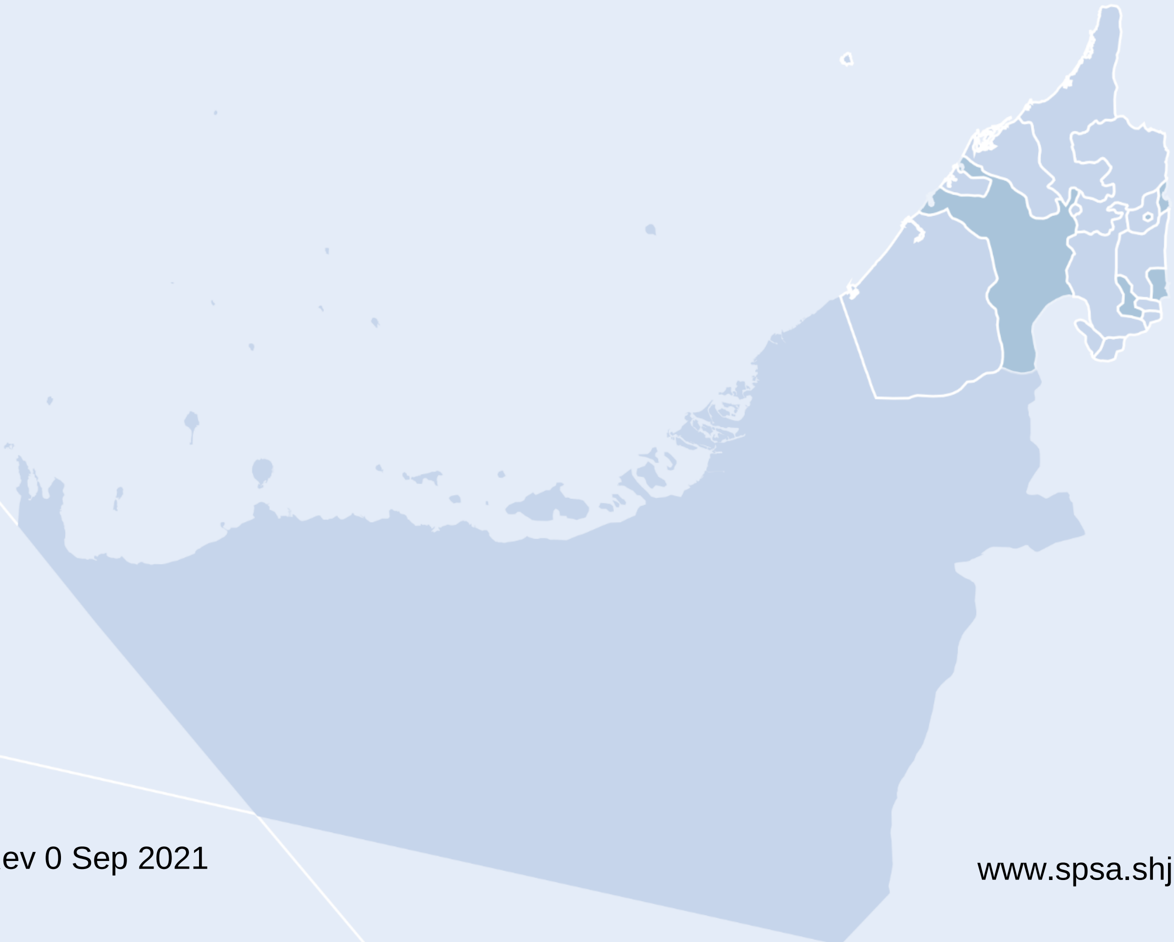
نظام الشارقة للسلامة والصحة المهنية
Occupational Safety & Health Sharjah

حكومة الشارقة
هيئة الوقاية والسلامة
Government of Sharjah
Prevention And Safety Authority

Guideline

Local Exhaust Ventilation

OSHJ-GL-12



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1 Introduction

A typical local exhaust ventilation system will extract air using a hood, partial enclosure or other opening and transport the contaminated air through ducting away from the workplace, cleaning it and then discharging it either outside or back into the workplace.

Local exhaust ventilation (LEV) is a method of reducing an employee's exposure to potentially harmful substances generated by the work activities. The LEV deals with the contaminant at or close to the point of origin/release, reducing the potential for exposure to the substance.

2 Purpose and Scope

This Guideline document has been developed to provide information to entities to assist them in complying with the requirements of the Occupational Safety and Health System in Sharjah.

To achieve compliance in the Emirate of Sharjah, all entities are required to demonstrate a standard of compliance which is equal to or higher than the minimum acceptable requirements outlined in this Guideline document.

3 Definitions and Abbreviations

Entities:	Government Entities: Government departments, authorities or establishments and the like in the Emirate. Private Entities: Establishments, companies, enterprises and economic activities operating in the Emirate in general.
Risk:	Is the combination of likelihood of the hazard causing the loss and the severity of that loss (consequences).
Risk Assessment:	The systematic identification of workplace hazards and evaluation of the risks associated. This process takes existing control measures into account and identifies and recommends further control measures where required.
Hazard:	Anything that has the potential to cause harm or loss (injury, disease, ill-health, property damage etc).
Competence:	The combination of training, skills, experience and knowledge that a person has and their ability to apply all of them to perform their work.
Local Exhaust Ventilation (LEV):	A system for removing airborne contaminants such as dust, mist, fume, vapour or gas from a space.
Airborne Contaminants:	Airborne contaminant means a contaminant in the form of a fume, mist, gas, vapour or dust and includes microorganisms. An airborne contaminant of this type is a potentially harmful substance that is either not naturally in the air or is present in a high concentration and to which employees may be exposed in their working environment.
Hood:	Where airborne contaminants enter the Local Exhaust Ventilation.
Ductwork/ Ducts/ Ducting:	Ductwork, ducts, or ducting, are conduits, or tubes, that typically form part of a ventilation system, used to convey air throughout a building.

Air Cleaner or Arrestor:	A device which removes contaminants from the air.
Air Mover:	The engine that powers the extraction system, usually a fan.
Air Discharge:	The place where the extracted air is released to a safe place.
PPE:	Personal protective equipment.
Manufacturer's Manual:	The instructions, procedures and recommendations which are provided by the manufacturer to ensure the safe operation, maintenance and repair of the equipment.

4 Roles and Responsibilities

4.1 Entity Responsibilities

- Undertake a risk assessment to determine the risks and introduce adequate controls to reduce employees exposure to airborne contaminants;
- Identify locations where an LEV system is required to control the risk of airborne contaminants;
- Identify airborne contaminants by conducting air quality assessment and continuously monitor where applicable;
- Ensure an LEV system is designed and installed to adequately control exposure to an acceptable level;
- Provide safety information, instruction, supervision and training to employees;
- Maintain, test and inspect the LEV on a regular basis as per the manufacturer's manual.

4.2 Employee Responsibilities

- Not endanger themselves or others;
- Follow precautionary control measures to ensure work activities with LEV are performed safely and without risks to health;
- Cooperate with the entity and receive safety information, instruction, supervision and training;
- Report any activity or defect relating to the use of LEV which they know are likely to present risks to the safety and health of themselves or that of any other person.

5 Guidelines

5.1 Planning

The entity should consider the following factors when identifying whether an LEV is needed and in what form, including but not limited to:

- The key properties of airborne contaminants;
- How gases, vapours, dusts and mists are generated;

- How contaminant clouds move with the surrounding air;
- The processes in the workplace which may be sources of airborne contaminants;
- The needs of the operators working near those sources;
- How much control will be required.

5.2 Risk Assessment

The entity should conduct a risk assessment of the processes and sources that generate gas, vapour, dust, fume and mist in workplace air, including but not limited to:

- Rotating tools and parts;
- Hot and cold processes;
- Free falling, solids, liquids and powders;
- Spraying and blasting;
- Abrasion;
- Housekeeping.

Further information on risk assessment can be found in OSHJ-CoP-01: Risk Management and Control.

5.3 Airborne Contaminants

Air contaminants are particles, gases or vapours and combinations of these, particles include dusts, fumes, mists and fibres. Table 1 shows some of the basic characteristics of airborne contaminants.

Name	Description	Visibility	Examples
Dust	Solid particles, can be provided in powder form or generated through process Inhalable particle size 0.01 µm to 100 µm Respirable particle size below 10 µm	In normal light: • Inhalable dust clouds are partially visible • Respirable dust clouds are practically invisible at concentrations up to tens of mg/m3	Grain dust Wood dust Silica flour
Fume	Vaporised solid that has condensed Particle size 0.001 µm to 1 µm	Fume clouds tend to be dense. They are partially visible. Fume and smoke are generally more visible than equivalent concentrations of dust	Rubber fume Solder fume Welding fume
Mist	Liquid particles – process generated, e.g. by spraying Particle size ranges	As for dust	Electroplating Paint sprays Steam

	0.01 µm to 100 µm but the size distribution may change as volatile liquids evaporate		
Fibres	Solid particles – the length is several times the diameter Particle size – as for dust	As for dust	Asbestos Glass fibre
Vapours	The gaseous phase of a substance which is normally a liquid or solid at room temperature. Behaves as a gas	Usually invisible, at very high concentrations, a vapour-laden cloud may just be visible	Styrene Petrol Acetone Mercury Iodine
Gas	A gas at room temperature	Usually invisible, some coloured at high concentrations	Chlorine Carbon monoxide

Table 1: Characteristics of Airborne Contaminants

5.4 Movement of Particles in Air

'Heavy vapours'

A saturated vapour-air mixture cloud exists above a liquid surface. Initially it will be heavier than air and will flow downwards, away from the source, as evaporation occurs. If circumstances inhibit dilution, for instance the vapour-air mixture flows into a confined space, the vapour-air mixture will settle. It could create a toxic risk and, depending on the material, a flammable risk.

In most workplaces, turbulent air movement and draughts quickly dilute a saturated vapour-air mixture cloud which, fairly rapidly, mixes and moves with the workroom air.

The vapour-air cloud flows away from the top of the mixer and mixes with the workroom air, directly causing exposure. It also flows down the mixing vessel sides, all the time mixing with the room air. Some vapour-air mixture flows onto the floor. Designing and applying floor-level LEV will not effectively control employee exposure to the vapour-air cloud. Slot extraction at the lip of the vessel is one LEV control solution which could be effective.

Low-level LEV is often, but mistakenly, applied to control exposure to 'heavy vapours'. In practice, such controls will fail to control exposure. LEV controls should be applied to contain and capture vapour-air mixtures before they can mix with the workroom air.

'Heavy dust'

Particle aerodynamic size, not simply the density of the parent material, determines how particles move in the air. Dense materials do not produce 'heavy dust' and therefore LEV hoods placed at floor level do not work due to:

- Large particles fall out of the air easily;
- Small particles, even of high-density material can float away in a contaminant cloud.

LEV should remove both suspended inhalable particles and intercept the larger particles.

Other properties of airborne particles

Process-generated and process-related substances dust, fume and mist may have abrasive or sticky properties or be liable to condense. Some may be flammable, these properties will determine the design of LEV.

Abrasive or corrosive particles

Some particles are more abrasive than others and some are more chemically active and may attack the LEV system components. This may severely restrict the selection of materials used to construct the LEV system.

Sticky dust, mist and condensate

If a particulate is sticky or likely to condense, the LEV design should take account of this. A heavy condensate can progressively block ducts. In these circumstances, the design of the system needs to incorporate drain points for condensates and access points for ease of inspection and cleaning.

Flammable or combustible substances

Many organic and metal dusts are combustible and LEV systems should reduce the risks of ignition and cope with a possible dust explosion, where such hazards exist the design should take them into account.

5.5 LEV Components

The entity should design and install an LEV system to adequately control exposure of the specific airborne contaminants to an acceptable level. The LEV system should also be designed and installed in a way that would allow for adequate maintenance and inspection of all its components. The components of an LEV system include:

- A hood or inlet where the contaminant enters the LEV;
- Ductwork conducting air and the contaminant from the hood to the discharge point;
- An air cleaner/arrestor removing the contaminant from the air in the duct;
- A fan or air moving device and ducting to the outside atmosphere, in some systems the cleaned air is recirculated to the workroom;
- A discharge or exhaust where the extracted air is released to a safe place.

5.5.1 Inlets

The inlet is the most important part of LEV system and requires careful design to be fully effective. The important factor to be considered by the entity is that the effectiveness reduces considerably with distance from the source of the contaminant. The capture velocity at one duct diameter away from the face of the hood is about one tenth of the face velocity. Therefore, if the hood is wrongly positioned, this will result in virtually no capture of the contaminant.

The entity should ensure the suction inlet is positioned as close to the point of emission as possible to capture the contaminant effectively and as soon as it is generated before it can enter the workplace atmosphere.

The entity should design the extraction inlet to ensure an effective capture velocity, the speed of airflow in metres per second at the inlet of the LEV, different situations will require different velocities and therefore different solutions.

The higher the required capture velocity, the greater the necessary air moving capabilities of the LEV system.

5.5.2 Hoods

LEV systems work effectively when the airborne contaminant cloud is contained, received or captured by the hood. The effectiveness of LEV can be judged by:

- How much the hood constrains the contaminant cloud;
- How well the LEV-induced airflow carries the contaminant cloud into the system;
- How little of the contaminant cloud enters the process operator’s breathing zone.

Hoods vary in size and design depending on the application. Hoods are of three basic types, enclosing, receiving and capturing, sometimes referred to as receptor and captor.

- An enclosing hood are more effective than capturing or receiving hoods. A full enclosure is where the process is completely enclosed. A room enclosure or enclosing room is where the operator and the process are enclosed. A partial enclosure contains the process with openings for material and/or operator access.
- A receiving Hood is one where the contaminate is forced towards it in some way;
- A capturing Hood is required where the process, source and contaminant cloud are generated outside the hood. A capturing hood has to generate sufficient airflow at and around the source to capture and draw in the contaminant-laden air.

Examples of hoods include:

- Flexible hoses and captor hoods which can be positioned close to the source of the release;
- Extraction equipment where the hood is positioned to collect the dust within the direction of its movement;
- Lip extraction;
- Soldering extractors, including ‘tool-tip’ extraction systems.

5.5.3 Ducting

Once the contaminant has been captured it needs to be transported via ducting to the air cleaner. The entity should design ducting to ensure the transfer efficiency and avoid solid particles dropping out of suspension in the air. The following design factors should be taken into account, by the entity, including but not limited to:

- Ducting should be of a suitable material which will not become damaged by the contaminants;
- The system should be as simple as possible with a minimum number of bends and be as short as possible;

- Branches should join at the sides and be at an acute angle with respect to the air flow in the main duct;
- There should be an adequate number of inspection hatches and inspection points to allow proper cleaning and inspection. These should be placed at the top of the ducting;
- Flexible ducting should be kept to a minimum as it tends to wear more quickly and offers higher resistance to air flow;
- Noise through ducting can be a serious issue and care should be taken at the design stage to minimise this;
- Where there are several inlets to an LEV system, balancing will be required to ensure that there is a suitable air flow at each inlet. Without balancing, one inlet may have an excessive air flow at the expense of others which are then not adequate. This is often the case where an inlet is closer to the main branch and motor than outlying inlets where longer pipe runs introduce losses and reduce the velocity of the air inlet.

The velocity of the air passing through the ductwork must be sufficient to achieve the required transport velocity and to prevent settling of material. Recommended duct velocities depend on the contaminants being transported.

5.5.4 Air Cleaner/Arrestor

Air cleaners or arrestors filter/cleans the extracted air and are positioned within the LEV to protect the air mover.

5.5.4.1 Air Cleaners - Particles

Particle collectors are the most common group of air cleaning devices associated with LEV systems. The group consists of fabric filters, cyclones, electrostatic precipitators and scrubbers.

Fabric filters

These are suitable for dry dusts. Dusty air passes one way through a fabric layer that is flexible and porous. The fabric may be constructed and treated to carry electrostatic charge which help attract and retain dust. Particles are removed by:

- Impaction, where particles larger than the weave meet the surface of the filter;
- Impingement, where medium-size particles meet the fibres within the filter weave;
- Diffusion, where small particles are attracted towards the fibres.

The main ways to clean filters are:

- Mechanical shaking;
- Reverse airflow;
- Pulse-jet.

The cost of the filter material is a major expense. It is also an operating cost as filters need periodic replacement before they fail. The designer should specify the replacement interval, which is normally between one and four years.

Cyclones

Cyclones consist of a circular chamber, tapered at the bottom. Dusty air feeds at a tangent into the top of the cyclone and swirls around the chamber. This throws particles out to the wall by centrifugal action. The particles' velocities decrease and they fall to a collection hopper at the base of the cyclone. Cleaned air passes through a central outlet in the top of the cyclone. The larger the particle, the easier it is for a cyclone to remove it from the air.

Electrostatic Precipitators

Electrostatic precipitators are suitable for fine dusts, but unsuitable for heavy contamination. They give dust and fume particles an electrical charge and attract them onto collecting surfaces with an opposite charge. Cleaned air flows out of the device. There are two classes of design:

- Pipe or tube, where a high-voltage wire lies along the axis of a grounded tube;
- Parallel plate, where a series of high-voltage wires lie between a series of grounded metal plates.

Scrubbers

Scrubbing means wetting particles and washing them out of a contaminant cloud. The design requirements are to:

- Wet the particles;
- Cause them to settle out in water;
- Provide a suitable disposal system;
- Prevent dust building up at the inlet;
- Prevent water carry-over in cleaned air.

There are numerous designs of scrubbers, the most common being venturi scrubbers, self-induced spray collectors and wet cyclone scrubbers.

Venturi Scrubbers

Dusty air passes through a narrow venturi throat which has water injection. The conditions in the throat are highly turbulent. The water separates into small droplets that collide with the dust particles. A cyclone separates the droplets to produce a sludge containing the dust. Cleaned air passes through a central outlet in the top of the cyclone.

Self-induced Spray Collectors

Dusty air is drawn under a baffle in a water trough. The dust impacts on droplets and also on water in the trough. A 'spray eliminator' or 'drift eliminator' separates water droplets from the cleaned air. The contaminant settles out as sludge at the bottom of the collector. To avoid bacterial infection and consequent bad odours, spray collectors need regular cleaning. There may be a legionella risk.

Wet Cyclone Scrubbers

Dusty air enters a cyclone collector that has a centrally located water spray directed outwards. The cyclone separates the droplets, producing sludge from the dust. Cleaned air passes through a central outlet in the top of the cyclone.

5.5.4.2 Air Cleaners - Gases and Vapours

The technologies used include destruction methods, packed tower scrubbers and recovery methods.

Destruction methods, including thermal oxidation (incineration) or flare

Gases or vapour are destroyed before discharge by burning or thermal oxidation. Thermal oxidiser units can be fitted with heat recovery that partially offsets the fuel costs.

Packed tower scrubbers for substances that mix with water

A tower is filled with packing to provide a large surface area. Water or a reagent solution flows in at the top of the tower and contaminated air enters at the bottom. Trickling fluid absorbs the contaminant and cleaned air emerges at the top. To avoid bacterial infection and consequent bad odours, tower scrubbers need regular cleaning. There may be a legionella risk.

Recovery Methods, including absorption

Contaminated air passes through filters that remove gases and vapours. Activated carbon filters are the most common. Air is usually filtered of particles before being passed through a carbon filter. Regeneration of carbon filters and solvent recovery is feasible, but recovery becomes viable only when the solvent usage is high. Impregnated carbons are able to absorb specific chemicals. Typical disadvantages include:

- A frequent requirement to change the filter;
- The filter fails suddenly when saturated;
- Carbon can develop ‘hot spots’ that need detectors and fire-extinguishing systems.

5.5.5 Air Movers

Air movers are a fan which is normally placed at the outlet on the clean side of the filter and pull air through the system.

The two main types of fan are axial and centrifugal.

- Axial fans are ‘propeller’ type designs generally placed in roof units. They can overcome only low resistances to flow.
- Centrifugal fans are able to deliver greater air flows against high resistance and are therefore the typical choice for LEV systems.

Other types of fans used are:

- Propeller fans are often used for general or dilution ventilation, they do not produce much pressure and operate best against low resistance;
- Turbo exhausters can generate the high suction pressures needed to power low volume high velocity systems, they are not conventional fans. They use high-precision blades that are susceptible to damage by dust and require a filter to protect the exhauster;
- Compressed-air-driven air movers are appropriate where electrically powered fans are unsuitable. They are small, inexpensive and easily portable. Their main disadvantages are the high running cost and high levels of noise for relatively small amounts of air moved.

The entity should consider the following factors in the selection of the fan, including but not limited to:

- The airflow required;
- The total flow resistance of the system;
- The type of contaminant;
- If a flammable or combustible contaminant is present;
- Space limitations;
- The method of mounting and type of drive;
- The operating temperature;
- The noise level;
- The intrinsic safety;
- The fan pressure characteristics;
- Failure warning devices.

5.5.6 Discharge

The discharge takes the cleaned exhaust air from the fan and expels it into the atmosphere. The entity should consider the following factors regarding the discharge, including but not limited to:

- Positioning the discharge point to avoid air re-entering the building;
- Positioning to ensure that the discharge is not discharging air which then enters air inlets;
- Ensuring that the discharge is discharging at an appropriate height to ensure dispersal of the emissions;
- Ensuring that the termination of the discharge is appropriate to ensure efficient air-flow, prevent ingress of rainwater and assist fume dispersal.

Should air be re-circulated directly back into the workplace, the entity must ensure air is sufficiently cleaned so as not to present a risk to employees in the workplace.

5.6 Maintenance

Regular inspection, testing and maintenance of LEV systems is critical. The frequency and detail of the inspection, testing and maintenance should be planned by the entity at a minimum in accordance with the manufacturer's manual.

Both planned preventative maintenance and regular pre-start inspections should include the following elements, including but not limited to:

- Moving parts;
- Non-moving parts that may wear or be damaged;

- Routine replacement of filters and/or collection bags;
- Cleanliness of ductwork and other components;
- Flow rates/capture velocities.

5.6.1 Visual Inspections

The entity should determine by visual inspections of an LEV system whether:

- LEV hoods are in good condition;
- Air is being effectively drawn into the extract booth;
- Any safety or warning devices are operational;
- Ducting is intact without holes or splits;
- The area is reasonably clean and contaminant free.

The check is generally undertaken by the operator and should be recorded.

5.6.2 Thorough Examination

The entity should conduct thorough examination and testing of the LEV, including but not limited to:

- A thorough visual examination to verify that the LEV is in efficient working order, in good repair and in a clean condition;
- Measuring and examining the technical performance to check conformity with commissioning data.

5.6.2.1 Visual and Structural Examination

The entity should conduct thorough external examination of all parts of the system for damage, wear and tear, including but not limited to:

- Internal duct and hatch seal examinations;
- Checks that any filter cleaning devices work correctly;
- Inspection of the filter fabric. Where filters have built-in pressure gauges, checks on their function and that the operating pressure is correct;
- Checks of the water flow and sump condition in a wet scrubber;
- Checks that monitors and alerts/alarms are functioning;
- Inspection of the air mover drive mechanisms;
- Checks for indications of effectiveness, is there significant deposits of settled dust in and around the LEV hood or is any part of the system vibrating or noisy.

5.6.2.2 Measuring Technical Performance

The entity should measure the technical performance of the LEV system, including but not limited to:

- Measuring the air velocities at suitable test points indicated in the system documentation and includes hood faces, branch ducts and the main duct;
- Measuring static pressure at suitable test points indicated in the system documentation and includes all hoods, ducting, across the air cleaner and fan;
- Checking the fan speed, motor speed and electrical power consumption;
- Checking the replacement or make-up air supply;
- Testing alarms by simulating a failure, and the alarm's ability to detect the failure;
- Measuring air temperatures;
- Testing the air cleaner performance.

The examiner should calculate volume flow rates, including:

- Comparing the results of testing with the LEV design specification as identified in the system manufacturer's manual;
- Diagnosing the causes of any discrepancies, the examiner may make simple alterations that restore the required performance.

If a defect is fundamental or obscure, the examination should stop until the system has been repaired and its original performance restored.

5.6.2.3 Control Effectiveness

The entity should control effectiveness, including but not limited to:

- Careful observation of processes and sources;
- Assessment of how effective the LEV is at controlling operators' exposure;
- Challenge tests using smoke with the process running, to check for smoke leakage, eddying and breathing zone encroachment;
- Dust lamp tests with the process running to check for escape of dust or mist;
- Observation of the way operators work, whether they are using the methods specified and whether these methods are suitable.

5.7 Records

The entity shall record and retain a logbook or suitable records of maintenance, inspections, examinations and tests carried out on LEV systems.

6 Training

The entity should ensure that employees are competent and receive training in languages and in a format that employees understand, including but not limited to:

- The hazards of substances used during operations;
- How exposure may occur;
- How to use an LEV as per the manufacturer's manual;

- The design specification, capabilities and limitations of using LEV;
- The maintenance requirements of the LEV to ensure it operates as intended;
- The ability to recognise when an LEV is damaged or not working as intended.

Periodic refresher training should be conducted to ensure employees competency is maintained, including but not limited to:

- Where training certification has expired;
- Where identified as part of a training needs analysis;
- Where risk assessment findings identify training as a measure to control risks;
- Where there is a change in legal requirements;
- Where incident investigation findings recommend refresher training.

The entity must record and maintain accurate training records of OSH training provided to employees.

Further information on training can be found in OSHJ-GL-26: Training and Competence.

7 References

OSHJ-CoP-01: Risk Management and Control

OSHJ-GL-26: Training and Competence

8 Document Amendment Record

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