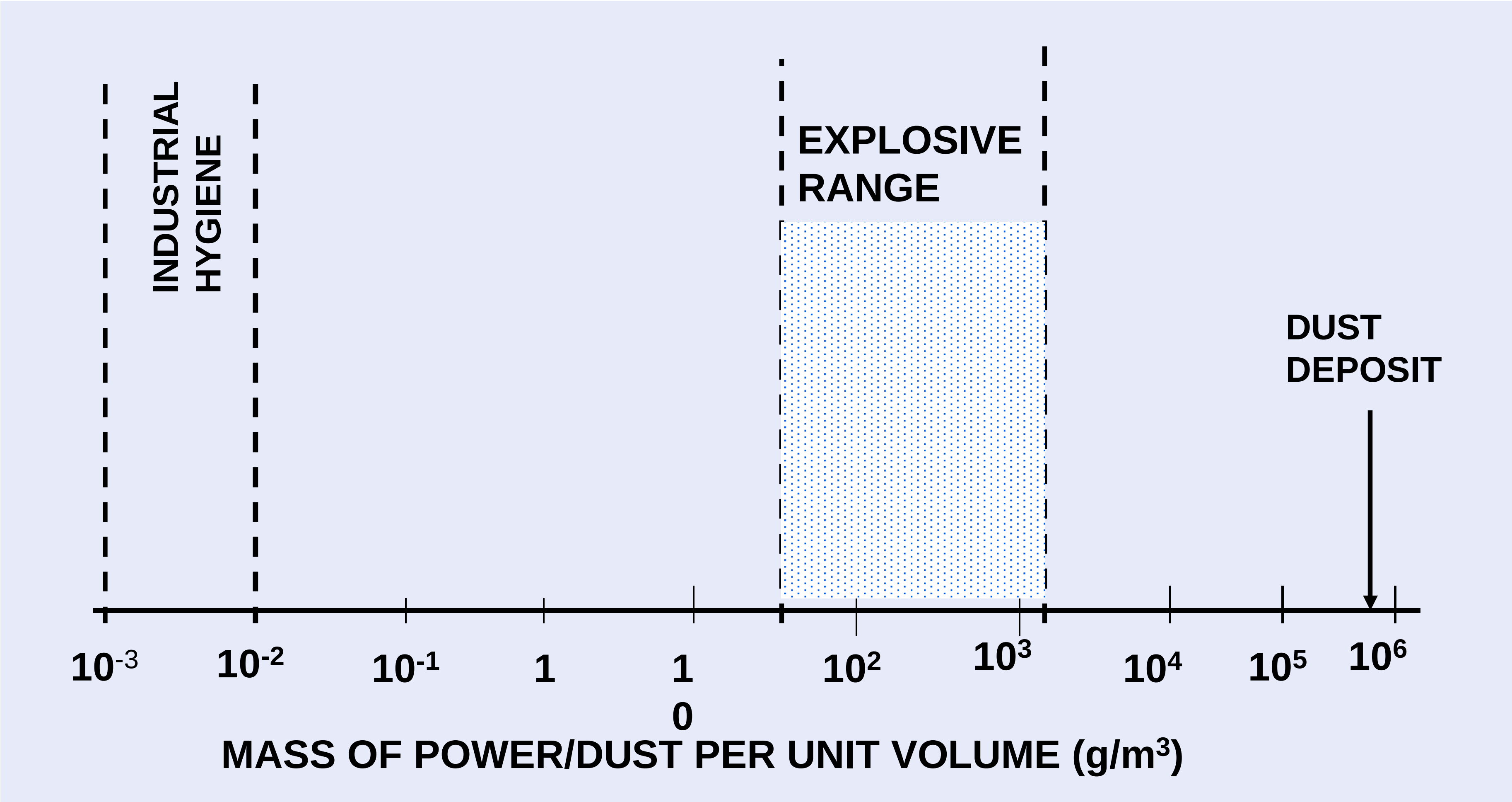
Dust Flammability



Equipment installed after 30 June 2003

- Only ATEX compliant equipment can be installed in the zoned areas.
- The installation of non-complaint equipment is not permitted.
- Certified equipment is generally more expensive to buy and requires specialist inspection, maintenance and repair

Dust Area Classification

- Difficult to get into the flammable region outside equipment
  - Case studies of an external primary explosion are rare.
- The disturbance of a dust cloud by a primary explosion to create a secondary explosion would not be prevented by external zoning.

Dust Area Classification (2)

- Lofted dust forming a cloud in the flammable range through smaller failures are unlikely to remain airborne long enough to be ignited in the open air, Eckhoff (2000).
- Dust cloud can only be created by additional aeration of a deposit
- Much un-certified equipment cannot ignite dust clouds
- DSEAR and standards are wrong in treating combustible dust the same as flammable gas

Conclusion
Is Certified Dust Equipment Needed Externally?

- Can the dust enter the enclosure?
    - Can it then be re-aerated?
    - By the time this has happened is there still a dust cloud outside?
- Is the equipment accessible for cleaning
    - Light fittings may need to have a temperature limit due to being inaccessible and a fire risk

Any questions?

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