Improving the Effectiveness of LEV
A HSL perspective

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Outline content of presentation

1. Report back from the LEV workshop organised at the International Ventilation Conference 2012

2. Investigation of the parameters that influence the effectiveness of an open fronted ventilated enclosure
1. Ventilation 2012

• International conference held every 3 years

• Attendees backgrounds:
  – Industrial ventilation
  – Occupational hygiene
  – Climate-control engineering for buildings and industrial processes
  – Ventilation and filtration equipment designers
  – Academics
LEV Workshop

- **Overview**
  John Saunders – Health and Safety Laboratory

- **A View from the ‘Front Line’**
  Emmanuel Marteau – CRAMIF, Safety Engineer

- **The Perspective of a Machinery Manufacture**
  Dr Edmund Weiss – Festool

- **The Perspective of the a LEV Designer**
  Dr Howard Goodfellow – Tenova Goodfellow Inc.

- **Discussion** (30 minutes)
  - Above presenters plus…
  - Jean-Raymond Fontaine (Researcher - French perspective)
  - Rolf Wolyzella (Inspector - German perspective)
  - John Saunders (UK perspective)
Summary

Similar issues everywhere

• LEV design needs to improve
  – Better understanding of ‘sources’
• Competencies
• Specification document
• Commissioning
• Machinery Directive

‘Testing’ of LEV systems was mentioned but hardly featured
2. HSE Project Aim

- To investigate the design parameters that influence the control effectiveness of small partial enclosures
  - Face velocity
  - Rear baffle design
  - Flanges to alter the enclosure entry geometry
Background (1)

- Performance – assessment usually based on face velocity measurements with no operator present

- A common criteria is that no reading should vary by more than 20% from the average i.e. a uniform face velocity
Background (2)

- Simple design – open fronted enclosures with extraction at the rear
Flow visualisation: Wall eddies
(0.5 m/s face velocity)
Wall eddies
Disturbing draughts
Presence of a worker

- The flow structure within the enclosure is further complicated by the presence of the worker.
Presence of an operator at the open faced enclosure (0.5 m/s face velocity)
Experimental set-up – Enclosure design

- Experimental full size partial enclosure – open face
- Positioned inside a test room with one wall fully open to minimise draughts
- Variable volume flow rate
- Two rear baffles studied
  - Baffle 1: Slotted rear baffle (good design)
  - Baffle 2: 250mm Circular opening in the centre (poor design)
Experimental set-up – Enclosure design

- Initially 4 entry conditions tested
- No flange
- $45^\circ$ panel
  - 60mm
  - 30mm
- Semicircular
  - 70mm diameter
Flange designs
Experiment set-up

- Neutrally buoyant tracer gas mixture used to mimic the contaminant
  - 17% SF$_6$ remainder helium
- Sampling in the Breathing Zone (BZ):
  - Nose of the manikin
  - Plane of the opening
- 10 minute tests
  - 1 minute run to waste
  - Triplicate tests
Experiments – Tracer gas ejectors

- **Ejector 1**: Omnidirectional source: 40 mm diameter perforated sphere
- **5.2 l/min release rate**
- **Default released position:**
  - 150mm inside enclosure on the centre line
  - 50mm from floor to the centre of the sphere (default)

- **Ejector 2**: Directional, 28 mm diameter tube
- **7.4 l/min** (5.2 l/min Tracer gas mixture, remainder air)
- **Mean discharge velocity ~0.2m/s**
- **Released 150mm inside enclosure on the centre line (default)**
Results: Tracer gas tests

- Ejector 1 (Omnidirectional source); Baffle 1 (Slotted)
Results: Tracer gas tests

- Ejector 1 (Omnidirectional source); Baffle 2 (Circular opening)
Modified semicircular flange

- Based on flow visualisation
Offset flange
Source **150mm** from the face, Modified semicircular flange

**Ejector: 150mm from face, 18mm high**

- **Modified Semicircular**
- **No flange**

Values for:
- 0.3 m/s
- 0.5 m/s
- 0.6 m/s

**Ejector: 150mm from face, 35mm high**

- **Modified Semicircular**
- **No flange**

Values for:
- 0.3m/s
- 0.5 m/s
- 0.6 m/s

**Ejector: 150mm from face, 70mm high**

- **Modified Semicircular**
- **No flange**

Values for:
- 0.3 m/s
- 0.5 m/s
- 0.6 m/s

**Ejector: 150mm from face, 140 mm high**

- **Modified Semicircular**
- **No flange**

Values for:
- 0.3 m/s
- 0.5 m/s
- 0.6 m/s
Source **300mm** from the face

Modified semicircular flange
Conclusions (1 of 2)

- Flow visualisation showed large eddies against all four internal wall of the enclosure – the size and shape largely governed by the entry conditions of the enclosure.
- With a manikin at the face of the enclosure, the flow structure was complex – the ‘wake’ interacts with the wall eddies – particularly the eddy against the floor of the enclosure.
- Increasing the face velocity did not necessarily reduce the breathing zone concentration – baffle dependent.
Conclusions (2 of 2)

• Breathing zone (BZ) concentration fell as the source was positioned further into the enclosure
• Of the four flanges tested only the modified semicircular flange reduced the concentration in the manikin BZ when compared to the ‘no flange’ condition
• The modified semicircular flange allowed an airflow between the torso of the manikin and the enclosure – ensuring the floor of the enclosure was continually ‘swept’ with clean air
• If you need to stand at the face of an enclosure, it’s likely that your BZ will be beyond the plane of the opening, i.e. inside the enclosure
Thank you for listening

Any questions?