LOCAL EXHAUST VENTILATION (LEV)
LESSONS TO BE LEARNT

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te ao rangahau

CONTENTS

This document summarises the webinar facilitated by the New Zealand Society for Safety Engineering, an Engineering New Zealand interest group.

The presenter was Derek Miller, a certified occupational hygienist and a fellow of the New Zealand Occupational Hygiene Society.

An occupational hygienist is a professional who works primarily in the occupational health space, and is concerned with prevention of harm to people resulting from contaminants, dusts, chemicals, toxins, and the things that can cause cumulative harm, such as chemical exposures.

Derek has many years experience in occupational hygiene, particularly in using Local Exhaust Ventilation (LEV) systems to reduce harm in industral, food and manufacturing workplaces.

For more about the New Zealand Society for Safety Engineering, including the principles of the society, go to https://nzsse.org.nz/

THE NEW ZEALAND SOCIETY FOR SAFETY ENGINEERING

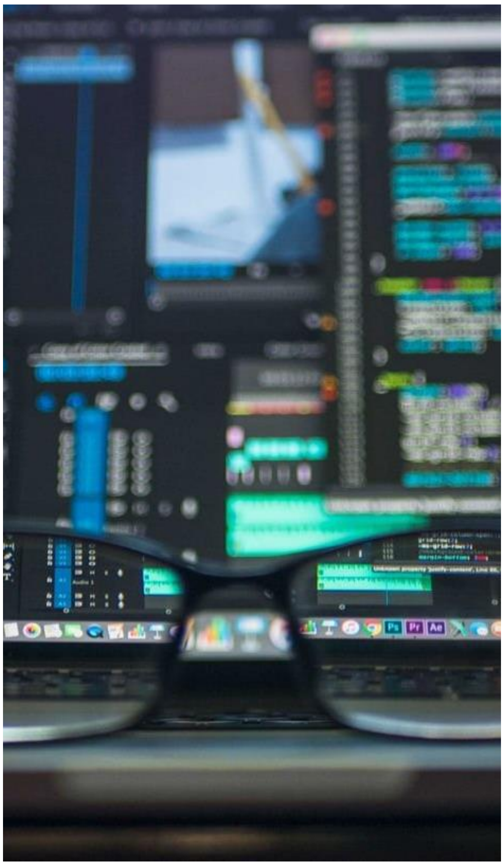
1: INTRODUCTION

While New Zealand has a strong focus on workplace safety, health issues caused by poor workplace ventilation exhaust systems maynot show for 10 to 15 years or more after a person's exposure. People affected may become unable to work, can become a burden on their families, and many may develop diseases (such as work-related cancers and respiratory diseases) because they have absorbed in too much dust, fumes, or other airborne contaminants at their workplace.

Every year it is estimated 750 to 900 people in New Zealand will die from work-related health issues and a further 5,000 to 6,000 will be hospitalised. A worker is 15 times more likely to die from a work-related disease than from a workplace accident.[1]

Most industries are affected, including woodworking, welding, paint-spraying, stonemasonry, engineering and foundry work.

The webinar explored how to reduce harm in these industries by using LEV systems.



[1] https://data.worksafe.govt.nz/editorial/work_related_health#:~:text=WorkSafe%20has%20revised%20its%20work,than%20from%20a%20workplace%20accident.

2: LOCAL EXHAUST VENTILATION (LEV)

It is important we learn to install effective ventilation systems into industry. LEV is particularly effective in controlling hazards.

TYPES OF VENTILATION SYSTEMS

LEVs are one type of ventilation system. There are three main types:

1. **Heating, ventilation, and air conditioning (HVAC)** systems aim to provide thermal comfort and acceptable indoor air quality, remove body odours and other unwanted odours. These systems will be particularly important in the future, with increasing temperatures due to climate change. HVAC is not a control system.When we are required to control contaminants, we need to look at other types of ventilation systems, dilution ventilation and LEV systems.
2. With **dilution ventilation** the goal is to control pollutants generated in the workplace by ventilating the entire workplace. This is not HVAC, but rather is specially designed to make sure all the air is changed in the workplace.
3. The purpose of **LEV** is to capture emissions at their source and transport them safely away from workers.
   - It’s not ventilating the whole workplace, rather it’s trying to capture the contaminant at its actual source, as it is released and then entrain it into the ducting system.
   - As the contaminant goes through the duct system, the LEV will make sure that it doesn't settle out which can cause problems with the ventilation system.
   - The contaminant will then go through the filtration system with the resulting fresh air being released outside.
   - An LEV system is much more than just moving air, and a lot needs to be taken into account when designing and installing these systems.
   - LEVs are very important in the reduction of workplace related death and illness.

COMMON ISSUES WITH VENTILATION SYSTEMS

The experience of the author is that, over the last 15 years, 90% of the ventilation systems he has tested in New Zealand have failed to effectively control hazards.

In the UK a study[2] has shown that only 24% of companies that have invested in installing an LEV system are effectively controlling hazards. That means 76% of systems installed and paid for in the UK are a waste of money.

So we're getting things wrong. The problem is that a lot of the systems have not been designed and set up to control substances hazardous to health correctly.

[2] ILEVE, CIBSE based on HSE(UK) data **https://www.cibse.org/get-involved/societies/institute-of-local-exhaust-ventilation-engineers-ileve/ileve-s-strategic-partnerships**

EXAMPLE: METAL WORK

The photo on the right shows a purpose-built designed LEV in New Zealand in a trade-training establishment for metal workers.

It is designed to capture the fumes from brazing and welding.

Issues

Whoever designed the LEV didn't understand how the contaminants are actually released.

When we tested the system, we found it is only effective one centimetre away from the bottom of the LEV. This means a person has to be welding or brazing hard up against the wall for it to capture the contaminant.

It is important to understand how contaminants move and behave in the air and the tasks that the system will be used for.

These issues are common among industries such as the woodworking industry, where LEV systems are not being designed to control substances hazardous to health at the point of release.

Figure 1: LEV at a metal workers training facility

EXAMPLE: DIESEL EXHAUST

The photo on the right shows a purpose-built LEV for a diesel exhaust. Diesel exhaust is a carcinogen and has a very low exposure level.

Issues

Note all the junctions in this LEV system are right angles and there many tight bends

- A right-angle joint going into one system then into another, will result in a lot of turbulence. With diesel particulates, the wetness and oiliness of the substance means that coating will occur immediately on the inside of the pipes and will start building up.
- Wherever there are corners and elbows, there will be settling out, which will then cause more turbulence, which will result in more settling out and eventually blockage.
- There are also no hatches to allow maintenance and cleaning out of contaminant settling around the elbows.

This system was installed but never commissioned and tested, so there is no knowledge of whether it is effective in entraining contaminants and removing them from the work area. Overall, this system design lacks an understanding of how the contaminant is acting outside of the system and also how it is acting inside the system.

Figure 2: LEV for a diesel exhaust

It has been designed to fail at some point in its life.

DOMINANT FAULTS

We need to learn from these examples. There is a general lack of understanding around:

- **how contaminants behave in the air** so the system can be designed to capture them.
- the **work processes and tasks** that the system will be used for. If the workers who will use the system are not consulted, the system may not be of design that the worker can use, e.g. interferes with their interaction with the task, and then it is not suitable for the task and workers will not use itand it will sit unused in the corner.
- **the importance of commissioning a system** - installing, testing and ensuring it is set up correctly. One of the things we can do once it's designed is to commission it properly and ensure the system performs how it is meant to (to control the harmful contaminants). Doing this well:
  - gives confidence to the workers and to the employers of the workplace that the system will remove the contaminant and protect their workforce
  - means users know how to use it and have been trained in using this type of system.

  Unfortunately this is not done well in New Zealand. We have a history of:

- designing a system, installing it, and leaving it;
- testing the system against old standards; and
- using the same people who built and installed the system to do the commissioning. That is bad work practice. Commissioning should always be done by another company as an independent check of your work. It is a quality control check.

- **training people** so the system is operated correctly and monitored. When we install a system, it's generally accepted that everybody knows how to use it. But in reality they don't. People need to be trained. They need to be shown. They need the supporting manuals and resources to refer to on an ongoing basis.

  Example: *During a visit to look at a woodworking LEV, although I had not commissioned it, I went through the testing process with the staff. We found the system was struggling to capture the contaminants and the level was in excess of 10 times the workplace exposure standard for wood dust in the area.*

  When we spoke with the operators, they admitted nobody had shown them how to use the system correctly. We spent a morning playing around and eventually got a configuration that would work. We got the LEV up and running correctly and then we retested the whole system. This time we got the LEV performance to less than 1% of the workplace exposure standard.

  So we've gone from 10 times above to less than 1% of the workplace exposure standard. This meant the situation was now under control. The system itself was fine but the workers never knew how to use it correctly.

3: LESSONS TO BE LEARNT

We need to increase competence in the practical application of LEV so we can provide LEV that is fit for purpose and can demonstrate that it works and will effectively control the hazards.

That way, we will collectively help reduce the burden of disease on workers, families, companies, the health system and our country.

SUMMARY OF KEY LESSONS

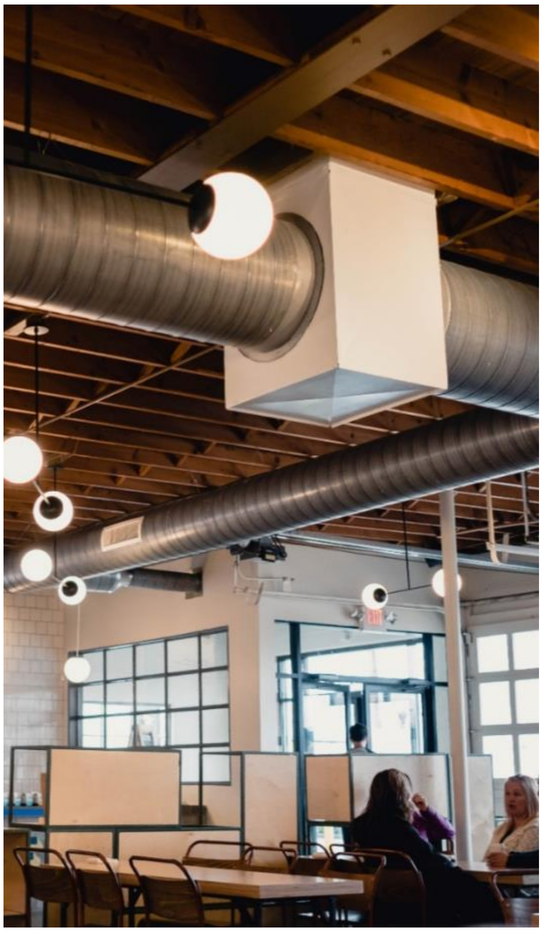
- We need to apply the principles of health and safety by design to controls such as LEVs.
    - We need to focus not just on the safety, but on health.
    - If 750 to 900 people each year are dying from ill health related to their occupations, and a few thousand get hospitalised, we can have a big impact on people's lives. We can help prevent workers getting work-related disease and ill-health.
- All LEV should be properly commissioned. Just because an LEV has been designed and installed, it doesn't mean it will necessarily do the job.
    - Once it's properly designed, we need to prove it to the workers.

      Example: *In many locations, we find an LEV system works well, but workers continue to wear respirators because they 'don't trust it'. We've got to build that trust and one of the ways we do that is by commissioning before it goes into full use, and prove that it does what it's supposed to do. Then we can persuade people they are able to stop using respirators.*

- We need competencies for people to build their knowledge and skills around LEV. It is not just occupational hygienists who need to be competent, we need engineers to be fully competent too.
    - If you're working on an electrical system, you have to be an electrical engineer. So why is there a belief that anybody can design an LEV system? It's a control and it's possible more people die every year from contaminant exposure due to improper systems than from gas exposure, gas fitting problems, explosion, or electrical issues.
    - There is an assumption that if you can design a simple system, you can design an LEV system. But HVAC and LEV are two different disciplines. Designers need to be competent in their chosen field.
- Also we need people who are competent in the commissioning of systems. They need to understand the testing required, the documentation, and that commissioning data needs to be present and trustworthy.

- The company that has designed or installed an LEV should not be the same company to complete the commissioning. It should be an independent company, with the required competency (such as someone from an engineering or hygienist background).
    - We need to demonstrate to the employers and to the workers through thorough commissioning that the LEV system is actually controlling the hazards and is effective.
    - A well-designed system that is properly maintained will last a very long time; potentially for 40, 50, or 60 years.
- We need training courses on LEV design (including design, commissioning, and maintenance). LEV has dropped off the current curriculum for engineers globally, not just here in New Zealand. This needs to be addressed.
    - The courses need to be practical with a strong understanding of physics, not just fluid dynamics.
    - We need to know how contaminants behave, before we can design a system to capture them. For instance, when we look at LEV and capture velocities, there is a range that can be used for the same substance. Designing an effective system will depend on whether the substance is wet or dry and what type of air it is being released into.

  Example: *a fume cabinet with a design face velocity over the minimum 0.5 metres per second, with about a 300 mil opening will usually be fine. However, if you've got a lot of foot traffic behind it, with people passing, you actually need a higher velocity so the chemicals actually get pulled back out of the fume cabinet. We need to understand the whole area and how the contaminant behaves in those areas with the different conflicting air turbulence, disturbance.*



- We need guidance for everyone and a criteria for best practice in LEV engineering that we can all follow and understand. This will help us improve existing systems.
- We need better partnerships and collaboration between the professional bodies. While engineers in New Zealand have partnered with the New Zealand Institute of Safety Management, there are other professional bodies. Occupational hygienists, occupational health nurses, physicians, and economists all have a role to play, and engineering cuts across all those roles. We all have different skills and knowledge to help improve the system provided to clients.

Reflect on work you have been involved with in the past that you have designed, manufactured, supplied and installed, and ask yourself these questions:

- Did you consider the workers who are going to use those systems?
- Is it something workers can use?

- Will it actually control the hazard effectively?
- Are we protecting the workers?
- Will the system last 50 or 60 years with good maintenance?
- What maintenance is required?
- Will it help reduce the numbers of people dying, being hospitalised or injured from related-health conditions?

Engineering New Zealand is working towards becoming a member of HASANZ, so that we can have deeper and more systematic engagement with groups like the Occupational Hygiene Society.

4: Q&A

Why is commissioning not a standardised activity in New Zealand? Surely it's normally included in the sales package?

Evidence in my work (when I look for commissioning data, the log books,and so on) usually says that commissioning is not included as part of the sale of an LEV system. But it should be part of the package, including the initial training engineers system.

We think this is being dropped because of cost, which is a common problem in other countries.

At a recent American Congress for the Governance of Industrial Hygiene (ACGIH) event I attended, they speculated that there is a generation of people trained in LEV who are retiring, and there no new generation of LEV-trained people. It has been dropped from the curriculum.

Can you recommend resources for those of us that want to learn more on LEV systems?

There's some very good resources.

- *There's some basic information on the WorkSafe New Zealand's website.*
- *The ACGIH industrial ventilation manual is a useful reference document.*
- *We are currently collating a resource pack using good stuff from the UK, America and Ireland etc.*

Why do engineers design LEV systems when you can buy them off the shelf. Really good systems that do what they say they will do?

For some reason, engineers keep reinventing the wheel and designing their own. So, don't do your own design if there's already one you can just buy.

Some vent systems such as spray booths require certification and testing and maintenance. Should this regime be applied to other industrial vent systems?

Yes. I believe it should be done. I also believe that systems for the spray booths need improving. I'm aware AS4114 talks about air changes, but most of the design on those booths, particularly in the paint mixing area, shows a lack of understanding of how paint vapour behaves.

Example: When we've tested them:

- *if you lie flat on the floor so your head's less than half a meter off the floor, tests show you don't need PPE, but*
- *if you are going to mix your paints any higher than within 50 centimetres off the floor, you need full PPE, because the air is heavily contaminated. What's happening is that all the air is not changing as the vents are at the bottom, and so there is a buildup of the chemicals in the air.*

When we ask people why all the vents are at the bottom, they believe it is because paint vapor is heavier, denser than air. As when you open a paint tin, the paint spills out over and it goes downwards, so it collects at the bottom.

But that's not true of paint vapour, because if it is, why when we open a can of paint do we get the smell of paint?

Are there standards that are recognised in New Zealand that can be applied to support LEV design? What do you say is the role of regulators, for example WorkSafe in the LEV space going forward?

There is a greater interest in occupational hygiene and worker health in general. Supporting organisations, like ourselves (the New Zealand Occupational Hygiene Society) who develop systems, are probably placed better to develop the guidelines for improving design. These could be used as a good industry guide.

WorkSafe, through regulations, need to ensure that systems like LEV are fit for purpose, effective and tested on a regular basis to prove this. WorkSafe also investigate and enforce when there is an incident or accident. For example prosecuting for a chemical exposure fatality.

But we need to build the systems which can be a benchmark.

Where should one look to find a competent or qualified commissioning agent for industrial LEV?

That's a challenge, but if we get better cooperation between the societies, build a system with courses and training for people, get trainer providers accredited (such as NZQA-accedited) then we will be building competency. Getting hygienists and engineers working alongside each other, doing these type of courses, will improve proficiency. Bringing others on board like gas plumbers, electricians and on on, will mean we are all working together. This will give confidence to the end users that these people are competent.

We have got some really good people out there. Some really good engineering companies could have a commissioning section, and complete independent checking on LEVs systems.

What checks can I do on my current LEV system to check its effectiveness? We have portable LEV systems in place for brazing of copper and stainless steel.

Basically make sure it's working. Have you serviced it recently? Do you have somebody to come in and test it for you?

There are people that can do that. You can find them on the Health and Safety Association New Zealand (HASANZ) national register, or via a group like the New Zealand Occupational Hygiene Society who are trained in LEV systems.

We are looking to create a list of engineers who are trained for LEV.

How would you go about installing ventilation for an open tank without enclosing the tank?

With the open tank, it depends what the substance is. For example, with solvents, normally there'd be a cooling coil around it. Or, you could have a push/pull system. It depends on the size of the tank.

For the ventilation, there's a lot of different variations that could be done around an open tank. But you've got to understand the contaminant. So we need to know exactly what it is, how it's being released, and what's happening in the area around it. Then that would actually govern the design of the system for the tank.

How about indoor shooting ranges LEV systems?

There's a lot of good stuff in the marketplace on what works for indoor shooting ranges. It depends on:

- *the calibre*
- *how many rounds are being put through the chambers*
- *the setup of the range, particularly at the back end where the targets are*
- *the design of the building and its layout.*

It's a bit more complex because it comes down to the building. But normally you look at air flow, so it blows from behind the individuals, and is extracted at the back through a filtered system. That way, the lead in the air is being blown away from behind the person, towards the end of the range.

There is information on the web. A lot of countries have done work, particularly in the military, around indoor ranges.

Are there hybrid systems for fume, dust and steam, for example, to apply in the steel industry?

Hybrid systems can be done. Fumes and dust are both particulate.

It does depends on the actual dust that we're talking about. With fumes, different ones will have different densities and behave differently. And steam is just moisture.

5: REFERENCES

American Congress for the Governance of Industrial Hygiene or ACGIH (**https://www.acgih.org/**)

Health and Safety Association New Zealand (**https://www.hasanz.org.nz/)**

Institute of Local Exhaust Ventilation Engineers (ILEVE) **www.cibse.org**

New Zealand Occupational Hygiene Society or NZOHS (**https://nzohs.org.nz/**)

New Zealand Society for Safety Engineering **(https://nzsse.org.nz/)**

WorkSafe New Zealand (**https://www.worksafe.govt.nz/)**