

A decorative graphic on the left side of the slide consists of several overlapping, semi-transparent, dark red chevron shapes pointing to the right, creating a layered, arrow-like effect.

Analysis of recent flammable mist incidents

Hazards 29 Conference

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Background: Gant review

- Review of previous research into flammability of mists
- Liquid temperatures at which mists ignite can be below the normal flashpoint
- Concentrations of liquid in air at which mists ignite can be below the gaseous LFL
- Detailed in HSE Research Report RR980 “Generation of flammable mists from high flashpoint fluids: literature review”

Background: MISTS 1 experiments

- Used kerosene, light fuel oil and hydraulic oil
- 1mm smooth orifice, various pressures, 1J spark
- Kerosene mists always ignited
- At ambient temperature, fuel oil and hydraulic oil never ignited
- Further experiments with fuel oil at higher temperature and with impingement did ignite

HCRD: Background

- Since 1993, duty holders operating on UKCS have informed HSE of potentially dangerous hydrocarbon releases – current reporting via the ROGI form
- Data compiled into the Hydrocarbon Release Database (HCRD)

HCRD: Incident data

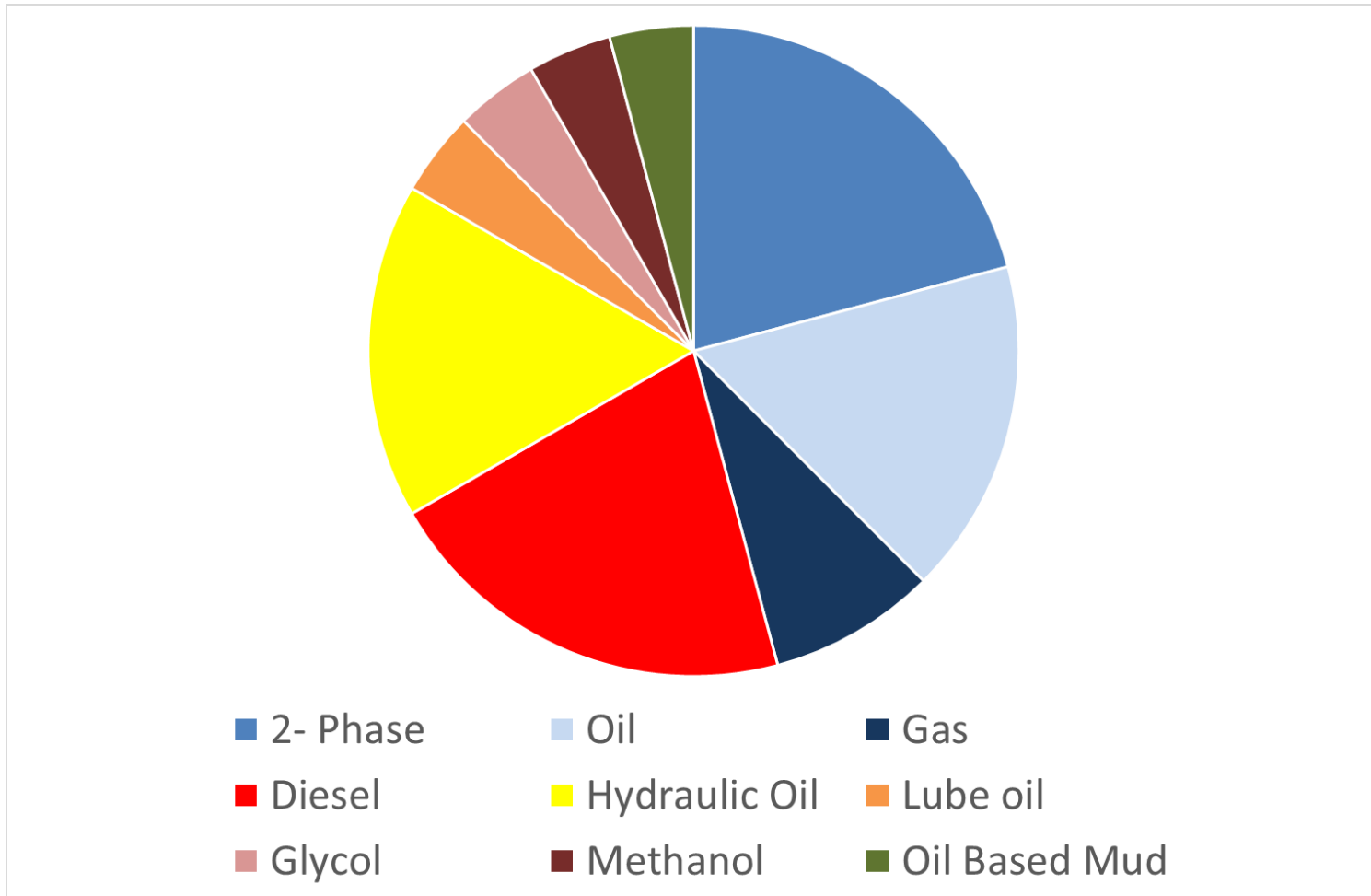
- New question recently added to ROGI form: “Did a liquid spray / mist release occur?”
- Data from start of 2016 to July 2018 contains 25 incidents where the ROGI form answers “yes” to the question “Did a liquid spray / mist occur?”
- 258 incidents in total during this period.

HCRD: Incident data

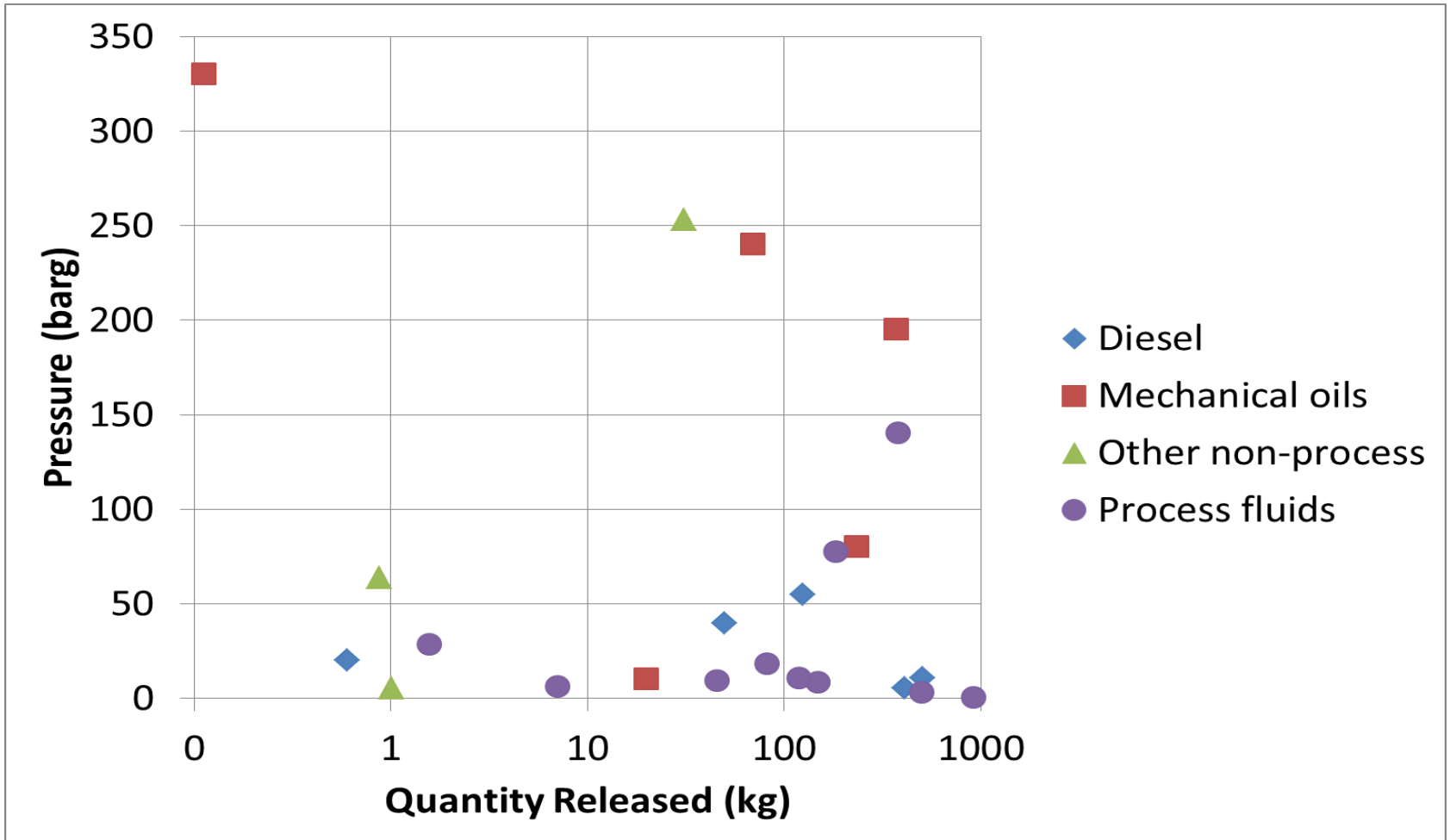
Fluid	Number of incidents	Percentage
Process Gas	136	53
Non Process Gas	2	1
Oil, 2-Phase, Condensate	37	14
Non-Process Liquid	83	32

The mist / spray incidents represent 10% of all incidents and 21% of all incidents involving liquid or 2-phase releases.

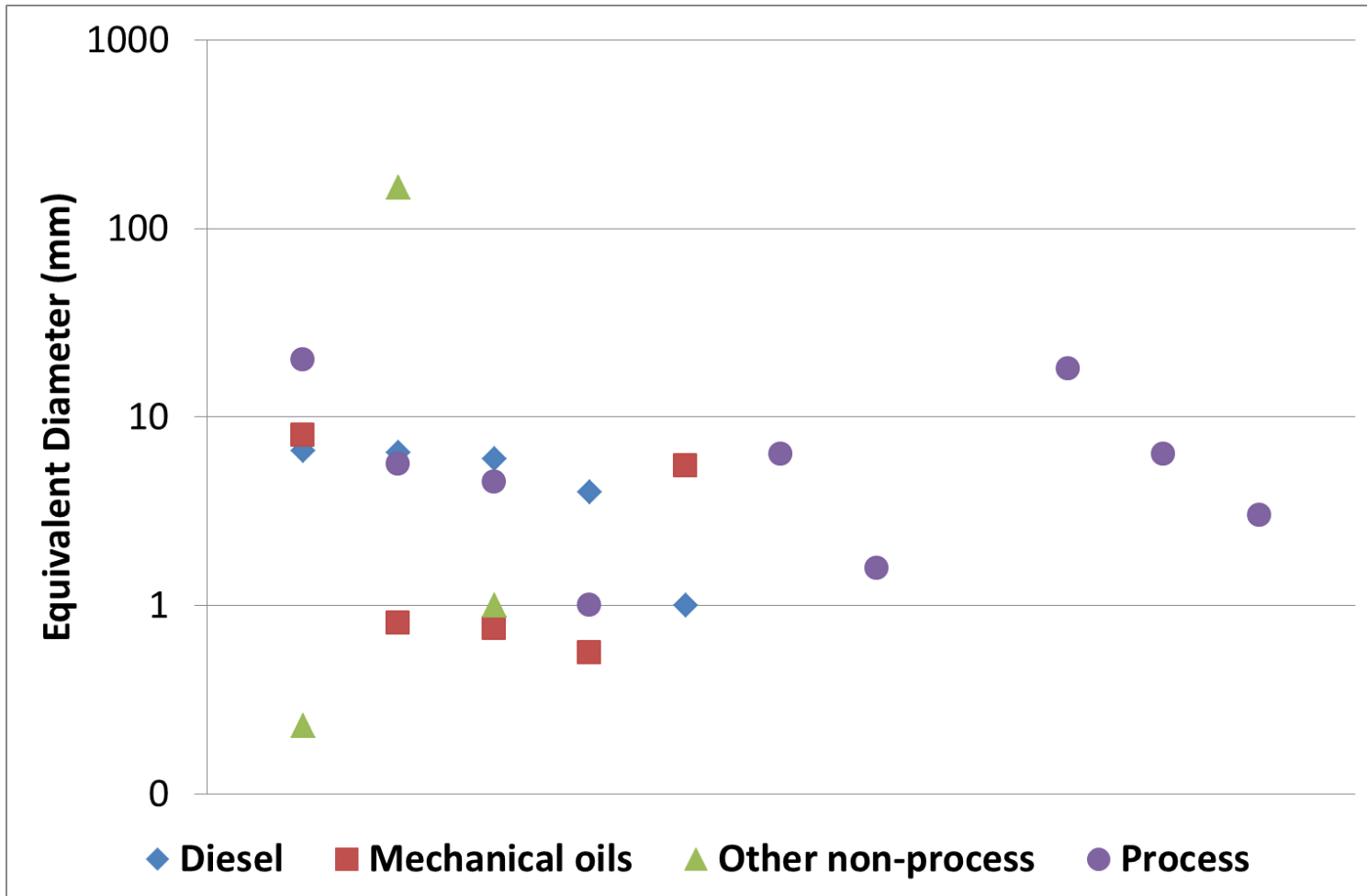
HCRD: Fluids released as spray / mist



HCRD: Pressures and quantities



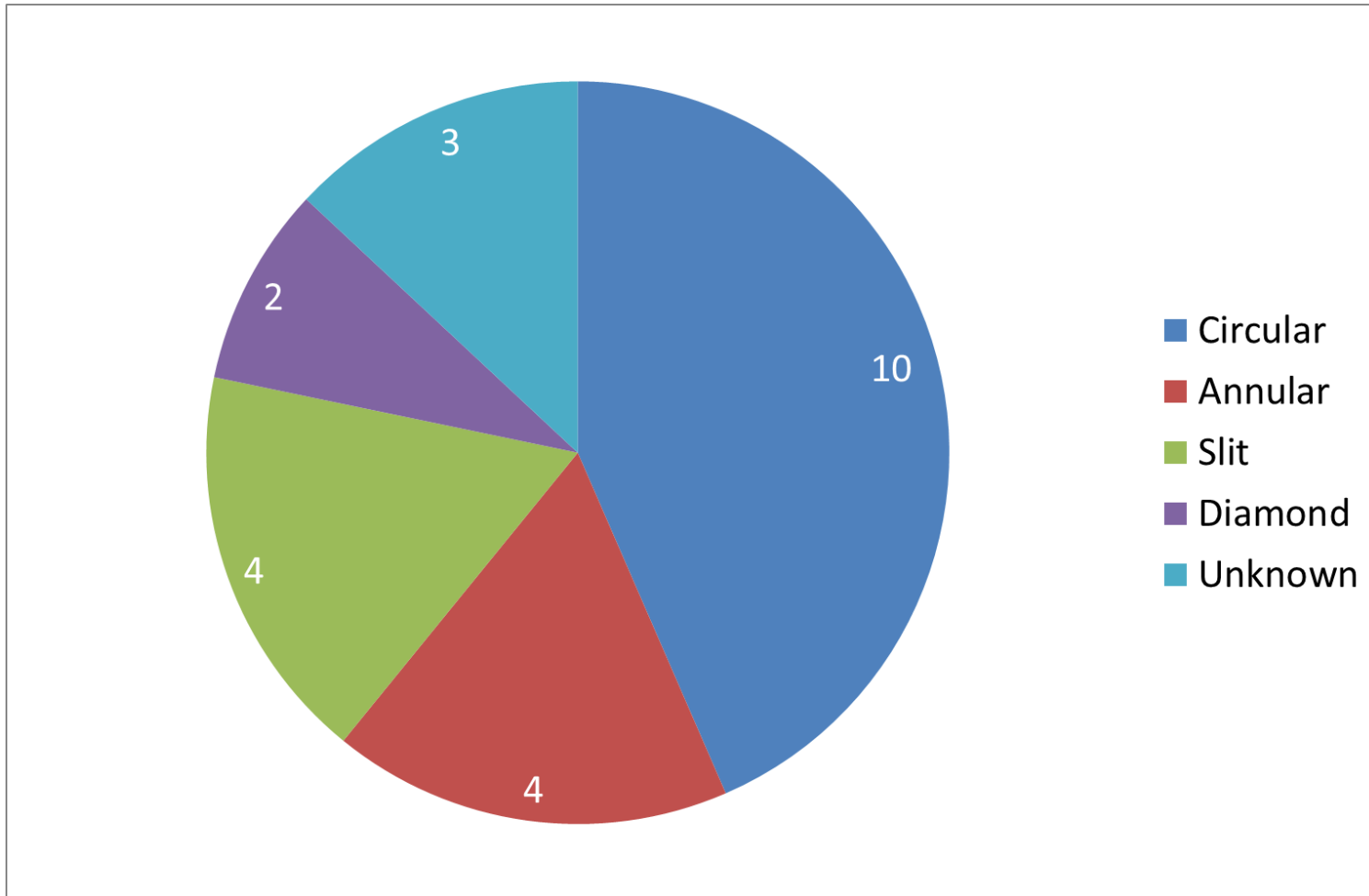
Hole sizes in equivalent diameter (mm)



Hole Geometry caveats

- Assessment is based on author's interpretation of descriptions, not on inspecting failed parts.
- Boundary between “a slit” and “a diamond” would be debateable in real examples.
- All failures described as “pinholes” (4) assumed to be circular.

HCRD: Hole geometry



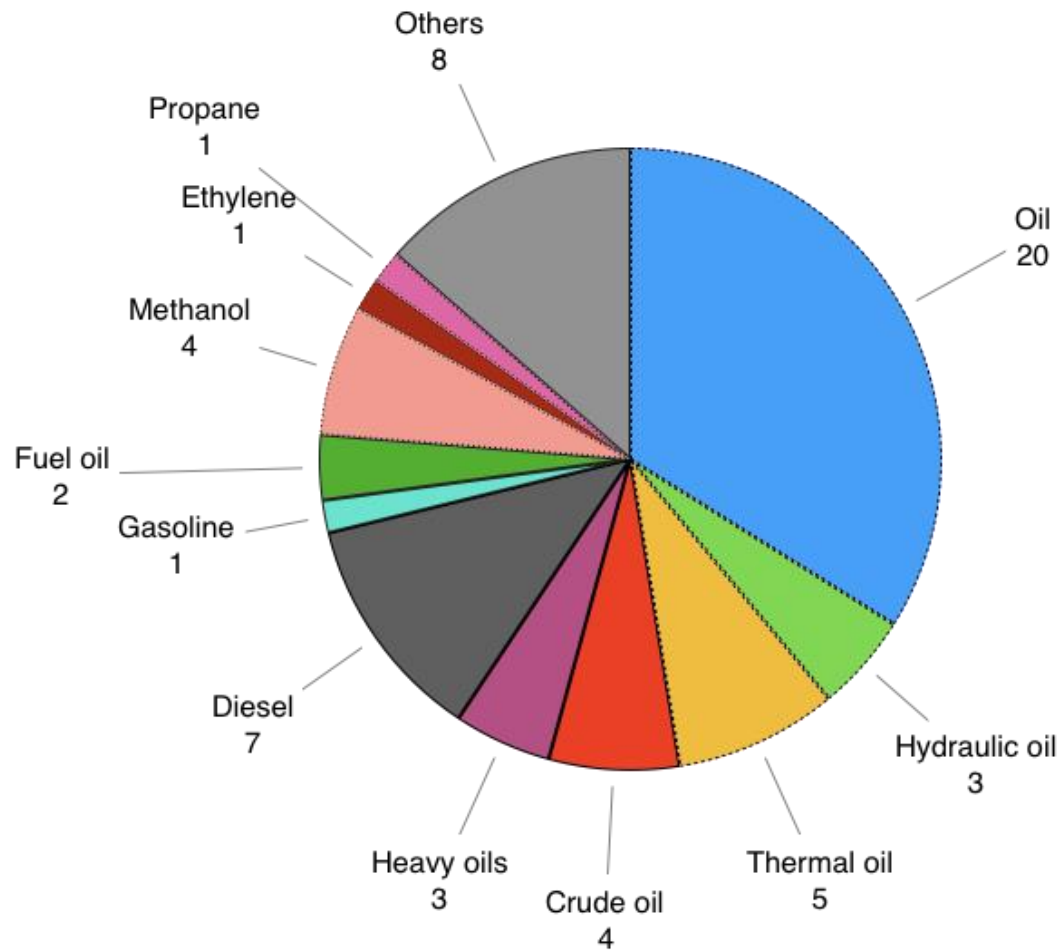
ARIA and ZEMA databases

- ARIA database has 47,000 recorded accidents in France (onshore) and some abroad
- Recent ARIA incidents typically at high-risk or classified facilities
- ZEMA database contains incidents reportable under German Accident Regulations
- Database reports less detailed than HCRD
- 40 incidents in ARIA and 19 in ZEMA

ARIA and ZEMA databases

- Quantified releases usually exceed 100kg, eight exceed 1 tonne.
- 36 out of 40 ARIA incidents record a fire or explosion
- Half of releases at pressures between 5 and 30 bar
- Where liquid temperatures are recorded, often in excess of 200 Celsius.
- Typical hole size is 10mm diameter.

ARIA and ZEMA liquids



ARIA industries

- Industries involved in ARIA incidents include:
 - Wood Panel Manufacturing
 - Metal Industry
 - Food Industry
 - Waste Treatment
 - Glass Industry
 - Synthetic Fibre Manufacture
 - Computer Industry

University of Lorraine Research

- Flammability of lubricating oils used in turbines
- High ignition energies needed to ignite pure lubricating oil
- Ignition energies required were much lower when the oil was contaminated.
- Substance-specific finding – difficult to translate to other substances.

Key Points from incident data

- Fires / explosions from flammable mists involve both process fluids and utility fluids.
- Real world incidents often involve pressures, temperatures, hole sizes and geometries and impurities not seen in laboratory experiments.
- Guidance on flammable mists hazards is still very limited.

MISTS 2

- Tests on diesel
- Assess the ignitability of mists from various orifice geometries
- Effect of parameters on the extent of the flammable cloud.

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Thank you

Questions?