Extracting the Best Practices
Tuesday 6 February
Welcome to LEV - Extracting the Best Practices
Thank you to our sponsors & exhibitors
LEV - Extracting the Best Practices

6th & 7th Feb 2018

ILEVE (Institute of LEV Engineers) UPDATE

Jane Bastow CMIOSH MILEVE
Chair - ILEVE - Institute of LEV Engineers
Managing Director P&J Dust Extraction Ltd
ILEVE Membership
795
Survey January 2018
Which LEV fields do you work in?

- Occupational Hygiene: 22.5%
- System Design: 57.5%
- Installation Management: 47.5%
- Commissioning: 45%
- Thorough Examination & Test: 70%
Do you work exclusively in LEV?

Yes 37.5%  No 67.5%
If no, what other fields do you work in?

- Other Occupational Hygiene Activity 14.81%
- HVAC 51.85%
- Other Statutory Inspections 40.74%
- Other 33.33%
Regions where ILEVE members work

- East Anglia: 50%
- East Midlands: 52.5%
- Home Counties: 50%
- Merseyside & North Wales: 55%
- North East: 60%
- North West: 67.5%
- Northern Ireland: 40%
- Scotland: 55%
- South Wales: 47.5%
- Southern: 57.5%
- Yorkshire: 57.5%
- Ireland: 37.5%
- Australia & New Zealand: 5%
- China, Hong Kong & Singapore: 2.5%
- Qatar: 2.5%
- United Arab Emirates: 2.5%
Which other professional bodies or trade organisations do you, or your employer, belong to?

- BOHS: 51.85%
- IOSH: 48.15%
- BESA: 22.22%
- SAFED: 18.52%
- SHAPA: 11.11%
- FETA: 7.41%
- EMADA: 7.41%
- Other: 33.33%
Do you have LEV qualifications?

- Yes: 68.57%
- No: 31.43%
Which LEV qualifications do you have?

- 3 - P601: 76%
- 4 - P602: 36%
- 5 - P603: 16%
- 6 - P604: 28%
- 7 - W505: 8%
- 8 - Other: 32%
What topics do you want more training/guidance in?

1. Design 55.56%
2. ATEX/DSEAR 55.56%
3. Filtration 66.67%
4. Testing and commissioning 51.85%
5. Other 3.7%
What do you hope to get from ILEVE membership?

- Recognition of competency: 80.56%
- Mentoring: 19.44%
- Career progression: 30.56%
- Access to training: 47.22%
- Information days: 55.56%
- Other: 22.22%
Upcoming Events

Members & non-Members Welcome

27th June 2018 – LEV Information Day & AGM
HSE Laboratory Buxton

Members Only

Date TBC - Fume Cupboard Training Day
North West
Thank You
Controlling Metal Working Fluid Exposures

Mick Fordham, Erik Lewry and Steve Slater
AWE
Introduction to AWE
Fast facts

- AWE has played a crucial role in **national defence** and **nuclear security** for over 60 years
- We provide and maintain warheads for Trident to ensure the UK continues to have a **credible** and **minimum** nuclear deterrent
- We are a centre of **excellence** in **science**, **engineering** and **technology**
- Using our **unique nuclear skills** and **technical expertise**, we develop and deliver national nuclear security and counter-terrorism solutions for UK government
- AWE is a **Government-Owned Contractor-Operated (GOCO)** organisation operated by a joint venture of Lockheed Martin, Serco and Jacobs Engineering on behalf of MOD

*Underpinning continuous at sea deterrence and national nuclear security*
Our sites

Aldermaston
(709 acres)
Fully nuclear licensed

Blacknest
(Five acres)

Burghfield
(215 acres)
Fully nuclear licensed

Coulport

Two nuclear licensed sites and a scientific support facility – approx. 5,500 employees
Our skills and expertise

AWE provides expertise to support the UK’s nuclear defence and national security
Contents

- The risks to health from metal working fluids
- Where and when the exposures occur
- Control requirement
- How we demonstrated control
  - Identifying a ‘safe’ level
  - Monitoring what is achievable
- Detail on engineered control measures
  - Design
  - Commissioning
  - TExT
National incidents

Martin Baker
- 3 people with permanent disability
- No extraction on enclosed machines
- Use of compressed air

An Uxbridge manufacturer of ejector seats has been fined £800,000 after three workers developed debilitating lung conditions.

Three skilled CNC machine operators developed extrinsic allergic alveolitis after many years of exposure to the mist of working metal fluid.

“One worker has been so severely affected they have become virtually paralysed by the illness.”
National incidents (2)

Koyo Bearings, Barnsley

- 100 people exposed to unmanaged MWF
- 15 cases of EAA and Occupational asthma

“We found that a combination of employees breathing in metal working fluid mist, along with no filter system and inadequate training, resulted in the entire workforce being put at risk.

Research shows that exposure to metal working fluids in this way can cause serious respiratory conditions, and the large number of cases of illness of this type at the company is shocking.”

HSE
Powertrain, Longbridge
- 87 cases of occupational asthma
- 24 cases of Extrinsic Allergic Alveolitis
- 1 case of humidifier fever

**Key point** The outbreak appeared to develop and peak while exposures to mist from metalworking and wash fluids and levels of mineral oil in air were apparently at or near levels, which represented good practice, as set out in HSE guidance, current at the time.

**HSE guidance** is that in the light of the outbreak the level of awareness of the risk of serious respiratory disease from metalworking and wash fluids has to be raised among all involved - employees, employers, as well as occupational health and safety practitioners.

**HSE guidance** is that direct means of monitoring bacterial contamination, such as dipslides, are essential to check the condition of fluids. These should accompany less direct means such as levels of pH or smell.

**HSE guidance** in the light of the outbreak is that the application of COSHH criteria for respiratory health surveillance for those exposed to metalworking and wash fluid mist should not be dependent upon exceeding guidance values, as there is no agreed health-based limit for exposure to mist.
Hazards in MWF

- Bacteria
- Endotoxins
- Fungi
- Metal fines
- Biocides

Potential ill health conditions:
- Dermatitis
- Extrinsic allergic alveolitis
- Asthma
- General lung conditions
Sources of exposure

- Mist during machining
- Mist held up in enclosure released upon opening the door
- Mist returned to the workplace
- Skin exposure from contaminated surfaces
CONTROL

FLUID MANAGEMENT
- Dip-slide monitoring
- Daily checks
- pH checks
- Concentration
- Biocide conc
- Cleaning and flushing

PREPARATION
- Control on a machine basis
- Define control benchmark
- Define monitoring technique

MONITORING
- Smoke testing and dust lamp
- Real-time particulate monitor
- In situ filter tests
- Health surveillance

INFORMATION AND TRAINING
- Management awareness of risk
- Operator awareness sessions

ENGINEERING
- LEV control measures
- Enclosure
- Door delays

REDUCTION
- Fluid Selection
Fluid Management

- Daily checks of fluid
  - Tramp oils
  - Smell
- Regular checks of bacteria levels
- Recirculation of underused fluids
- Concentration of fluid
- Addition of biocide
- pH
Good Operating Practices

- Applying MWFs at the lowest possible pressure and flow
- Applying MWFs at the tool/work piece interface
- Ceasing fluid delivery when not performing machining
- Keep breathing zone away from mist where possible
- Avoid use of compressed air to dry components
Identifying a safe level

• What are the required standards?
  – Exposure limits
  – As asthmagen – ALARP

• Guidance
  – HSE inspector pack
  – HSE essentials MW series
  – Expired guidance
  – Powertrain incident report

- NIOSH total particulate = 0.5 mg/m³
- HSE limit (withdrawn) = 1 mg/m³
- ‘In-house’ limit = 0.1 mg/m³
- ‘In-house’ guideline average value
  – 'In-house’ limit = 0.3 mg/m³
  – instantaneous peak
Control approach 2  Engineering control

✓ Provide mist extraction. On enclosed machines use a time delay between the machine stopping and opening the doors.
✓ You need an inward air speed of at least 0.5 metres per second into enclosed machine openings.
Defined monitoring technique

CONTAINMENT
- Measurement/visualisation around door and gaps
  - Inward airflow measurement

REMOVAL
- Smoke filled enclosure and timed clearance
- 6-10 air changes per minute found to be optimum
- Mist measurements during door opening and inspection to determine door delay

FILTRATION
- Smoke or mist and post filter real-time monitoring
DMU125P - Mist clearance 60 seconds vs 90 seconds door delay

Mist concentration (mg/m³)

Time from start

60s

90s
OUTCOME

- Tangible reduction in background mist levels
- Control is higher up the hierarchy
- LEV and machine manufacturers’ engagement
- Simple in-situ filter test developed
- Management and operator buy in
- Local ownership of risk
- Reports from operators of improvement in work environment

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What did we learn?

- Real-time monitoring is a good indicator of peak exposures
- Engage management using data and colours
- Engage operators and make them part of the solution
- Engage with suppliers with a clear specification
- Think control at source rather than obsess with numbers
- Don’t be afraid to use basic hygiene techniques, knowledge and experience where clear guidance is lacking.
- Importance of teamwork between Occupational Hygiene and LEV engineers
Design, Commissioning and TExT of Metal Working Fluid (MWF) – LEV Systems

Presented by: Mick Fordham
Commissioning and TExT of Metal Working Fluid (MWF) – LEV Systems

• **LEV Design**
  • Types of re-circulatory LEV systems available.
  • How we select the volume of extract required.
  • Other design considerations to take into account.

• **Commissioning**
  • The steps to be undertaken when undertaking an LEV Commissioning report.

• **Thorough, Examination and Testing (TExT)**
  • Inspection and Testing requirements.
LEV Design for controlling MWF

Electrostatic

FilterMist

Mechanical Air Purification
Electrostatic LEV Systems

• The filtration is less efficient than other available systems.
• Regular cleaning required.
• High Voltage Hazard.
• Higher running costs
• Often supplied as standard with machine tools originating from the U.S.A.

Note: The U.S.A. do not have to meet A.L.A.R.P. as such the filtration provided by these systems is acceptable in the U.S.A.
FilterMist Units

- Work by centrifugal force.
- Maintenance Periods - 1,000hr & 2,000hr.
- To meet A.L.A.R.P always use with the HEPA ‘Afterfilter’ - 10% reduction in flow.
- Always install a ‘F Monitor’ and/or pressure gauge.
- Filtration efficiency is lower than the mechanical air purification systems.
- Our on-site testing has demonstrated the filtration is effective for most coolants. These are not the most suitable systems for with mineral oil lubricants.

**Note:** Although the manufacture states the afterfilter is HEPA they do not claim this to meet BSEN 1822
Mechanical Air Purification

- Contain various static filters to clean the extracted air.
- Filtration available to HEPA (H13).
- Can be maintenance heavy.
- Require frequent pre-filter changes.
- Always install a pressure gauge.
- Volume of airflow reduces quickly with filter blinding.

Note: The HEPA filter can be supplied tested to BS EN 1822.
Selecting ‘LEV Volume Flow’ Requirements

In our internal guidance we state:

• Low Misting Processes / Lower Machining Speeds / Slower fluid delivery:
  • Design to achieve a minimum of 6 Air Change Per Minute (ACM).
• High Misting Processes / Higher Machining Speeds / High fluid delivery:
  • Design to achieve a minimum of 10 Air Change Per Minute (ACM).

Internal Volume (m³) = Width (W) x Depth (D) x Height (H) less the volume taken by the internal fittings (Chuck, Bed, Turret etc.)

$$\text{Internal Volume (m}^3\text{)} \times N \times 60 = \text{Airflow required (m}^3\text{/hr)}$$

$$N = \text{Number if Air Changes Per Minute required}.$$
‘Consideration Factors’ – To take into account during the design stage
‘Consideration Factors’ – To take into account during the design stage

- Large recesses will contain mist hold-up for longer
- No easy access to maintain extraction / filter units.
Commissioning of MWF LEV Systems

- HSG258 lists 4-stages for commissioning:
  - 1\textsuperscript{st} Stage – Installation.
  - 2\textsuperscript{nd} Stage – Performance Checks.
  - 3\textsuperscript{rd} Stage – Assessment of Control effectiveness.
  - 4\textsuperscript{th} Stage – Reporting.

Source: HSG258 – Chapter 8 Installing and Commissioning
1st Stage – Installation

Purpose:
To Verify that the system has been installed as designed.

Can include, but is not limited to: -

- Checking with employer, which MWF is being used.
- Machining speed, type of fluid delivery (High/Low misting).
- A thorough visual inspection of the entire system against the design criteria / manufacturers installation instructions.
- Confirm that the correct specification / type / model of LEV system has been installed.
- Measure the machine tool enclosure internal volume (m³).
1st Stage - Common issues found

Pressure signal tube installed in Bend!!!

Should be minimum of 200mm and clear.

Siphons are required on Mechanical and Electrostatic units.
1<sup>st</sup> Stage - Common issues found

Filter Medium split on folds.

A clear gap between clean and dirty side.

Piece of Card inserted through filter flange.
Rigid ducted system, this one is not ideal however we could perform a ‘Pitot Traverse’.

We take 10 readings across the open aperture, on systems where there is no other suitable test location.

Do NOT use the Airflow type volume flow hoods. The back-pressure created gives a false reading.
2nd Stage - Performance Checks

Using a calibrated ‘Particle Counter’ to give a qualitative test of the filtration.

Test Point location we used for taking ‘Enclosure Depression’

Using a Calibrated micro-manometer to check the pressure gauge reading.

Check the Gauge / Monitor reading.
3\textsuperscript{rd} Stage – Assessment of Control

Visual smoke test to observe for inward airflow with door open.

With representative mist being created by inside the machine tool enclosure. Tyndal beam testing is undertaken around all openings (doors, swarf conveyor etc.).

Timed ‘Smoke Clearance Testing’
An LEV Commissioning (LEV Initial Appraisal) Report, is then produced. The information within this report is a reference for which to compare regular checks, maintenance and the statutory TExT against.

Example of Report Contents:

- The report must be clear and document all required velocities, flow rates and pressure measurements undertaken.
- Door delay requirements and whether this could be programed into the control panel or is a procedural control.
- Diagrams, photographs, description of the system (including LEV test points).
- A written description of all Qualitative (Observational) and Quantitative (Measured) tests undertaken and the outcome of these tests.
- Results from the mist monitoring.
- Description of operator behaviour for optimum LEV Effectiveness / MWF Management requirements.
- The report should also list the required maintenance, periodic checks to maintain the effectiveness of the system.
  - Main Filter ‘Periodic Replacement’
  - Manufactures used to state that the main filter (HEPA) should be replaced on an annual basis. This has now been updated by most:
  - Example: AFS now state, replace when there is a noticeable reduction in the devices performance, due to oil and emulsion deposits, or hardened oil.
  - FilterMist state the filters should last between 6 and 12 months, they do not give a timescale on the periodic replacement.
  - Good gauges / monitors will provide an immediate indication of system performance and let the users / facility know when maintenance is required.

Source: HSG258 – Chater 8 Installing and Commissioning
Thorough, Examination and Testing

• Carry out at least once every 14-months
  – The actual period for the TExT must be based on the age, condition and type of system installed.

• For our TExT’s we undertake the same tests as already described within the commissioning section
  – With the exception of the mist monitoring of the process, which we only repeat if the TExT identifies the system is performing outside of the operating tolerance, specified within the commission report.

• In addition during the TExT our inspectors also check the status of the Risk/COSSH assessments and the LEV logbook (for use, entries, maintenance etc.) and the management of the MWF checks (dip-slides, visual).
EXTRACTING BEST PRACTICES

CAPTOR HOODS
DESIGN AND PERFORMANCE MEASUREMENT

PRESENTER: BILL CASSELS

Jury’s Inn, Hinckley Island – 6th February 2018
Lung Disease

Horrendous (HSE) Stats?

• 12-13,000 work-related lung disease deaths per annum in UK!

• 18,000 new cases of self-reported work-related breathing or lung problems each year

• 4,000 COPD deaths each year where occupational exposures contributed (including grain and silica dust, welding fume, isocyanates, and polycyclic aromatic hydrocarbons)

• 200-300 Estimated new cases of occupational asthma seen by chest physicians each year
Soldering

Solder Fumes

With and without dust lamp!
Captor Hood Effectiveness?

Figure 1. Hood Capture Velocities Near a Hood

- Extract air velocity 5 m/s at entry to hood
- Extract air velocities in tube region are 0.5 m/s or greater
- Outside this boundary, extract air velocities are less than 0.5 m/s (100 ft/min) and effective capture is unlikely
Captor Hood Effectiveness?
Introduction

• Refresher – Design Equations
  Dallavalle/Silverman
  Fletcher

• Effect of Flanges?

• On-Site Testing/Assessing

• Correlations – On-site vs Theoretical

• Conclusions?
Research from the 1930s, published in 1946

\( V_0 \) = Average Hood Entry Velocity

\( V \) = Captor Velocity on centreline out

\[
\frac{V}{V_0} = \frac{1}{10 \left(\frac{X}{\sqrt{A}}\right)^2 + 1}
\]

\[
V_0 = V \left(10 \left(\frac{X}{\sqrt{A}}\right)^2 + 1\right)
\]
BUT

Problem with these equations – two-fold;

- only usable where the Aspect Ratio is greater than 0.2 (ie a Length to Width ratio of not more than 5:1)
- So cannot use them for long(ish) narrow slots
- experimentation by HSE in their labs in the 1970s/80s showed these equations to be too optimistic in some cases.
Silverman (1942) published a variation in the Dallavalle approach which was reputedly more accurate for round hoods: -

\[
\frac{V}{V_0} = 0.17 \left(\frac{X}{\sqrt{A}}\right)^{-1.5}
\]
Fletcher came along in 1977 – extensive experimental and mathematical modelling work and published his equations.

NOTE: For unflanged Hoods!

For a wide range of Aspect Rations – Fletcher’s equations all came within 5% of measured values!
\[ V_H = V_C (0.93 + 8.58 \alpha^2) \]

\[ \alpha = \frac{x}{\sqrt{A}} \left( \frac{W}{L} \right)^{-\beta} \]

\[ \beta = 0.2 \left( \frac{x}{\sqrt{A}} \right)^{-\frac{1}{3}} \]
In 1977 computers had the computing power of a modern watch

So ….. Fletcher created a Nomogram which only required multiply, Divide and a Square Root button

Today we can put these equations into a simple Excel Spreadsheet.
What about a hood resting on a plane?

Ah – Fletcher considered this in 1985 and confirmed that the equations were not accurate for this situation.

But …. experiments showed them to be close.

If used on a hood resting on a plane the results would produce a ‘safe margin’ and values of Captor Distance will be conservative.

[As an aside - Garrison in 1977 did very similar research on LVHV]

So – lets have a look at this all in practice: -
Examining Captor Hoods

Testing in the field - most of us have:-

- Measured Hood **Face Velocity** (and size/area)

- **Released smoke** out to the loss of capture ..... and then gone back towards the hood about 50mm and recorded that distance as the Effective Range.

- **But ..... in still air** – at what Captor Velocity would smoke be captured?
Examining Captor Hoods

Table 9 Capture velocities

<table>
<thead>
<tr>
<th>Contaminant cloud release</th>
<th>Example of process</th>
<th>Capture velocity range, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Into still air with little or no energy</td>
<td>Evaporation, mist from electroplating tanks.</td>
<td>0.25 to 0.5</td>
</tr>
<tr>
<td>Into fairly still air with low energy</td>
<td>Welding, soldering, liquid transfer.</td>
<td>0.5 to 1.0</td>
</tr>
<tr>
<td>Into moving air with moderate energy</td>
<td>Crushing, spraying.</td>
<td>1.0 to 2.5</td>
</tr>
<tr>
<td>Into turbulent air with high energy*</td>
<td>Cutting, abrasive blasting, grinding.</td>
<td>2.5 to &gt;10</td>
</tr>
</tbody>
</table>

Use Upper end of range if:
- "toxic"* materials;
- high usage;
- continuous uses;
- smaller hoods;
- airflows away from the hood;
- draughts.
https://levcentral.com

Free to use LEV Resources Database (bit like “LEV Wikipedia” 😊)
The role of a trade association in promoting safe working practices

BOHS / ILEVE
2018
SHAPA : About the Association

SHAPA has been the UK’s leading specialist Association for the solids handling and processing industry since its formation in 1981. Our support and assistance has allowed our members to maximise their profitability, enhance employee safety and reward excellence whilst taking advantage of the many benefits afforded by the Association.

Shapa has 110 member companies who all operate in the solids handling sector, based in the UK and Ireland these companies operate around the globe.
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Image of a webpage with text: "Website"

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Shapa produce a range of technical information documents on a wide variety of industry-related topics.

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Practical Management of LEV controls

Tuesday 30 January 2017
Training & Conference Unit, Harpur Hill, Buxton, SK17 9JN

We are running a BOHS approved course on Practical Management of Local Exhaust Ventilation Controls.

Book your place here

The course will demonstrate how to successfully manage LEV controls in order to get effective, efficient, and reliable control of airborne contaminants, at least cost.

This innovative, practical and lively course was developed - and will be delivered - by Dr Mark Piney (former H Principal Specialist Inspector, main author of HSE LEV guidance), along with other HSL specialists in LEV. This course is British Occupational Hygiene Society (BOHS) endorsed.

- Visit our website to find out more information
- You can book your place online here

Local exhaust ventilation (LEV) guidance - information on a wide range of Local exhaust ventilation health and safety topics and issues available on HSE's website.

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Read more

Local exhaust ventilation (LEV)
Local exhaust ventilation (LEV), also known as dust and fume extraction, captures and removes...
Read more

Lead at work
Under the Control of Lead at Work Regulations employers and employees alike are responsible for protecting...
Read more

Legionella bacteria
Legionnaires' disease is a potentially fatal pneumonia caused by legionella bacteria...
Read more

SHARPS
Healthcare workers are probably already aware of the term SHARPS and people of the risks. SHARPS?
Read more

Full text and HSE2

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Promoting Best Practice

SHAPA Guidance Note

Purchasing Solids Handling Equipment.

The things you need to know to avoid the disappointment of an underperforming plant.

Statistics from past studies show that frequently, solids handling equipment does not satisfy the expectations of the buyer/user. One extensive UK study from some years ago showed that on new plants using solids as feedstocks, and intermediates, poor performance of solids handling equipment seriously impacted both cost and performance. Cost overruns averaged in excess of 100%, when including the cost of lost production, and 80% of new plants were not up to full productivity two years after nominal startup date. These problems were almost all due to poor flow of solids in the new plants.

Even on smaller projects, the frequency of problems with solids handling equipment is alarmingly high. Many SHAPA members relate story after story about troubleshooting on brand new plants that don’t meet the owner’s needs, and cost the suppliers hefty warranty claims.

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Supporting the next Generation

Presentation of the Arkwright Engineering Scholarship to Georgina Edwards
Insert MP4 Video
Explosions in Small Vessels

Supporting Research projects and PhD Students

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POWTECH 9–11.4.2019 | NUREMBERG, GERMANY

SOLIDS 07 | 08 November 2018 | DORTMUND

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Conveying and Handling of particulate Solids

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International Trade Association Links

- Deutsche Schüttgut-Industrie Verband e.V.
- Spanish Association of Solids Technology
- TUNRA Bulk Solids Australia
- Process Equipment Manufacturers' Association (USA)

www.shapa.co.uk
Thank You

BOHS / ILEVE
2018
Clive Bates IEng MIET, Managing Director
Dr Roger Watson AFOH, CEng MIChemE. Technical Safety Specialist
‘The Brain’
Energy Savings

\[ \frac{\text{Power 1}}{\text{Power 2}} = \left(\frac{\text{Speed 1}}{\text{Speed 2}}\right)^3 \]

Fan laws

So, for example: a 50kW fan running at \( \frac{1}{2} \) speed will only consume \( 6.25\text{kW} \) of energy.

If the process permits, running the fan at \( \frac{1}{2} \) speed saves \( 87.5\% \) of the running cost.
Other Savings

- Reduced filter velocity and loading, providing longer filter life & reducing compressed air usage (for filter cleaning)
  - Less maintenance / downtime
  - Reduced commissioning time, as no system balancing is required
  - Less loss of product
  - No unnecessary loss of heat loss from the workplace with the precise airflow control
### Return On Investment

<table>
<thead>
<tr>
<th>System</th>
<th>Fan Power</th>
<th>Total Annual Savings*</th>
<th>Cost of SmartAir System</th>
<th>ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>System 1</td>
<td>37Kw</td>
<td>£9,409</td>
<td>£23,870</td>
<td>2.5 years</td>
</tr>
<tr>
<td>System 2</td>
<td>37Kw</td>
<td>£9,268</td>
<td>£23,570</td>
<td>2.54 years</td>
</tr>
<tr>
<td>System 3</td>
<td>37Kw</td>
<td>£13,700</td>
<td>£22,990</td>
<td>1.7 years</td>
</tr>
<tr>
<td>System 4</td>
<td>11Kw</td>
<td>£3,942</td>
<td>£11,700</td>
<td>2.97 years</td>
</tr>
</tbody>
</table>

Figures based on installed system prices.

Estimated savings for approximately 60% ‘duty cycles’ at 11p/KWhr.

The costs do not reflect alternative motor starter costs; which would reduce the ROI period.

*Include estimated heat loss to atmosphere and filter life/maintenance savings.
Retrofitting into existing systems
Bleed-in Damper

Increasing main duct velocity when required
# Ignition Hazard Assessment Report

Compiled with reference to EN 1127-1 and EN 13463-1

<table>
<thead>
<tr>
<th>Potential ignition source</th>
<th>Frequency of occurrence Without applying additional measures</th>
<th>Measures applied to prevent Ignition sources becoming effective</th>
<th>Frequency of occurrence With additional measures applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description/basic cause</td>
<td>Normal operation. Foreseeable malfunction Rare malfunction Not relevant</td>
<td>Reason for Assessment</td>
<td>Measure applied Basis (Standard, technical rules, experimental rules)</td>
</tr>
<tr>
<td>Normal operation.</td>
<td>x</td>
<td></td>
<td>Monitoring during routine maintenance EN13463-1:2009, clauses 8.4 and 6.4.3 EN1127-1:2011 clauses 6.4.4</td>
</tr>
<tr>
<td>Over long time period linear bearing surface will wear between stainless steel and bronze of component parts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring during routine maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Due to length of travel and number of operations per day ambient temperature is not exceeded, see note 2</td>
<td>x</td>
<td>2GD</td>
<td>T6</td>
</tr>
<tr>
<td>Mechanical spark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakdown of slide bearing surface between slide and damper body</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damper blade heating up due to friction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only a concern if sliding bearing fault, bearing material is Bronze. To generate any heat build up would require the damper blade to be constantly moving. Actuator speed is set to 10mm/s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring during routine maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Due to length of travel and number of operations per day ambient temperature is not exceeded, see note 2</td>
<td>x</td>
<td>2GD</td>
<td>T6</td>
</tr>
</tbody>
</table>
We can control the air flow without interfering with our products, the air is a lot cleaner and it’s very reliable with an added bonus that the system saves money

Malcolm Wood
Supervisor. Compressor Products International
an EnPro Industries Company
Recognition For SmartAIR
Recirculating Filters

WORKSHOP
Recirculating Filters
Recirculation of Workplace Air – Regulatory perspective on Guidance

Duncan Smith

6th February 2018
Recirculation of Workplace Air

- Historical perspective of GB regulatory guidance
• Lead contaminated air from the exhaust system should not be discharged after filtration from the system into work areas unless the concentration of lead in the exhaust air is less than one-tenth of the lead-in-air standard
• Internal guidance to HSE FOD Inspectors

• Advised other than the Lead ACOP, there was no applicable guidance for other substances

• Referenced earlier pre-COSHH FOD guidance suggesting an acceptable level of contaminant in recirculated filtered air to be 10% of the relevant OEL, up to a maximum figure of 0.1 mg/m$^3$
• Post-COSH, the employer's own risk assessment should be the key to justifying re-circulation of filtered air to the workplace

• Where the substance has a MEL, the amount of contaminant in the re-circulated air should be not more than a small fraction of the MEL, and in any case ALARP
This examination & testing should be made:

• rigorous visual examination of the filter for damage and to ensure a good seal - signs of dust on the clean side will indicate a problem

• check the filter pressure drop; too high a pressure indicates blockage, too low a pressure indicates damage or a poor seal

• Test the filters for compliance with published standards especially for `HEPA` filters
• Arrange for tests of the quality of the air as it leaves the filter
• It may be necessary to sample isokinetically for dusts after the filter
• If gases or vapours are being filtered then an analyser can be used
• Alternatively, filtered air can be sampled for subsequent chemical analysis
HSG258 (current)

- Recirculation easier with
  - particulates
  - low concentrations of airborne contaminant compared to the WEL
  - relatively small LEV systems
  - lower toxicity materials

- The air cleaner must match the contaminant and concentration

- Air must be ‘thoroughly cleaned’
Where air cleaners could fail, a recirc’ system should incorporate monitoring and alerts

For recirc’ fume cupboards,
  – HEPAs should be fitted for dust/mist/fume and there should be continuous monitoring
  – adsorption filters may be used where it is possible to predict breakthrough
Recirculating Filters

Ask 3 questions
- 5min per question
- Discuss amongst table

Write comments on sheet provided

Feedback with discussion
• When should we be using recirculating units?
• When shouldn’t we be using recirculating units?
How do you ensure they are working effectively and not contributing to risk?
• What would the delegates see come from this?
Changes to LEV Qualifications
The changes to LEV Proficiency Modules

Changes apply from 1 January 2018.

Why have we made the changes?

• Overall objective is to Improve standards and ensure the courses are appropriate for the application and at the right level.

• We have moved some syllabus items into its appropriate module, and added additional material where required.
P600 (introduced February 2017)

Why introduce P600?

• Many candidates do not meet the P601 entry requirements.

• P600 has been designed as a one-day course to fill that gap.

• It covers the basic use of LEV test equipment and maths equations.

• Recommended, but not a compulsory pre-requisite for P601.

Level 3 Foundation Course
P601 – Thorough Examination and Testing of LEV Systems

Syllabus changes:

• Reduced detailed technical content.
• Increased emphasis on practical and reporting aspects. New section on reporting added.
• Brief overview of Fan Laws and Fletcher-Garrison method – not tested in exam.
• Brief introduction to earth bonding and explosion control.
• No calculations in closed-book written theory examination.

Now available: IP601 for International courses  Level 4 Qualification
500+ candidates have taken P601 – but have never completed the qualification by submitting report assessments.

They are now out of time – therefore they do not hold the P601 qualification.

Looking at ways to address this – currently only option to gain P601 certificate is to re-take whole course, and then submit reports. Considering P601 report amnesty, one day refresher course?

*Level 4 Qualification*
P602 - Basic Design Principles of LEV Systems

Syllabus changes:

- **Detailed** working of Fan Laws and Fletcher-Garrison method.
- New and real practical case study assessments for both LEV system design and fault finding.

*Level 4 Qualification*
P603 - Control of Hazardous Substances - Personal Protective Equipment

No major changes
P604 - Performance Evaluation, Commissioning and Management of LEV Systems
Advanced Proficiency Module

P601 is now a **compulsory pre-cursor** for this higher level qualification.

**Syllabus changes:**

- Revision of measurement and basic system requirements removed, changed to **upgrade of knowledge**.
- Practical elements reduced.
- **No** formative practical assessment.

*Level 5 Qualification*
P604 Advanced Proficiency Module

- Development of management systems increased with more emphasis on installation and commissioning.
- More included on explosion control and prevention.
- Assessment of systems using tracer materials included.

Only one examination: mixed written theory and practical. Open book, 2.5 hour exam, 55% pass mark. Includes some calculation questions.

Only one report assessment - commissioning or Installation of a system (no longer required to do two TExT reports)

Level 5 Qualification
Booth Clearance
Time Determination

LEV Extracting The Best Practices
Jurys Inn Hinckley Island
6\textsuperscript{th} February 2018

MARY CAMERON, BSC, AFOH
OCCUPATIONAL HYGIENE TEAM LEADER (SOUTH)
WHO IS SOCOTEC?

SOCOTEC is the UK’s leading provider of testing, inspection and compliance services.

National capability including nationwide UKAS accredited laboratories.

Offering a broad range of testing, inspection and compliance services delivered by in-house teams.

Strong project and sector focus.

SOCOTEC UK operates from over 30 sites nationwide

www.socotec.co.uk
Booth Clearance Times
Spray Booth Example
Smoke Method
Alternatives

- PID MONITORING
- AIR FLOW CALCULATIONS
  > Drawbacks
What is clearance time?

• The time taken to dilute and remove the contaminant cloud (mist) after the activity (spraying) ceases in an extraction booth or room.

The way that air re-circulates within a booth or room will depend on air input and extract arrangements and dimensions.

HSG 258…
the ‘LEV commissioner’ needs to establish or confirm the clearance time.
SPRAYING EQUIPMENT

Video: Spraying with a conventional gun

Video: Spraying with a HVLP gun with excessive air pressure
   - [http://www.hse.gov.uk/mvr/resources/videos/video2c.htm](http://www.hse.gov.uk/mvr/resources/videos/video2c.htm)

Video: Spraying with HVLP compliant spray gun
WHAT IF THE CLEARANCE TIME IS UNKNOWN?

A user manual provided by the system’s manufacturer should supply the clearance test time.

The ‘LEV commissioner’ (normally the manufacturer/supplier) needs to establish or confirm the clearance time.

But what if a user manual was not supplied and a clearance time had not been designated?
MEASURING BOOTH CLEARANCE TIME

SMOKE METHOD NOTES

> Checked just before the filters are changed, to give a worst-case time

> Appropriate RPE should be worn.

> Check during the test that the booth runs at slight negative pressure. If there are any leaks, air is drawn inwards.

> A disposable dust mask with a combination A/P3 filter will suffice for most smoke/fog types.
1. The spray booth or room should be empty when measuring the clearance time.

2. The booth or room should be set up for normal spraying operations except with the ventilation deactivated and the lights on maximum to enable the smoke aerosol to be seen.

3. Ensure that the extraction system is turned off.

4. Fill the room with smoke, making sure to distribute smoke evenly throughout the room (an extension lead may be useful in allowing all areas of the room to be reached).
5. The room shall be regarded as full when the facing wall is no longer visible when viewed across the short axis of the room.

6. Switch on the ventilation system and start a timer.

7. During the smoke test the opportunity should be taken to do a visual inspection of the exterior of the booth and any associated ductwork to check for any leaking air.

8. The room shall be regarded as clear when smoke is no longer visible in any part of the room.

➢ Use a lamp to help judge this.

9. Note the time at which the room is judged to be clear of smoke. This time should be rounded up to the next quarter minute.
• Tyndall illuminated spraying, illustrating invisible mist

• Measuring paint spray booth clearance time
  – https://www.youtube.com/watch?v=arksnOhGyF0
  – https://www.youtube.com/watch?v=u-_B6eEbBxl
VISUALISATION OF CLEARANCE
VISUALISATION OF CLEARANCE
VISUALISATION OF CLEARANCE
A practical alternative to ensuring people are not exposed to the invisible paint mist is to provide sensors which automatically warn spray booth/room users of the potential presence of isocyanates.

RR742 describes the design and assembly of a device consisting of a timer switch, programmed with the clearance time, which is triggered by a sensor that detects when the spray gun is turned on and off.
HSE guidance states...

‘If there is some reason why a smoke test cannot be carried out, an equally effective method of determining the clearance time should be used’
WHEN YOU CAN’T USE SMOKE…

Examples-

- Greasy deposit on the vehicle from smoke generating a glycol aerosol
- Two-stage fan start up

Alternatives-

- PID monitoring
- Air flow calculations
METHOD 1

PID MONITORING
DOWNDRAUGHT SPRAY BOOTH EXAMPLE
METHOD NOTES

> Consultant paint product(s) material safety data sheets

> The PID is positioned in the booth during spraying.

> The moment the spraying ceased, the PID data-logged the dropping levels of n-butyl acetate.

> The PID readings were monitored at 1-second intervals until these plateaued to minimal levels.
PID TESTING
METHOD 2

AIR FLOW MONITORING
# Exchange Rate Calculation

<table>
<thead>
<tr>
<th>Grill ID</th>
<th>Grill Dimensions (m)</th>
<th>Average Velocity Across Grill (m/s)</th>
<th>Average Flow Rate Across Grill (m³/s)</th>
<th>Total Flow Rates Across Grills (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraction Grill 1R (front)</td>
<td>0.668 x 0.473</td>
<td>0.13</td>
<td>0.0411</td>
<td></td>
</tr>
<tr>
<td>Extraction Grill 2R</td>
<td>0.668 x 0.473</td>
<td>0.29</td>
<td>0.0916</td>
<td></td>
</tr>
<tr>
<td>Extraction Grill 3R</td>
<td>0.668 x 0.473</td>
<td>0.28</td>
<td>0.0885</td>
<td></td>
</tr>
<tr>
<td>Extraction Grill 4R</td>
<td>0.668 x 0.473</td>
<td>0.13</td>
<td>0.0411</td>
<td></td>
</tr>
<tr>
<td>Extraction Grill 5R</td>
<td>0.668 x 0.473</td>
<td>0.15</td>
<td>0.0474</td>
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</tr>
<tr>
<td>Extraction Grill 6R</td>
<td>0.668 x 0.473</td>
<td>0.21</td>
<td>0.0664</td>
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</tr>
<tr>
<td>Extraction Grill 7R</td>
<td>0.962 x 0.839</td>
<td>0.66</td>
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<tr>
<td>Extraction Grill 8R</td>
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<td>0.52</td>
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<tr>
<td>Extraction Grill 9R</td>
<td>0.962 x 0.839</td>
<td>0.65</td>
<td>0.5246</td>
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</tr>
<tr>
<td>Extraction Grill 10R</td>
<td>0.962 x 0.839</td>
<td>0.33</td>
<td>0.2663</td>
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</tr>
<tr>
<td>Extraction Grill 11R (back)</td>
<td>0.962 x 0.839</td>
<td>0.75</td>
<td>0.6053</td>
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</tr>
<tr>
<td>Extraction Grill 11L (front)</td>
<td>0.668 x 0.473</td>
<td>0.70</td>
<td>0.2212</td>
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</tr>
<tr>
<td>Extraction Grill 2L</td>
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<td>0.17</td>
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<tr>
<td>Extraction Grill 3L</td>
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<td>0.29</td>
<td>0.0916</td>
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</tr>
<tr>
<td>Extraction Grill 4L</td>
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<td>0.22</td>
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<tr>
<td>Extraction Grill 6L</td>
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<td>0.0885</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
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<td>0.962 x 0.839</td>
<td>1.25</td>
<td>1.0089</td>
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<tr>
<td>Extraction Grill 9L</td>
<td>0.962 x 0.839</td>
<td>1.35</td>
<td>1.0896</td>
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<td>Extraction Grill 10L</td>
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<td>1.43</td>
<td>1.1542</td>
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</tr>
<tr>
<td>Extraction Grill 11L (back)</td>
<td>0.962 x 0.839</td>
<td>1.68</td>
<td>1.3560</td>
<td></td>
</tr>
<tr>
<td>Ceiling Input Grills, Front</td>
<td>5.828 x 2.888</td>
<td>0.072</td>
<td>1.212</td>
<td></td>
</tr>
<tr>
<td>Ceiling Input Grills, Back</td>
<td>5.950 x 2.888</td>
<td>0.049</td>
<td>0.848</td>
<td></td>
</tr>
<tr>
<td>Input from door slot, Front</td>
<td>0.10 x 2.735</td>
<td>4.42</td>
<td>1.208</td>
<td></td>
</tr>
<tr>
<td>Input from door slot, Back</td>
<td>0.10 x 2.735</td>
<td>10.89</td>
<td>2.978</td>
<td></td>
</tr>
</tbody>
</table>

Output: 8.849

Input: 6.246
EXCHANGE RATE CALCULATION

Booth Dimensions:
Length 14.122m x Width 4.029m x Height 2.640m
Booth Volume: 150.21 m³
Extraction Flow Rate: 8.849 m³/s
Air Changes per Hour (ACH): 212.08 /hr

The formula to calculate the minutes required for a removal efficiency of 99.9%, assuming;

**Perfect Mixing** (mixing factor = 1):
\[ T = \frac{-\ln (0.1/100)}{212.08} \times 60 \times 1 = 1.95 \text{ minutes} \]

**Poor Mixing** (mixing factor = 10):
\[ T = \frac{-\ln (0.1/100)}{212.08} \times 60 \times 10 = 19.5 \text{ minutes} \]

Where
- \( T \) = time in minutes to achieve removal efficiency
- \( C_1 \) = initial concentration of contaminants
- \( C_2 \) = final concentration of contaminants
- \( Q \) = air flow rate (cubic meters per hour)
- \( V \) = room volume (cubic meters)
- \( Q/V = ACH \)

Note: Output flow rates are greater than input flow rates therefore the booth is under negative pressure. However, excessive negative pressure noted. Two input air supply fans are located on top of the booth, one at the front and one at back. It is suspected that these fans are not inputting air sufficiently into the booth thus this is the cause of the inwards pull of air from the slots on top of the shutter doors to the booth. The personnel entry door was very hard to pull open.
ALTERNATIVE METHOD DRAWBACKS

Imagined movement of air in a downdraft booth

What really happens
What are the essential features of a spray booth?
Figure 12 Imagined air movement in a spray room

Figure 13 What really happens

HSE document: “Controlling isocyanate exposure in spray booths and spray rooms”
QUESTIONS
REFERENCES

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