LEV Working Demonstration Model

User Manual

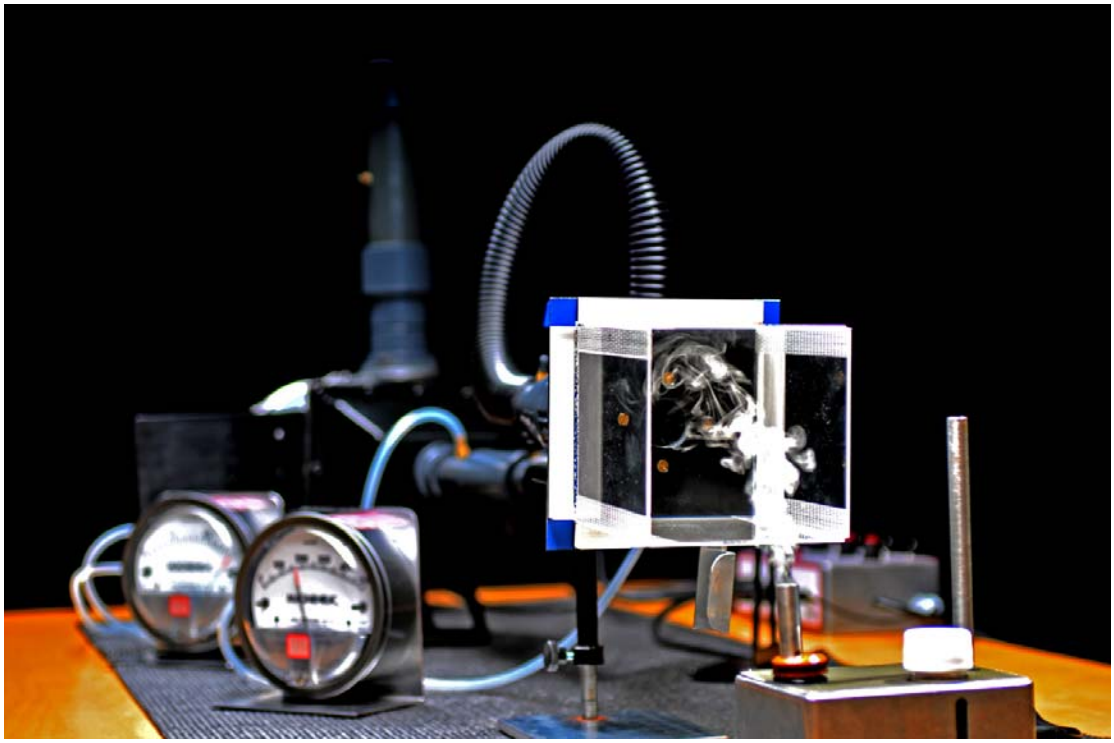


Table of Contents

1. Introduction

Thank you for purchasing the LEV Working Demonstration Model. Local Exhaust Ventilation (LEV) is the most common way of controlling exposure to airborne dust, fumes, and gases etc that can cause ill-health. Unfortunately, all too often, it is poorly selected, designed, applied and maintained, and doesn't protect people's health.

The LEV working demonstration model, developed by Health and Safety Executive (HSE) and the Health and Safety Laboratory (HSL), is a powerful training tool that brings theory to life in a memorable way that people will not quickly forget.

From experience HSL/HSE have found that the instruction on how LEV works is best shown by oscillating between LEV model demonstration and PowerPoint slides and video, which are included with the model.

To fully appreciate all the features of the model, please read this guide before using.

2. Package contents

The two cases contain the following:

- LEV Working Demonstration Model (unassembled)
- User guide
- DVD containing:
    - Electronic copy of the User Guide
    - Video showing how to set-up the model
    - Video giving an introduction on how to use the model
    - PowerPoint material that has been carefully selected to complement the working model
    - Unique video clips that can be embedded with a PowerPoint presentation

3. Health and Safety information

3.1 General

The model control unit operates on 220-240v AC mains supply. This is used to power the fan and a 12 volt transformer. The transformer powers all the other electrical items (i.e. the fan speed controller, smoke machine, spotlight, and the small receiving fan. As with all mains powered appliances there is a small risk of harm. To minimise this, normal safety precautions should be observed. These include:

- Unplug the mains supply before cleaning the model
- Fit and remove the smoke element only with the mains off
- Before use check for damage to cables and other electrical items
- Do not expose the electrical equipment to wet or damp conditions
- When not in use, the model should be stored in the cases supplied in a dry place

If the mains plug is removed for any reason it should not be reused.

3.2 Smoke machine and fluid

The smoke machine pumps fluid from the reservoir to a small heater in the smoke tube. The fluid is then heated until it vaporises, generating the smoke cloud.

WARNING The smoke tube gets extremely hot during use. Do not touch during use and allow to cool before removing and packing. Do not insert anything into the smoke tube, as this could damage the delicate glass smoke heating element.

Only use the fluid supplied with the model, which is available from Mechanical Products Ltd. to avoid damaging the smoke machine.

The material safety data sheet for the smoke is provided on the DVD that accompanies the model.

4. Description of the LEV model components

The model is supplied in two cases. One case has wheels and an extendable handle, the second case is designed to sit on top of the first one, allowing the model to be easily transported. See Figure 1 below.

Figure 1 Illustration of how the cases are arranged for easy transport

The contents of each case are shown below in Figure 2.

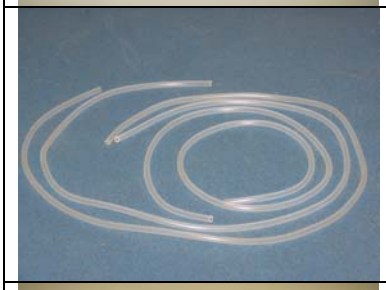
Figure 2 Contents of each case

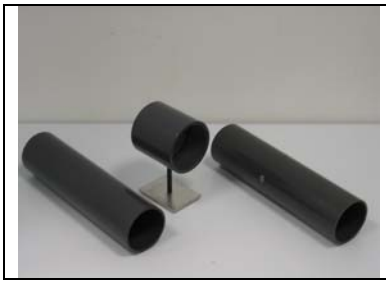
Identification and a description of each component is given below.

Illustration	No.	Description and use
	x1	Mains powered fan and housing incorporates a stand. Flow rate is adjustable
	x1	Exhaust silencer
	x7	Interconnecting ducting with pressure tap. Used to connect the different components of the model together

	x1	Filter unit with slider to simulate filter loading
	x1	Ducting Y-junction – used to create a branch
	x3	• Long flexible hoses • Short flexible hose – can be used to extend the long hose
	x1	Ducting with hole – used to join the long/short hoses together. Can be used to simulate damage to ducting when the flexible ducting is slid away slightly
	x2	• Damper used to isolate one branch and can be used to simulate a blockage in the duct • Adjustable height damper. Can be used to simulate a blockage in the duct
	x2	Capturing hoods, one with pressure tap one without

		Flange – used to demonstrate the effect of adding a flange to a capturing hood. Also used to hold the clear Perspex enclosures
	x1	Small Perspex hood – when connected to the flange can be used to demonstrate working at the face of an enclosure and can be used as a receiving hood
	x1	Large hood – when connected to the flange it creates an enclosure. There are four positions where the smoke source can be released inside the hood
	x1	• Smoke machine – used to generate the 'source' smoke that is controlled by the LEV. Adjustable flow rate and adjustable height. • Smoke element - plugs into the smoke machine before use and is removed after use • **WARNING** the smoke tube gets very hot during use. Allow to cool before removing
	x1	100 ml of smoke fluid
	x1	• Small variable flow fan – used with the smoke machine to create a directional smoke laden air jet. Could also be used as part of the 'Push' of a 'Push-pull system'. The fan speed is adjustable • Lamp – a 10w halogen lamp used to enhance the visibility of the smoke • Hinged black background screen – enhances the visibility of the smoke by providing a good contrast

	x1	• Whisk – used with the smoke machine to create an ‘energetic source’ • Hand held cooling fan – used to demonstrate the effect of draughts on an LEV system • Black non-slip mat for the model
	x2	Pressure (Magnehelics) gauges with stands –used to show pressure drop across the filter and to measure static pressure at a number of locations
	x3	Silicone tubing – used to connect manometers to pressure taps
	x1	Mains powered control box – used to control (i) operation and speed of the system fan; (ii) smoke production; (iii) operation of the lamp; (iv) operation of the small fan
	x1	Ducting section with 75 % blockage – from the outside appears to be identical to the other ducting section. Could be used to replace an existing section and a manometer used to find the ‘blockage’. Can also be used as a crude orifice plate (See section 6.2)
	x1	Adaptor used to connect the large diameter duct to the fan

	x1	• Large duct with access holes • Large duct • Large diameter socket with stand for joining the two large ducts

5. How to assemble the model for demonstration

As each plastic component of the model is connected using identical rigid tubing sections it is possible to exclude some components depending upon what you wish to demonstrate. Below are two typical assembly configurations.

5.1 Full assembly

Figure 3 shows an exploded diagram of the full model set-up. For instruction on how to assemble the model, please see the video file 'How to setup the LEV Working Demonstration Model', which can be found on the accompanying DVD.

Figure 3 Exploded diagram of the full model

5.2 Example of partial assembly

If you wish to concentrate on specific parts of an LEV system then some components of the model can be excluded from the set-up. For example Figure 4 below shows just the fan and hood. This could be used to demonstrate how the different types of hoods work. Note in this arrangement the filter has been excluded. See Figure 4. Other configurations are possible.

Figure 4 Possible model set-up for demonstrating how different hoods work

5.3 Smoke machine

Before switching on the model, insert the smoke tube (which contains the heater) into the socket on top of the smoke machine. After use, allow to cool before removing and packing. Ensure no fluid is left in the tube before packing – the best way to do this is to gently shake on to a paper towel. Do not insert anything into the smoke tube as this could damage the delicate glass smoke heating element.

To fill the smoke machine with fluid, remove the white plastic cap of the reservoir and pour in the smoke fluid. Replace the cap. After use pour any remaining fluid back into the bottle.

Note The smoke cloud can be made directional using the small variable flow fan. The 'smoke' is more of a mist and doesn't easily set-off smoke alarms. Smoke visibility is enhanced with the low wattage halogen lamp. If the model is used for audiences greater than 5 it is recommended you purchase the optional extra ‘bullet’ camera. This allows images to be projected onto a screen so that everyone can see the demonstration.

5.4 Model assembly for the measurement of duct velocities

Figure 5 below shows the arrangement for measurement of duct velocities. Note: the duct section with the two holes 90 degrees to one another should be positioned closest to the fan. A Pitot static tube (not supplied) can be used to demonstrate how to make duct velocity traverses. This could be used as part of a demonstration, instruction or as part of a test/examination.

Figure 5 Arrangement for making duct velocity traverses

6. How to use the model

6.1 LEV demonstration

The model can be used to demonstrate most features of any LEV system. Including:

- How the different types of hoods work
- Why the LEV flow rate falls e.g.
  - Damage to flexible tubing – inc. holes and kinked tube
  - Out of balance dampers
  - Filter loading
  - Partially blocked ducting
  - Problem with fan causing a fall in flow rate
- Effect of silencer
- Static pressure measurements
  - Assessing the condition of a filter
  - Hood static pressure
  - The pressure 'profile' throughout the system and the effect of a blockage in the system

As hood design is critical to the effectiveness of an LEV system, a video file explaining how hoods work has been included on the DVD which accompanies this model. The video covers how the three different types of hoods work. Of course you may wish to cover this in more or less detail. The accompanying PowerPoint material should help you do this.

6.2 Estimation of flow rate using the blockage as an orifice plate

Orifice plates are a common way of measuring volume flow rates through a pipe. Whilst the blockage has not been designed as an orifice, it does present a restriction to flow and can be used along with a manometer, to estimate the flow rate through the model. This can be useful as a demonstration or instruction.

Figure 6 below shows how to set-up the ‘orifice’ plate.

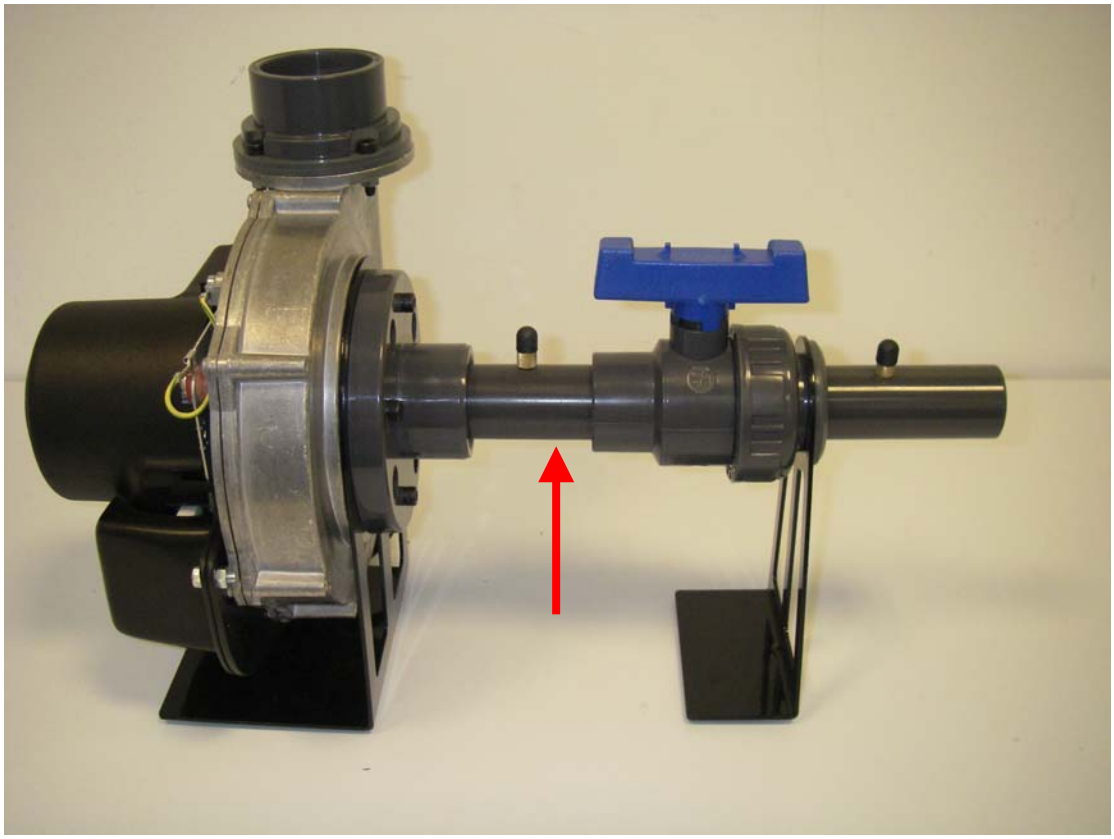


Figure 6 Model arrangement for the estimation of volume flow rate, position of blockage is shown by the arrow

The flow rate can be estimated from the equation below.

$$Q = 10\sqrt{P}$$

Where:
Q = Volume flow rate (l/min)
P= Pressure (Pa)

6.3 Measurement of duct velocities

By assembling the model as shown in Figure 5 it is possible to demonstrate how to measure duct velocities.

The insertion depths for both a single traverse and two traverses at 90 degrees to one another are given below:

Single traverse (x positions):

Two traverses (x positions):

7. Tips to getting the best from the model

A smoke tube can be used in addition to the smoke machine to demonstrate how air enters a capturing hood from all directions

The optional bullet camera is recommended when presenting to a large audience. This allows images to be projected onto a screen to enable everyone to see the demonstration. The bullet camera can be purchased from Mechanical Products Ltd.

8. Cleaning and maintenance

The model requires no specific maintenance. However, in time the filter installed in the filter housing will become blocked and will need to be replaced. You will know when this occurs as the flow rate will fall (as shown by the hood static pressure and pressure drop across the filter). The filter is removed by undoing the bolts holding the filter housing together. New filters (type AEG FIL 74, with tabs removed) are available from the supplier.

If you wish to clean any part of the model, isolate from the mains supply first. It is recommended that you use a damp cloth.

9. Troubleshooting

Problem	Solution
The fan does not operate	• Check mains supply is on and the red LED on the control box is lit • Check fuse is okay
Flow rate low	• Check that the filter housing damper is not closed • Check the valves are open • Check that the filter is not blocked
No smoke from smoke machine	• Check reservoir is full • Ensure smoke machine is plugged into the control box and the switch is on and the smoke production dial set above minimum • It takes a few seconds for the smoke fluid to be pumped from the reservoir to the heater – ensure you have left it running for a few seconds
Hand held cooling fan does not work	• Replace the batteries

If you are still experiencing problems, contact the manufacturer.

10. Spare part list

- 100 ml bottle of smoke fluid
- Filer unit AEG FIL 74
- Smoke tube with heater

11. Suppliers details

Mechanical Products Ltd
The Barn
Pye Road
Heswall
Wirral
CH60 0DB

Telephone: +44 (0)151 342 2206
E mail mechanicalproducts@ntlworld.com

12. Guarantee and Warranty

All parts are covered by a 12 months warranty

13. Acknowledgements

Original concepts and early prototype developed by Dr Mark Piney.

14. Further reading

If you are interested in learning more about LEV then the following publications are recommended:

- ACGIH, Industrial Ventilation: A Manual of Recommended Practice for Design. http://www.acgih.org/home.htm

- ACGIH, Industrial Ventilation: A Manual of Recommended Practice for Operation and Maintenance http://www.acgih.org/home.htm

- Hemeon's Plant & Process Ventilation, 3rd ed., ISBN 10 1566703476

- HSG 258 Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV), ISBN 978 0 7176 6298 2, http://www.hsebooks.co.uk, or available free at: http://www.hse.gov.uk/pubns/books/hsg258.htm