MIST EXPLOSIONS INCIDENT SURVEY AND A NEW RESEARCH PROJECT

UKELG 46TH DISCUSSION MEETING, 22ND SEPTEMBER 2010, IMPERIAL COLLEGE, LONDON

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ATEX (user) Directive:

“explosive atmosphere” means a mixture, under atmospheric conditions, of air and one or more dangerous substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture”

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DSEAR ACOP, paragraph 145:

"Some substances do not form explosive atmospheres unless they are heated, and some liquids if released under pressure will form a fine mist that can explode even if there is insufficient vapour."

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Rolf Eckhoff [1]

"Published reports on accidental spray or mist explosions, apart from crank case explosions in ship engines, are scarce."

Similar comments in other references

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- 2008 Literature survey carried out by HSE library services

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Databases used:

- **Chemical Engineering and Biotechnology Abstracts**
- **National Technical Information Service**
- **Ei Compendex**
- **Pascal**
- **Tulsa World**
- **Chemical Abstracts**
- **MHIDAS – Major Hazards Data Incidents Service**

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- **HSEline (based on the HSE's library catalogue)**
- **Nioshtic and Oshline from the National Institute for Occupational Safety and Health (NIOSH) in the US**
- **The Reyerson International Labour Occupational Safety and Health Index, from the Ontario Ministry of Labour**
- **Cisdoc, the database of the International Occupational Safety and Health Information Centre of the International Labour Organisation in Geneva.**

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- 23 relevant records detailing 33 incidents have been identified. In some cases, the incidents may have been large fires or explosions. In all cases, the incidents arose from the ignition of mist, in most cases at a temperature near or below the liquid flash point.
- For full details of the incidents, and references, see the presentation from the 44th discussion meeting on the UKELG website.

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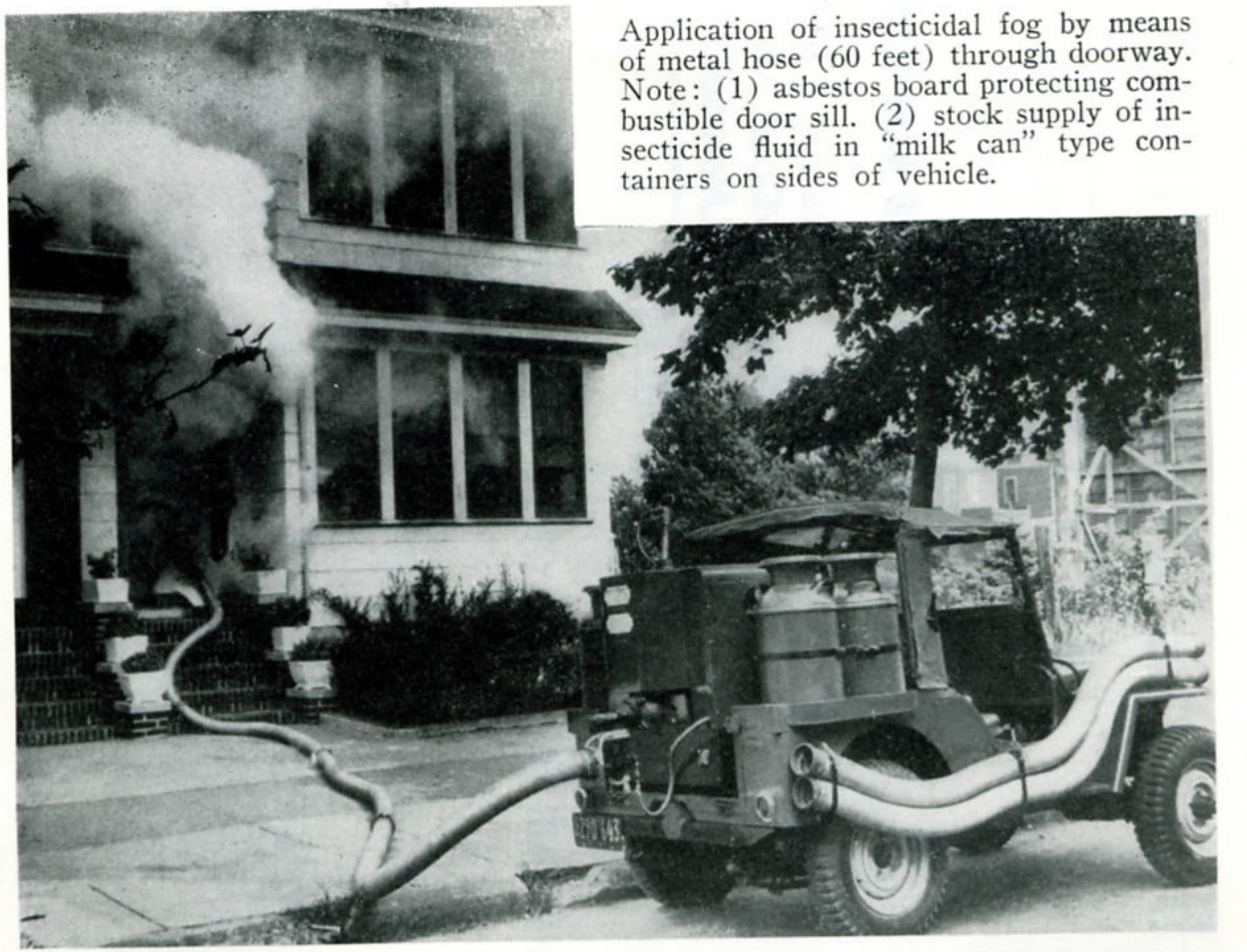

Application of insecticidal fog by means of metal hose (60 feet) through doorway. Note: (1) asbestos board protecting combustible door sill. (2) stock supply of insecticide fluid in "milk can" type containers on sides of vehicle.

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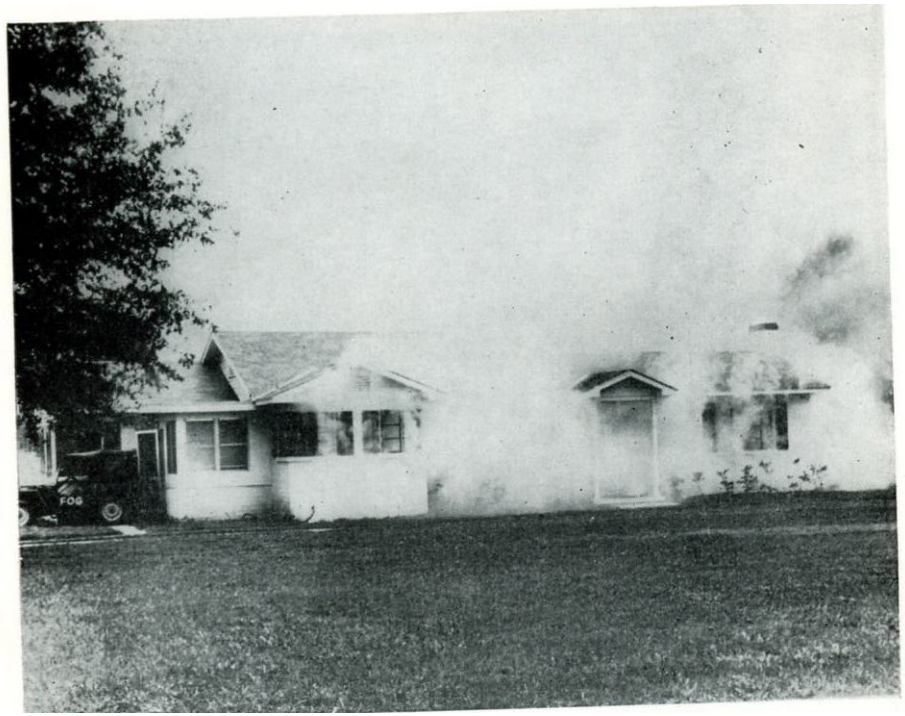

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- 9 incidents alone responsible for 29 fatalities

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Fuels

Oils:	Lube oil	5 incidents
	Transformer oil	1
	Vegetable oil	3
	Hydraulic oil	1
	Fuel oils	7
	Crude oil	3
	Heat transfer oil	4
Kerosene		7
Naphtha		4
Butyl acrylate		2

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Sources of Ignition

Compression autoignition	1
Electric arc	1
Hot surface	3
Static	6
Combustion chamber/igniter/pilot flame	10
Hot work	1
Engine induction	1
Catalyst	1
Naked light	1
Unknown	13

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Conclusions

- **Insufficient data for realistic use in QRA.**
- **The listed incidents are mostly in UK and USA, with a few in Europe. Whole world numbers will be higher.**
- **The listed incidents are mostly those that were significant and worthy of report. Whole world numbers including less significant incidents and near misses will be far higher.**
- **The number of reported incidents is far higher than had been known. The hazard is very real and must be taken into account in risk assessments and mitigation.**

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Conclusions

- A further conclusion drawn from the presentations at the UKELG 44th meeting was that the existing guidance on mist explosions is clearly deficient. A new research project, to be jointly funded by HSE and Industrial partners, has been developed to remedy this situation so far as possible.

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OBJECTIVE

- To develop practical guidance on:
  - The likelihood of the formation of flammable mist
  - Mitigation measures
  - Area classification zone and extent
  - Protected equipment concepts, and equipment selection

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PROJECT STAGES

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LITERATURE SEARCH

- Large existing body of literature
- No holistic model
- Most recent major search was by Prof. Rolf Eckhoff in 1995
- Further search will be carried out to ensure that all and any relevant more recent work is taken into account
- Knowledge gaps to be identified

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MIST GENERATION

- Generic model to be developed from existing references if possible
- Simultaneous alternative experimental programme

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EXPERIMENTAL

- Determine maximum safe pressure below which flammable mist formation is improbable for a range of fluids

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EXPERIMENTAL

- Range of fluids:
  - Lubricating oil
  - Vegetable oil
  - Hydraulic oil
  - Light fuel oil
  - Heavy fuel oil (at operating temperature)
  - Heat transfer fluid (at operating temperature)
  - Jet fuel
  - Naphtha
  - Kerosene
  - Diesel
  - White spirit

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EXPERIMENTAL

- Variables
  - Pressure
  - Hole size
  - Temperature
  - Hole roughness
  - Impingement
- Ignition energy only so far as necessary to advise on selection of equipment
- Flammable extent so far as necessary for area classification

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MITIGATION

- Flange guards
- Mist detection
- Double containment
- ??

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TIMETABLE

- Stakeholders' meeting-October 15th 2010, HSL Buxton
- Financial or other contribution commitments – November 2010
- Project Jan 2011 – March 2012
- Final report – Dec 2012

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PROTECTED EQUIPMENT

- No standard for design, testing, or certification against mist exposure
- Guidance required

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PROPOSAL

- The detailed proposal is available from
  - HSL, from Bronwen Ley 01298 218835
  - R Santon - r.santon@btinternet.com

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