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International Association for Soaps, Detergents and Maintenance Products

# Enzyme Safety Management

## A series of web based training and Information Sessions developed and presented by the AISE Enzyme Safety Task Force

A.I.S.E. aisbl • Boulevard du Souverain 165 • 1160 Brussels • Belgium

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Welcome to the third webinar in the AISE Series on Enzyme Safety Management. This follows on from our initial introduction to Enzyme Safety, and previous webinar presented by Anthony Panepinto which discussed the steps you need to take to take in order to plan an effective risk management strategy for safe handling and manufacturing of products containing enzymes. In this session we will take a more practical look at some of the engineering control options that have been successfully employed by the detergent industry to control exposure to enzymes at source.

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## Objectives of This Webinar

- Define what we mean by “Control” of exposure to enzymes
- Review Engineering options for process containment
- Discuss the use of Respiratory Protection
- Look at a case study for  Product Rework

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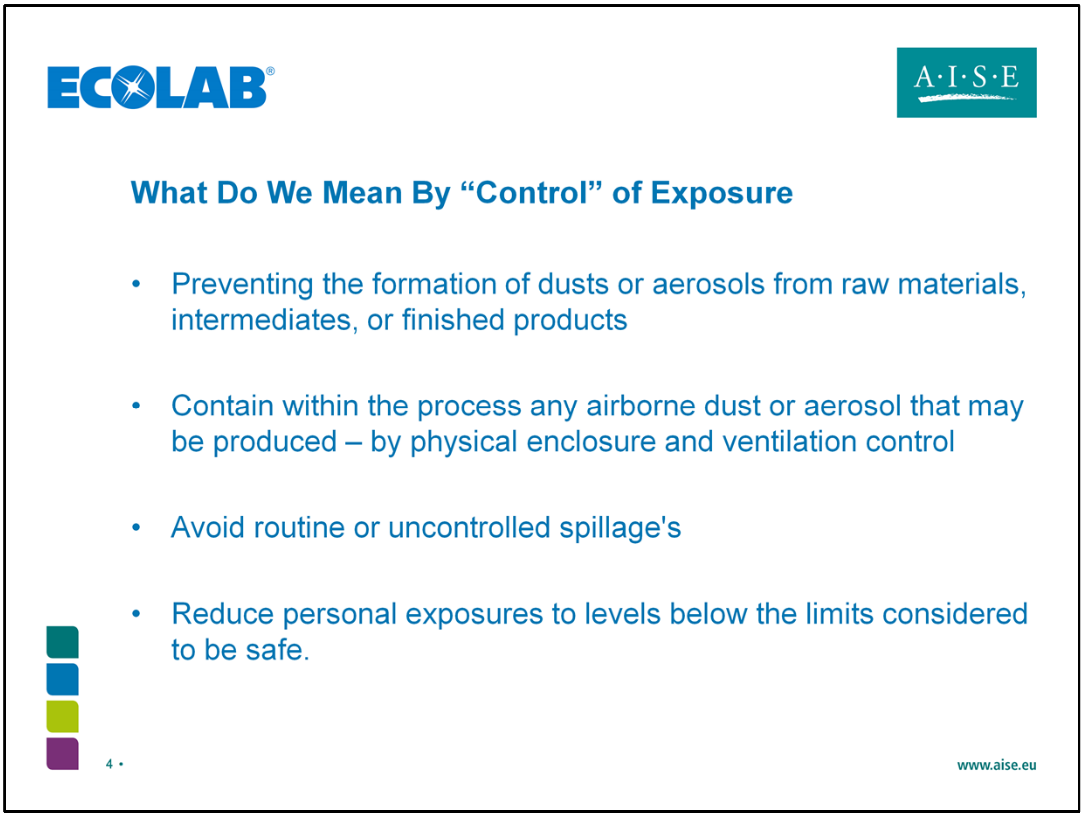
Our objectives today are to consider what we actually mean by “control” of exposure to enzymes and we will look at some of the engineering options used to contain and control exposure to enzymes within the detergents industry. We will also look at the role of respiratory protection in our risk management strategy, and finally  take a look at a case study on product reclaim / rework – a topic that is quite frequently overlooked by many companies.




Given that we have to handle enzymes - which we will discuss in a few moments - we can consider control of exposure to them, and to other materials that are hazardous by inhalation of dust or aerosol as a combination of several strategies; firstly we should prevent or minimise the formation of airborne dust or aerosol from raw materials or finished products, then we must contain and/or remove any airborne dust or aerosol that might be produced by their handling or processing through a combination of engineering and ventilation control. From a process perspective we must avoid spillages of raw materials and products – and in doing all of the above prevent personal exposure or reduce it below the limits that are considered safe.

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## How do we decide on which controls to use?

By using a combination of techniques based on a strategy known as the "Control Hierarchy

That is a series of steps which must be considered in turn to ensure that the most effective and practical control measure is selected.

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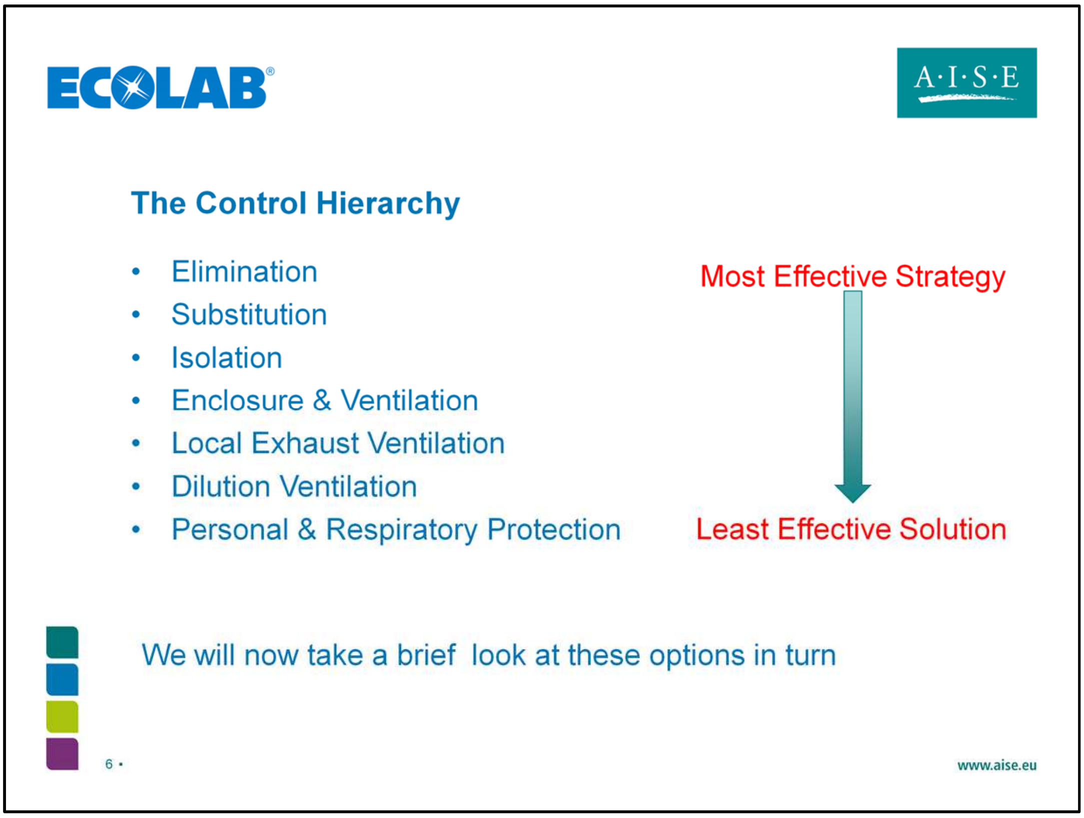
We employ a strategy called the control hierarchy to decide on the control measures to employ; you may have heard of this already, it is relevant to virtually any safety strategy and there are various formats around with slightly different numbers of step's but the fundamental approach is to consider each level of the hierarchy in turn in order to Eliminate the Hazard, Prevent it's Release, or Protect People or Property from it should escape confinement.




For Industrial Hygiene there are 7 steps, beginning with the most effective control measure “Elimination”, working through the engineering control options, and finally as a last resort considering the use of personal and respiratory protection. The key point is that as we descend the control hierarchy the soltions become less effective.

## Elimination and/or Substitution

Some regulations mandate that for certain classes of substance Elimination or Substitution must be the primary control considered; i.e.

- Eliminate the substance from the process / formulation
- Substitute the substance for something less hazardous

Enzymes are an essential ingredient of detergents & cleaning products.

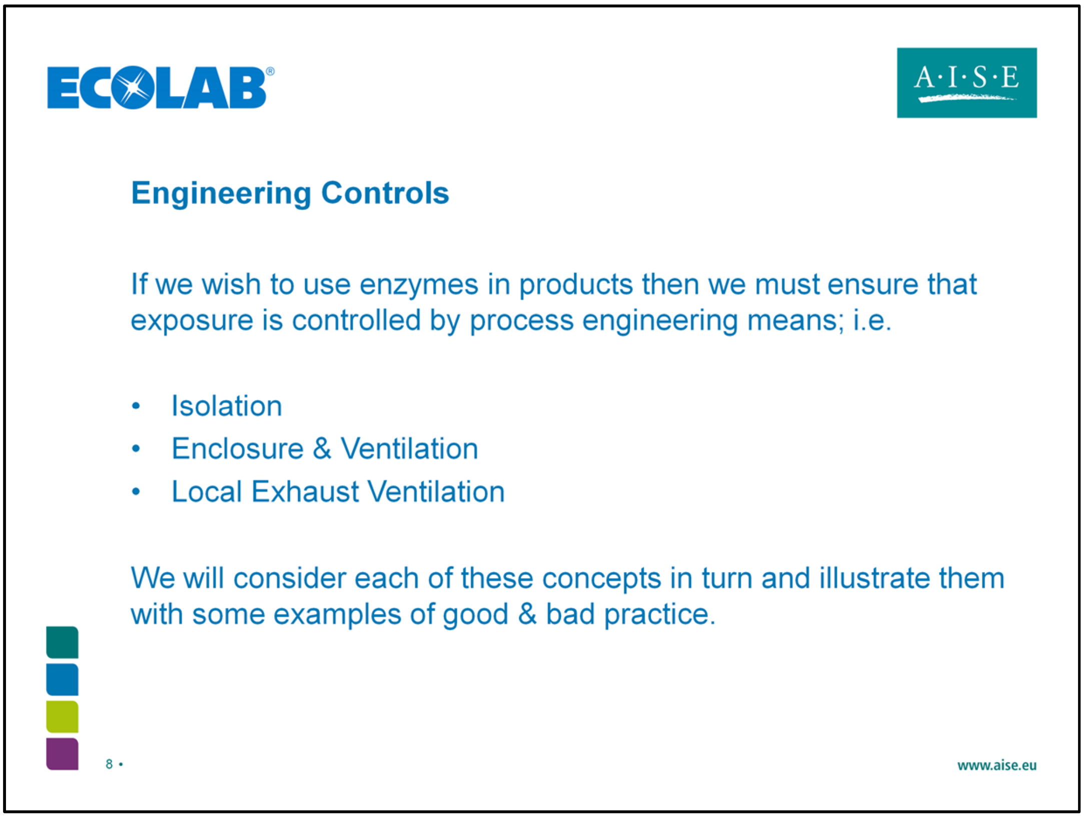
They provide great benefits to the consumer and to the environment

There is no substitute, nor is there an alternative.





Unfortunately we cannot Eliminate enzymes from our formulations, they provide great benefit and there is no effective substitute. As we saw in our introductory session enzymes provide superior cleaning of surfaces, at low temperatures, they are non toxic, and completely biodegradable. We can however substitute their form, particularly powders, to make them less dusty and thereby reduce the risk of exposure; however even the modern enzyme encapsulates as low dust and robust as they are can not reduce the risk of exposure sufficiently and engineering controls are still an essential part of the risk management strategy.




Engineering controls are based around isolating people from the raw material or products by using closed or sealed processes, providing partial enclosure and ventilation control for those processes or equipment that cannot be fully closed or sealed, and in some instances by using or incorporating local exhaust ventilation –we will now consider these control options in turn, in more detail, and illustrate the key features with some examples.

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## Isolation

Completely Isolate the hazardous material from the employees & the workplace…..how ?

- IBC's directly coupled to the process (Liquid Enzymes)
- Dust Free [Hygienic] Big Bag / Super sack discharge systems
- Fully closed transfer & dosing systems
- Sealed mixing vessels, etc.





Isolation; essentially this is the use of fully closed or sealed equipment; designed so that dust or aerosol from raw materials or products cannot escape into the working environment during transfer or processing; we will look at some examples commonly used to discharge enzymes into processes, to blend formulations, and transfer raw materials and products between process stages.

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## Isolation – Liquids Dry Break Coupling

Prevent spillage from open ended hoses

IBC inclined forward to ensure it empties.

- No spillage of liquid enzyme
- No generation of aerosol
- Safe discharge system

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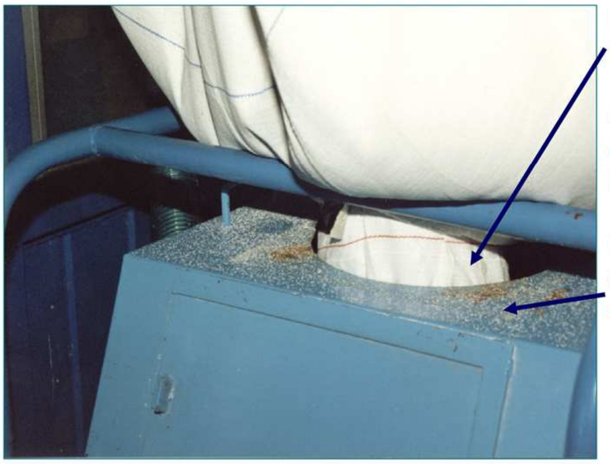
In our first example – the use of Dry break couplings for connection of liquid totes / IBC's to dosing equipment prevents spillage or aerosol release from either end of the coupling, and effects a safe transfer from the supply unit to the process.


Polythene lined big bags / super sacks can seal to a discharge station before being untied, resulting in a dust free transfer of enzyme encapsulates to the process. The liners can be removed by an automated system, or can be vacuum deflated prior to retying and removal from the outer big bag.

## Isolation - Poor Example of a “dump station”



Neck of Big bag loosely fitted into ventilated hopper

Spillage occurs when opening or removing “empty” bag from hopper

Result - enzymes on equipment, on the floor, enzyme dust in the air,

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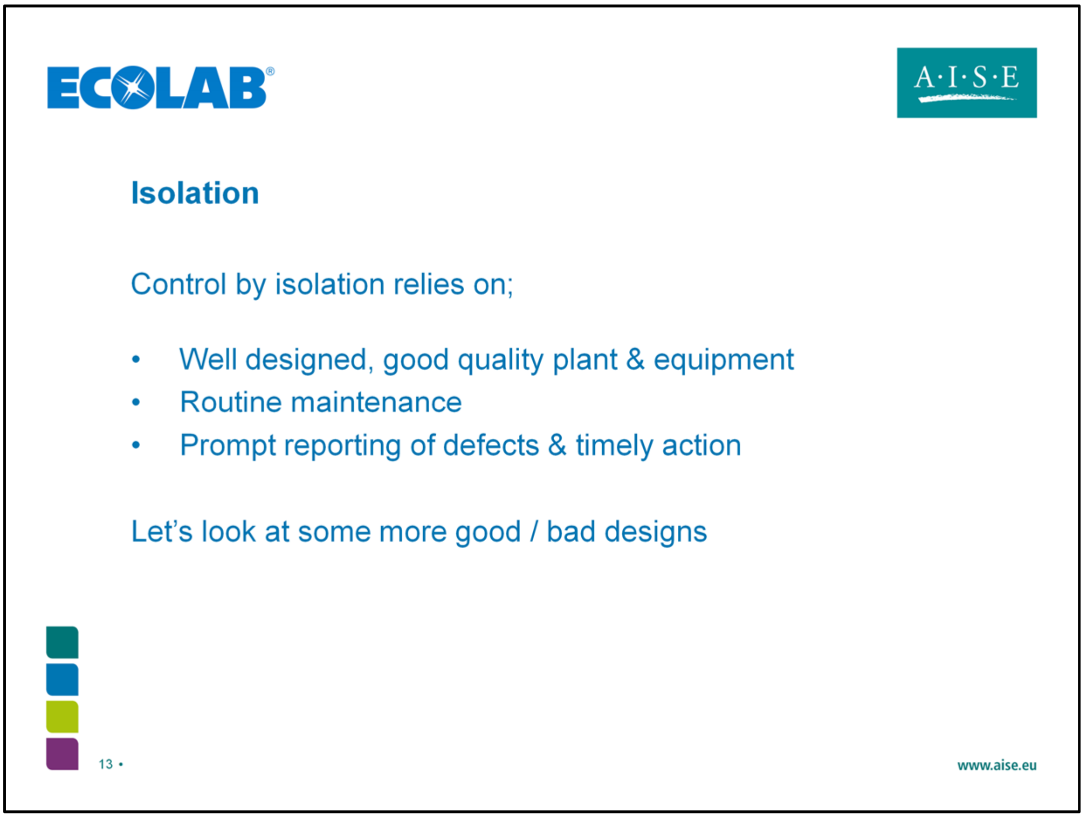
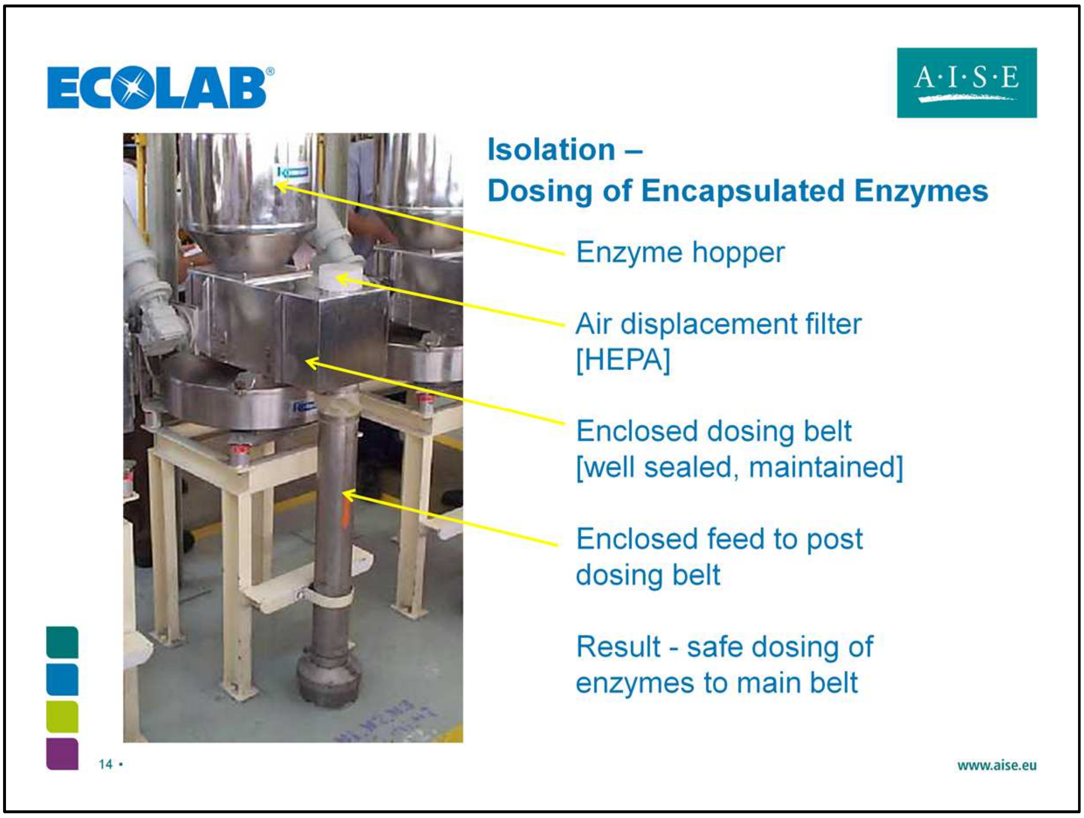
This is a more traditional type of big bag discharge station, with a loose fitting bag that is not sealed onto or into the discharge opening - resulting in the release of dust and spillage of granules – which can then be crushed under foot or by pallet trucks to release even more enzyme dust.

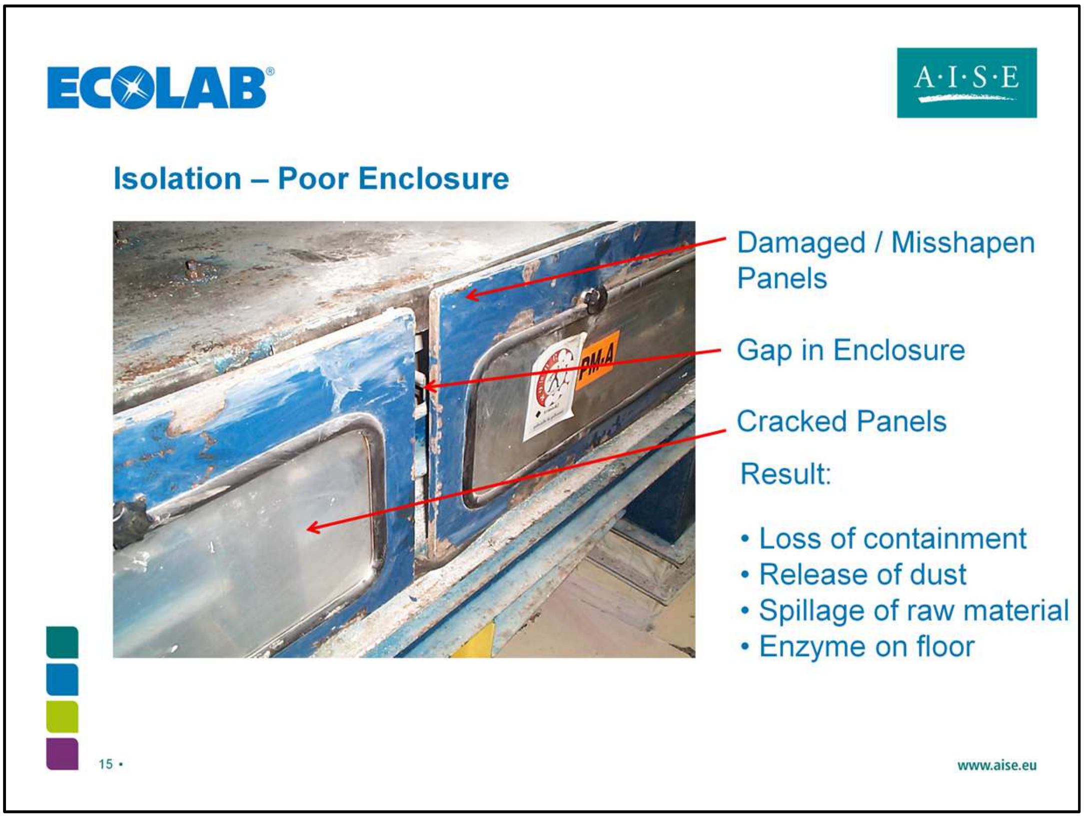



Control by isolation relies on well designed and well maintained plant and equipment; which in turn requires prompt reporting of defects;

Lets look at a few more examples;




This is an encapsulates dosing station; so the big bag we saw earlier might feed enzymes directly into the small hopper. A short belt within the closed system doses enzymes continually onto a post dosing belt or into a batch process via closed the outlet. Any air that is displaced from the unit into the workplace by the material flow passes through a HEPA filter to remove dust. [High Efficiency Particle Arrestor]. This is a good example of a closed/sealed dosing unit.




Here is a poor example of a weigh belt, the enclosure is damaged, the panels do not fit correctly, the transparent panels are cracked – leading to loss of containment / release of dust.

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## Isolation – Drum Mixing / Blending

- Powders Drum Mixer.
- Good Design
- Well maintained.
- Closed process.
- No Spillage.
- No Release of Dust.





Drum mixing – either continuous or batch mixing – is commonly used to blend detergent powders. This is a great example; closed, well maintained, clean, no spillage, no dust release – the containment is so good that you cannot tell what it is blending just by looking at it.

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## Isolation – Drum Mixing / Blending [Not so good]

Powders Drum Mixer.

Poor Design

Poorly maintained.

Resulting in;

Release of dust

Spillage.

Product on floor.

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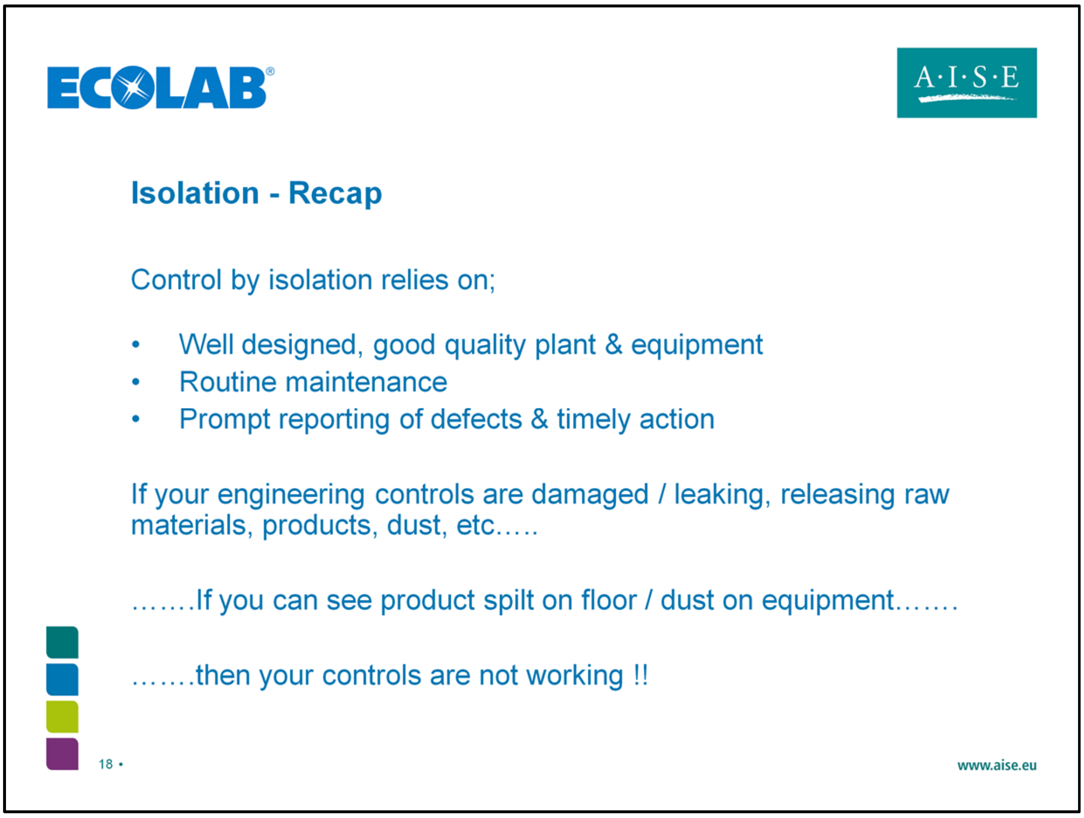
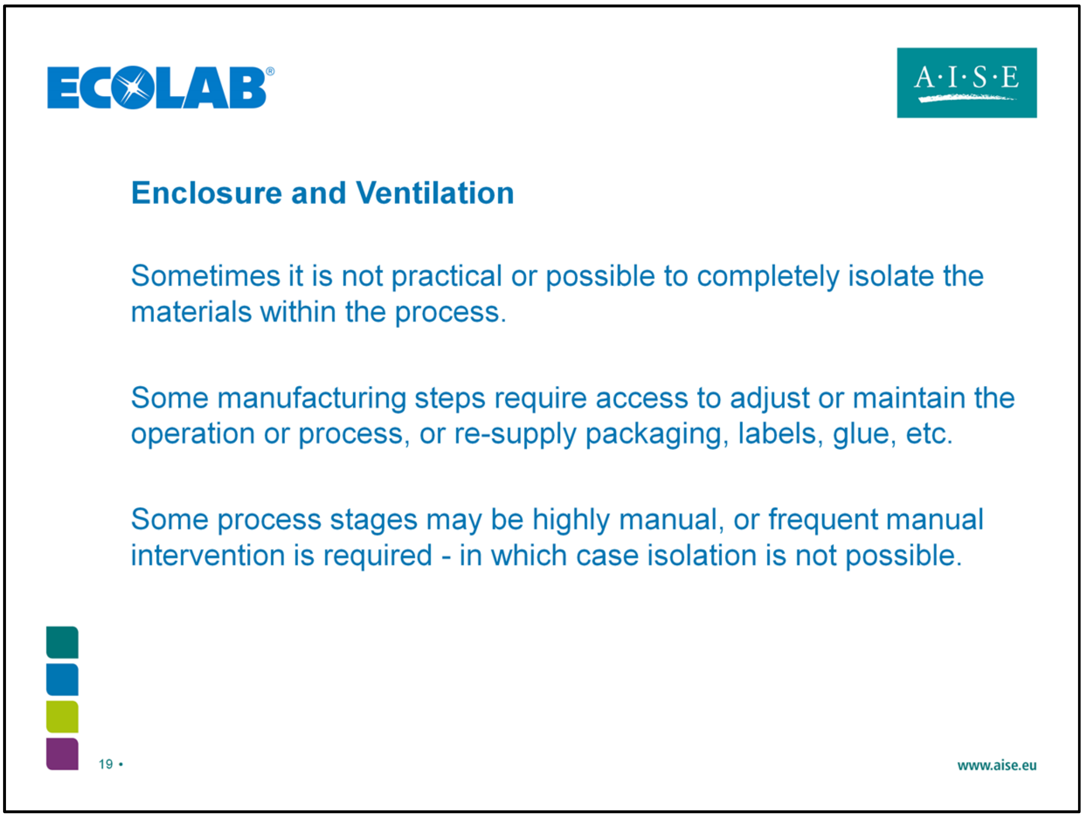
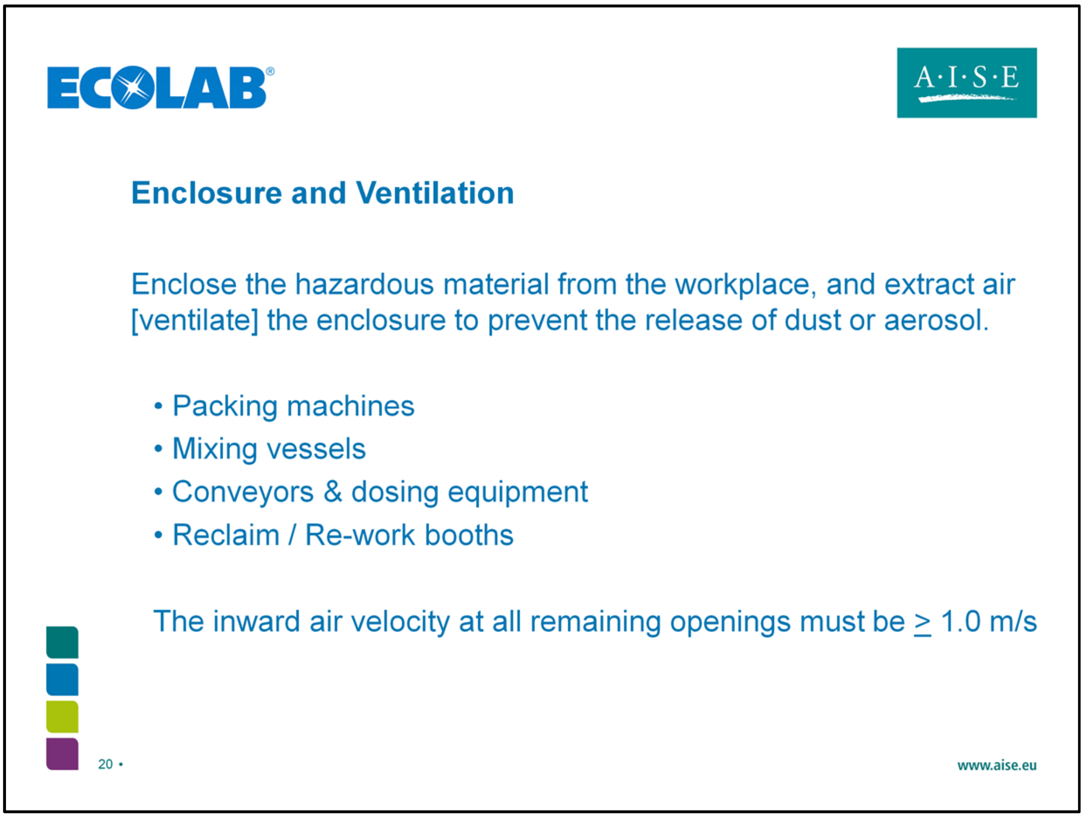
This is a bad example of the same process – it is clear that there are many faults with this equipment leading to gross contamination and significant release of dust.




To Recap; Isolation depends on well designed equipment, well maintained. If you can see spillage or dust then isolation as a control strategy is not working and you may need to fix it or supplement it with ventilation control.




Some processes cannot be fully isolated; or regular access is required for some reason, in which case we need to enclose the process as much as is practical and then provide ventilation control [extraction] to ensure that at any remaining gaps or openings in the enclosure air is always moving inwards at a high enough velocity to stop dust or aerosol coming out into the workplace !

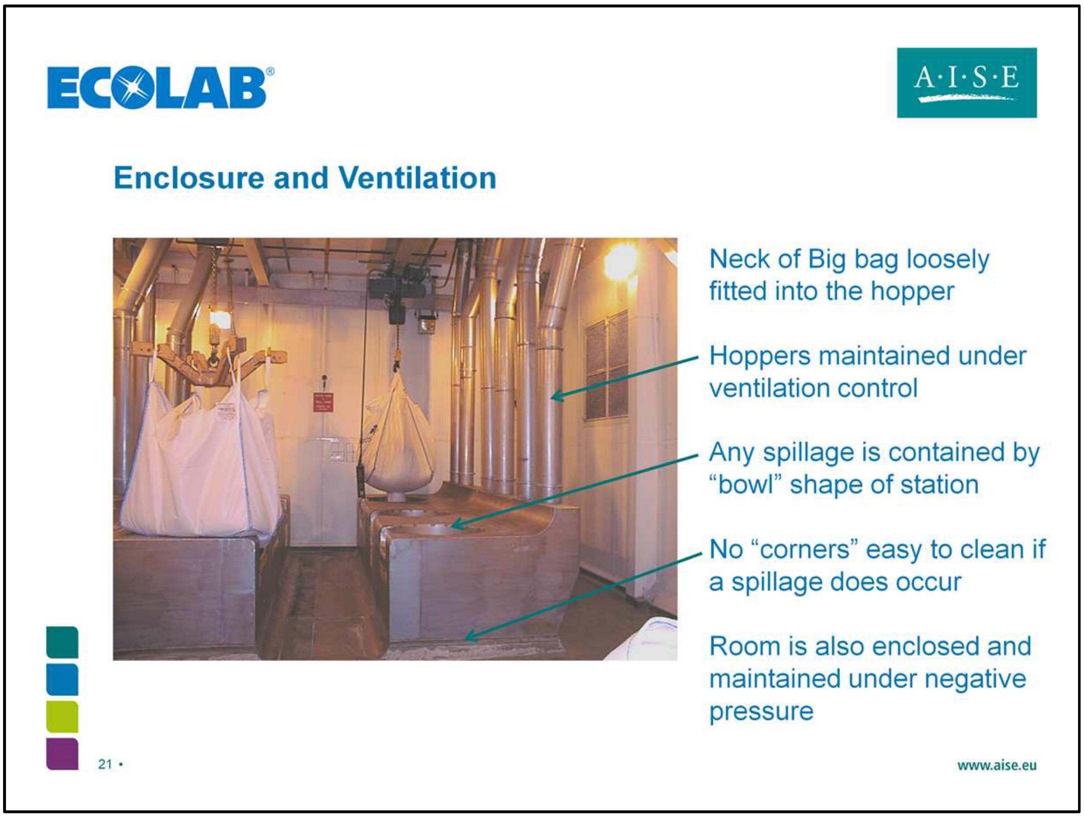



Typically this strategy is applied to packing machines, some mixing vessels, belt conveyors, and product reclaim booths. To achieve effective control the inward air velocity at any gap or opening must be >= 1.0m/s.

Similarly across the open face of a product rework booth the average air velocity must be >=1.0m/s, but it must be uniform across the face, so no single point of measurement must deviate by more that +/- 10% from the average.

This is the industry standard

We will discuss this more when we consider rework booths




This is a big bag / super sack dump station; we saw one before that was poorly designed – this is a good example; it is designed to capture any spillage from the empty big bag, the stations are well ventilated to contain dust, and the whole room is under negative pressure as a safeguard if there is any accidental release / spillage within the room. An operator working in this room, discharging bags, would be expected to wear respiratory protection as a safeguard to protect against high peak exposures in the event of an incident – we will return to the use of respiratory protection a little later.

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## Enclosure and Ventilation – Packing Machines

Openings Minimised

Header Tank and/or Hopper Included within enclosure

Ventilation maintains inward air flow > 1.0 m/s at all openings; i.e.

- Packaging Inlet
- Product Outlet
- Reject Point
- Around Doors

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This is a liquids packing machine; note the full enclosure including the header tank and the small entry and exit openings for packaging It is maintained under negative pressure and meeting the >=1.0m/ standard. Note also the bunding on the floor in case of major leaks/spills/failures. The ventilation control on this particular enclosure is linked to the operation of the filler; if the ventilation is not working the filler cannot operate. The doors are also interlocked and cannot be opened until a time delay has passed – to allow the ventilation to clear any airborne aerosol that may be present within the enclosure before the doors are opened.

## Enclosure and Ventilation – Belt Conveyors

Must be enclosed to prevent spillage.

Ventilated to contain dust, especially at transfer points.

This conveyor is not too bad, but is in need of some maintenance to prevent spillage from the belt return underneath.

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Belt conveyors must also be enclosed and ventilated; the return belt underneath the conveyor can often present problems - as you can see in this picture. If you see temporary fixes / powder spillages then act on them and put them right – do not live with them !!

## Enclosure and Ventilation

- Is the most commonly found engineering control in many manufacturing operations
- Requires very careful design & specification to work effectively
- Requires an understanding of air distribution within the enclosure
- Must be designed with the operational tasks in mind
- Must be monitored to ensure continued operation
  [Static pressure gauges installed with clearly marked references]
- Must be maintained at optimum performance

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Enclosure and ventilation requires careful design to work effectively; it is important to understand how the air circulates within a process enclosure; you can force air to travel in a certain way and increase effectiveness of ventilation if you plan it correctly. It is also important to fit static pressure gauges to ventilated equipment, with clearly marked working pressures, so that the performance can be checked by anyone at any time.

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## Static Pressure Gauges


Clearly marked zones of acceptable operation

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Static pressure gauges come in many formats; they are inexpensive, require no power, are simple to install, and can provide direct confirmation that ventilation control is operating as it should – if installed, marked correctly, and validated against the ventilation design.

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## Enclosure and Ventilation

…does not always appear to be practical, it may be that;

- A complex piece of machinery cannot be enclosed
- The process requires constant open access
- The cost is prohibitive
- Enclosure results in other safety or performance issues - e.g. Heat build up, maintenance, cleaning

In this instance many opt to use LEV - Local Exhaust ventilation

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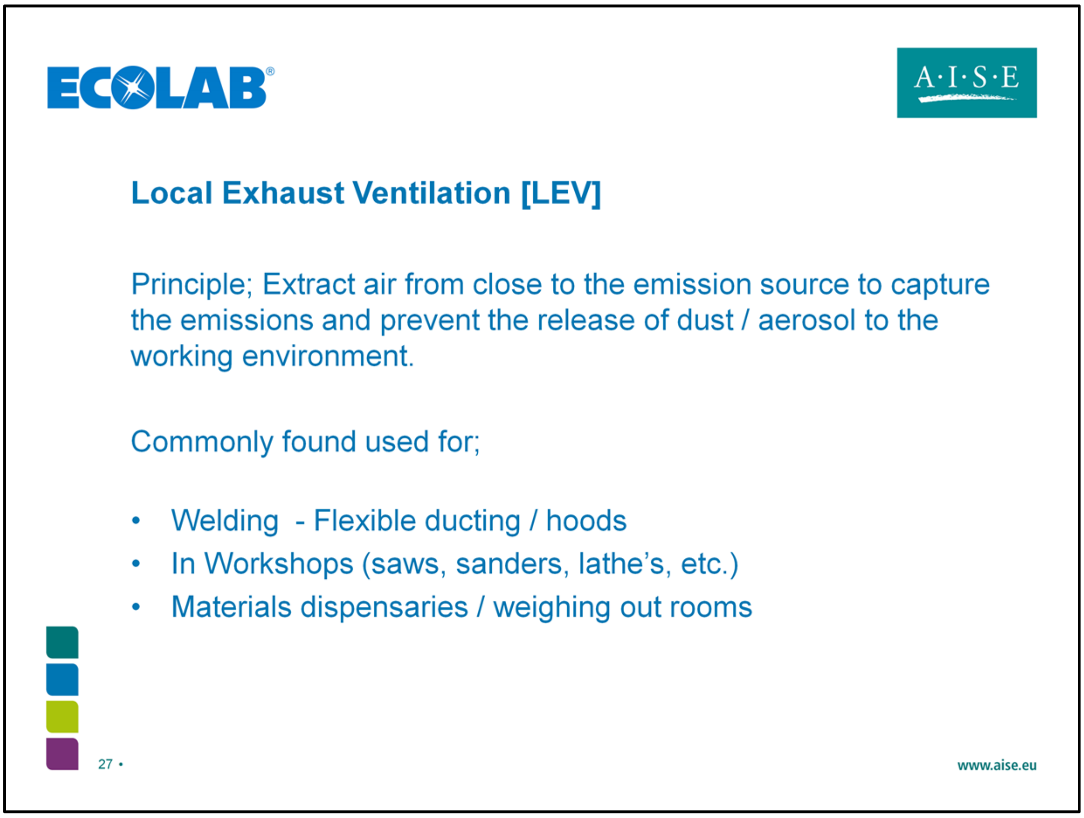
Sometimes enclosure and ventilation might seem an impossible task, due to complexity of equipment, space, cost etc. Sometimes Local Exhaust ventilation [LEV] appears to be the cheapest or easiest option.




LEV is typically found in engineering workshops or material dispensaries. To work it has to be positioned correctly and very very close to the source of the contaminant to work properly.

It is not normally used for very hazardous materials as we will see……

## Local Exhaust Ventilation [LEV]

Efficiency of LEV depends upon;

- The position of the extraction point – has to be close to source
- The shape of the extraction point – influences the capture zone
- The volume of air extracted – high volumes are required !
- The air velocity at the emission source (Capture Velocity)
- Localised air currents [draughts]

It is very easy to get one, or all of these wrong !

LEV alone is not suitable for high hazard materials like enzymes !

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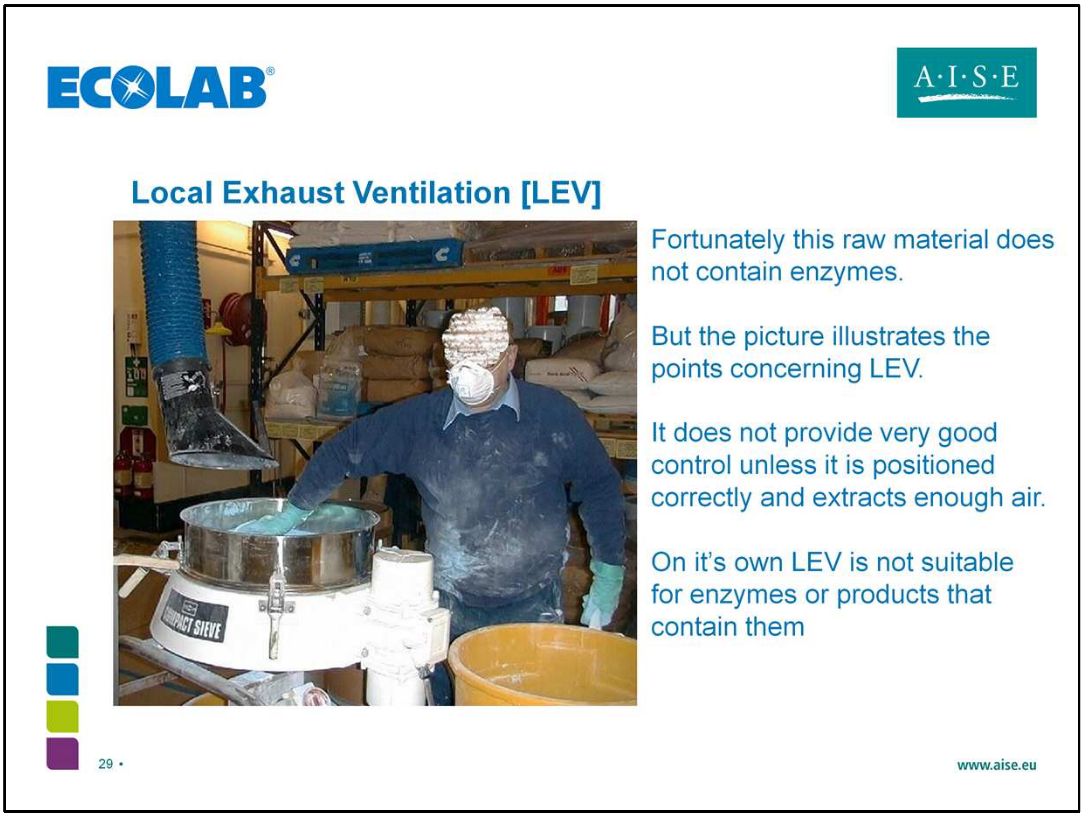
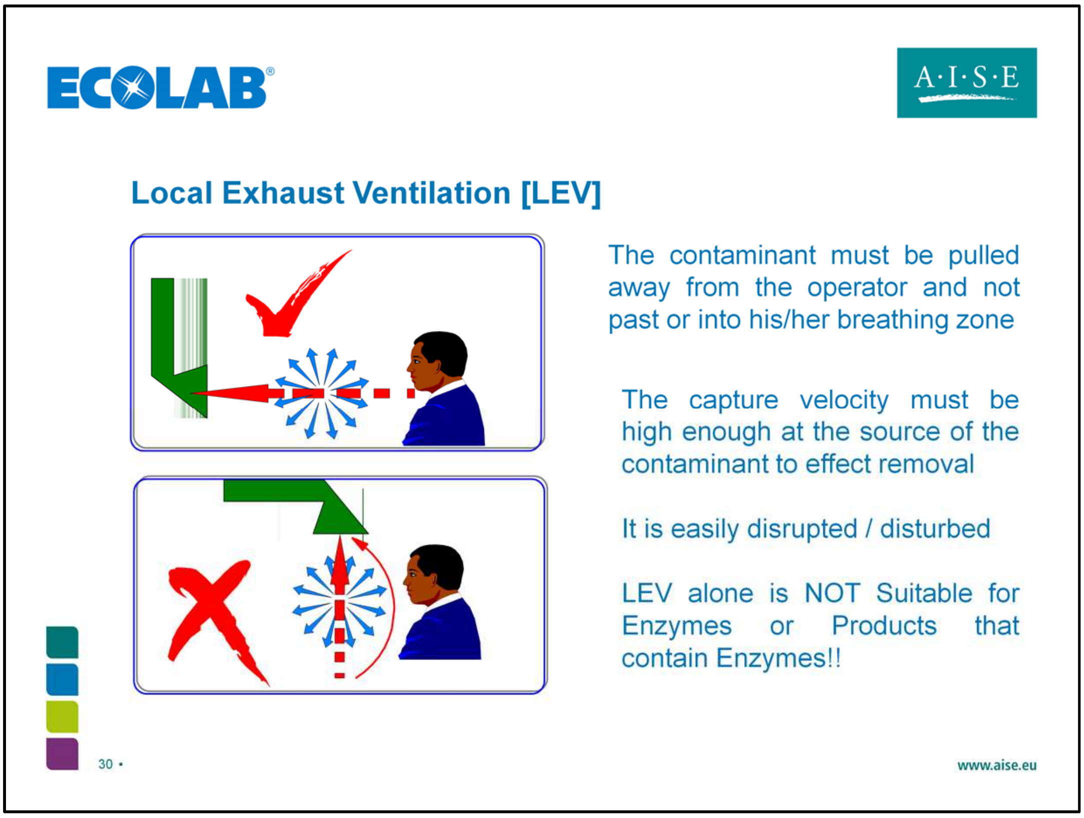
There are many factors that determine the efficiency of LEV; getting any one of these wrong, or installing it in the wrong place, can cause it to fail. LEV is not considered suitable on its own for control of exposure to enzymes from raw materials, intermediates or finished products.




The example demonstrates that LEV alone is not very efficient and as we discussed already it is very easy to misuse and to lose control ! That is why we do not rely on LEV for control of exposure to enzymes or products that contain them.

LEV is more suited to materials of lower hazard




Just to compete the picture on LEV

The position of LEV is important; it must pull the contaminant way from the operator; and the contaminant must be released within the capture zone of the LEV – if not then it will not work.

If the LEV is <u>above</u> the source of dust then it ensures that the operator gets exposed – it pulls dust/aerosol right through the breathing zone; if you have LEV fitted this way at a workstation to try and control dust or aerosol then you should change it immediately.

## Local Exhaust Ventilation [LEV] for Supplementary Control

Local Exhaust Ventilation is often used within a ventilated enclosure [e.g. a packing machine] to capture dust or aerosol emissions at source.

In combination with ventilated enclosures LEV is an acceptable supplementary control measure for enzymes

- Captures some of the dust / aerosol at source
- Improves the efficiency of the enclosure
- Keeps the enclosure cleaner – less need to clean it manually

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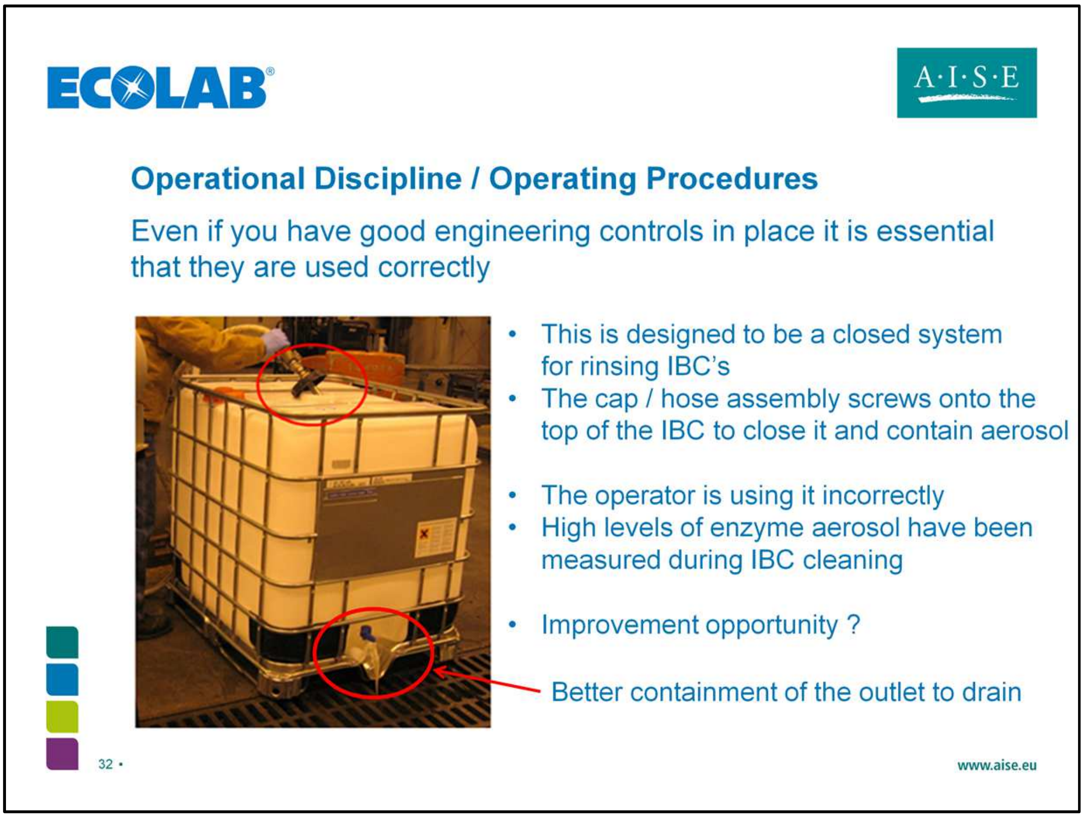
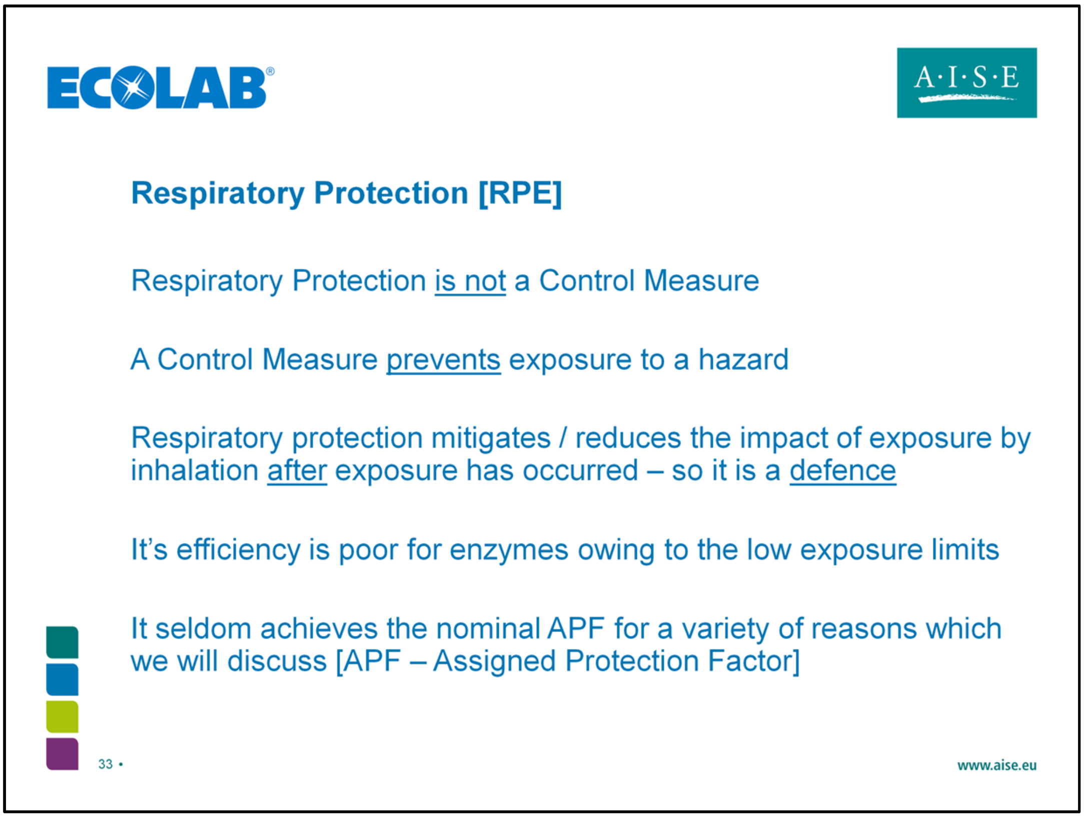
LEV can be used inside enclosures such as packing machines to supplement the ventilation provided to the enclosure, capture point sources of emission, keeps the enclosure clean, and contribute to the overall performance.

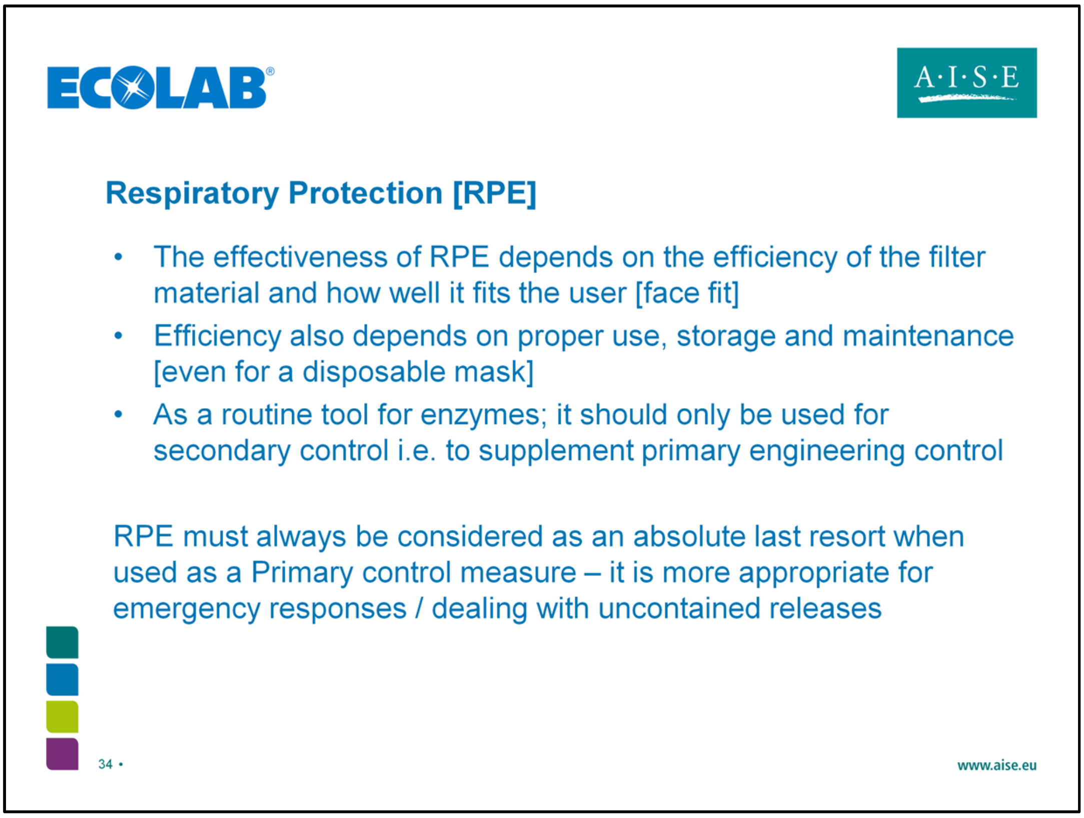



A final word about controls; it might seem obvious but if they are not used properly then they will not work. Operators must use the controls provided to protect themselves and their co-workers. In this example the IBC cleaning station is designed to be a closed CIP system, the cap and CIP nozzle should be screwed on to the top of the IBC, but the operator is using the CIP system like a hosepipe to make the job quicker; as a result he is exposing himself and others to enzyme product aerosol that is expelled from the open top of the IBC as it fills with water.

For this type of activity a high level of enzyme aerosol, well above the Occupational Exposure Guidance Limit, is frequently measured.




We have mentioned respiratory protection several times; RPE is a defence it is not a control measure. RPE minimises exposure after it has already occurred. Generally good quality dust masks can offer up to a 20x reduction for an airborne particulate contaminant, but rarely is that obtained in practice.




It's efficiency is generally poor and depends upon the "face fit" to the person. If a man is not clean shaven then the face seal will be poor and the efficiency of the mask will be low. For a lady if a small size mask is not available then the standard size may be too big and leave gaps around the siders – again reducing the performance. RPE seldom achieves its APF, and is not suitable for enzymes other than secondary protection in addition to control measures, for short term activities such as cleaning spillages, or in the case of an emergency.

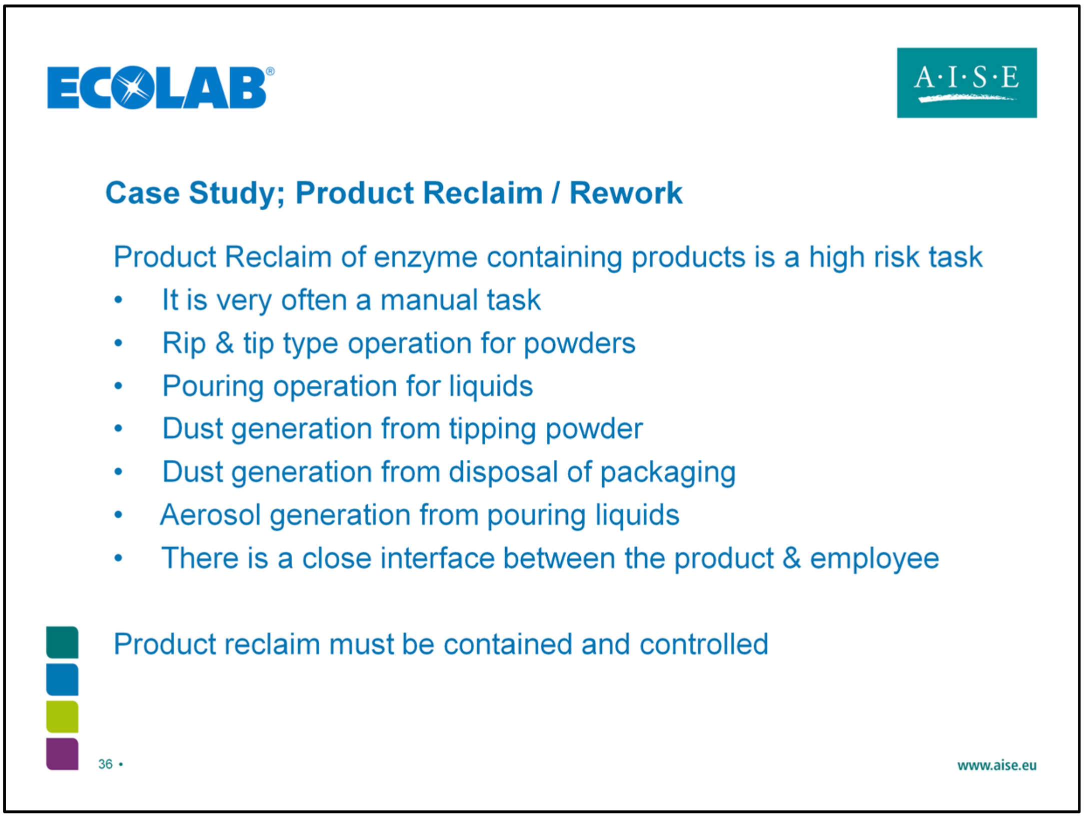
All operators required to use respiratory protection must be fully trained to do so, and must undergo face fit testing for the type that they are asked to use.

## Case Study; Product Rework

- The rework of products is required for packs that might be
  - Overweight
  - Underweight
  - Damaged
- Finished products containing enzyme at <1% still present a high risk of exposure to enzymes by inhalation
- This is something often overlooked by manufacturers of enzyme based products



Reclaiming product from packs for rework / repacking can expose operators to dust and aerosol containing enzyme. Even the dust or aerosol from products containing less than 1% enzyme can contain a significant amount of protein and result in exposures in excess of the occupational exposure guidance limits. It is often thought that the dilution of enzyme in a finished product renders the product non hazardous with respect to enzymes – that is not the case.




Reclaim/rework is a high risk task, more often than not it is a fully manual rip and tip operation for powders, or pouring operation for liquids. There is close interface between the operator and the task hence a high risk of exposure to dust or aerosol.

In our introductory session it was emphasised that even a very low airborne concentration of airborne dust or aerosol from finished products can contain a very significant quantity of enzyme protein sufficient to exceed the exposure limits.

## Case Study; Product Reclaim Booth

This is a poor design because;

The ventilation control is positioned incorrectly in “top” of enclosure

The waste packaging is collected in a sack outside of ventilation control

The reclaimed powder is collected in bin placed inside enclosure and needs to be handled again in the plant

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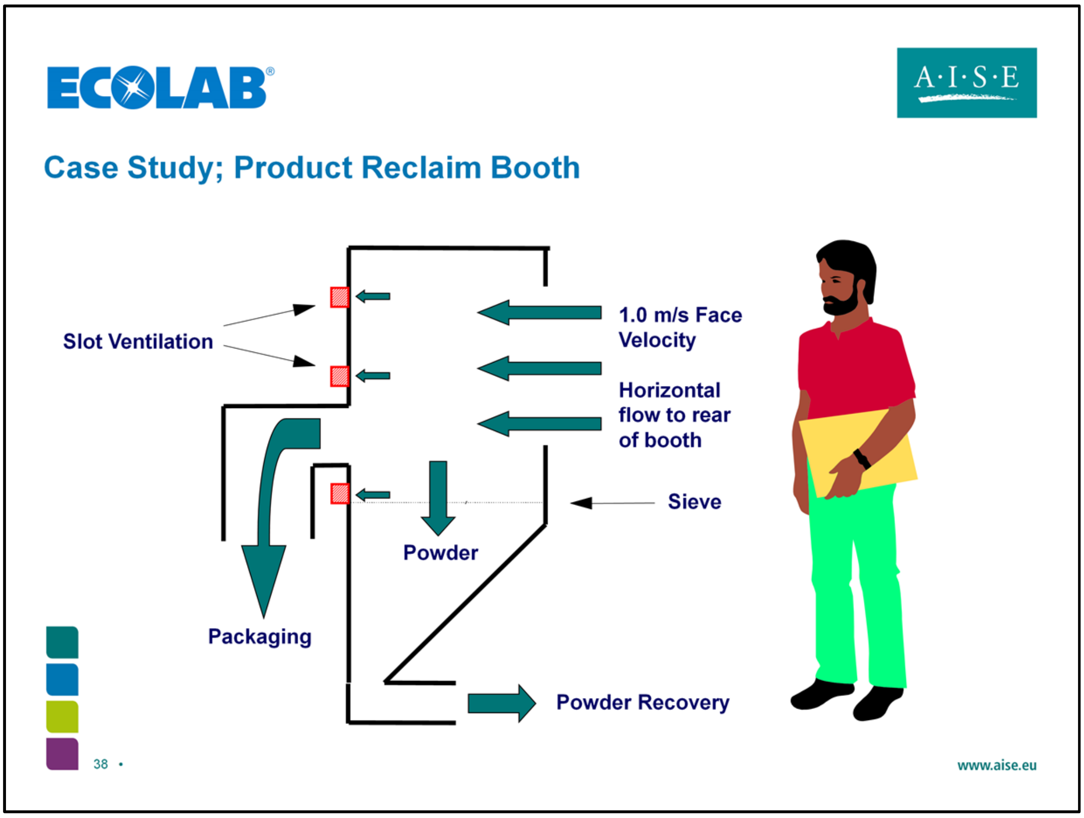
This reclaim booth is a poor design; the ventilation extract point is positioned incorrectly, air will short circuit into the top of the booth, and there is no airflow where the operator is opening packs. The waste bin is behind the operator – empty packs are pulled out of the booth and through his breathing zone, and powder is collected in a bin underneath which requires additional handling.




A properly designed booth is illustrated here; the face velocity is uniform as a result of the extraction being positioned at the back of the booth at three levels; reclaimed powder [or liquid] is diverted direct to the process [or a day bin/silo]; and the packaging is posted through a slot at the back [or side] of the booth into a waste sack.

The process is in a single direction – as is the airflow

Nothing is withdrawn from the booth through the operators breathing zone

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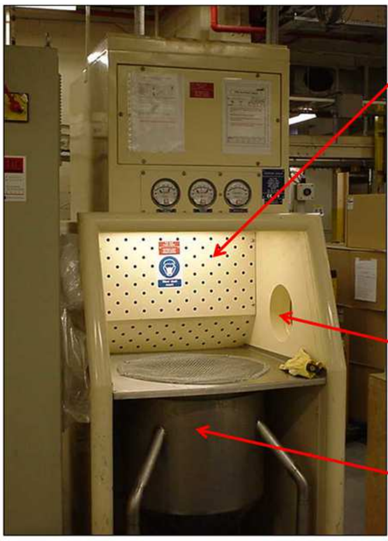
## Case Study; Product Reclaim Booth [Powders]



Rear ventilation maintains horizontal inward air flow away from operator.

Reject packs opened & tipped out within enclosure.

RPE must be used - this is still a high risk task

Packaging disposed of from within booth [through “post box” into a bag]

Reclaimed product conveyed direct to storage by dense phase vacuum transfer.

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This is a real example – a horizontal laminar flow rework booth

Note that the risk of short duration peak exposures from handling damaged / open packs, or if spillages occu,r is still high and therefore respiratory protection is always required for this type of task

### Engineering Controls; Summary

In this presentation we have discussed the most common types of engineering control measures for processing enzymes / enzyme products.

We cannot cover every manufacturing option in this short time – but the principles in this presentation can guide you towards implementing effective engineering controls

For more information refer to the "Guidelines For The Safe Handling Of Enzymes In Detergent Manufacturing" available for download from the AISE web site

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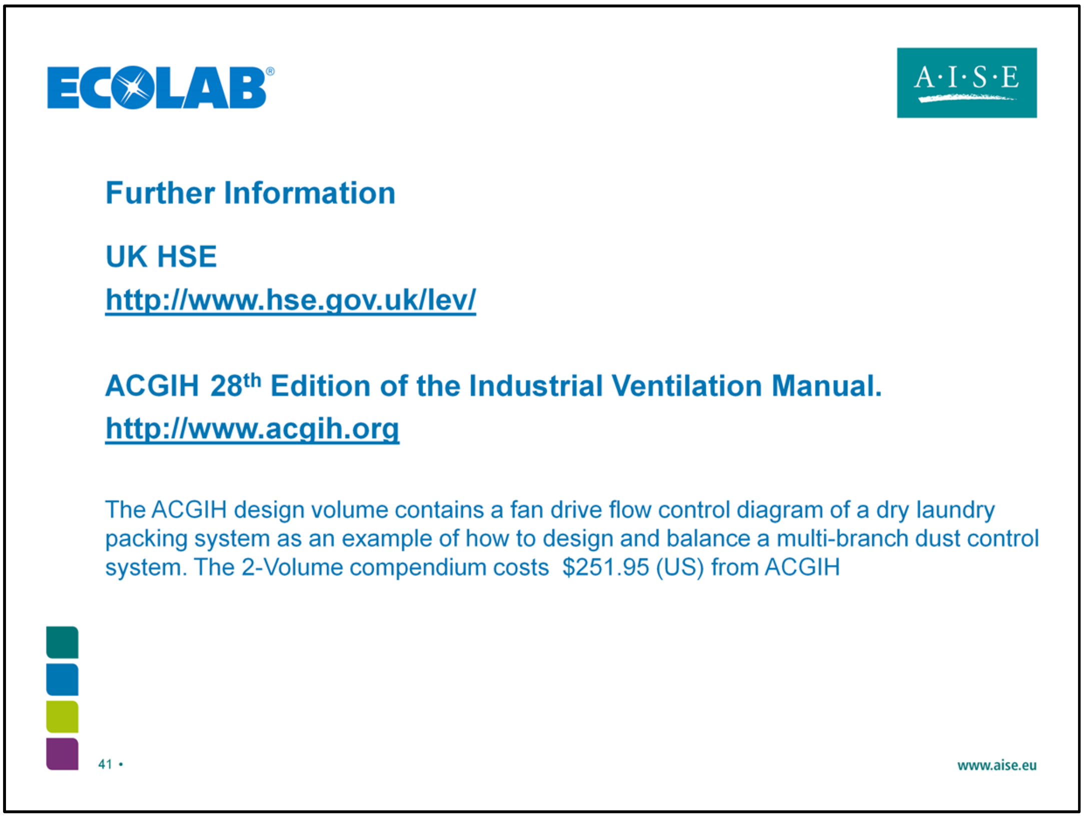
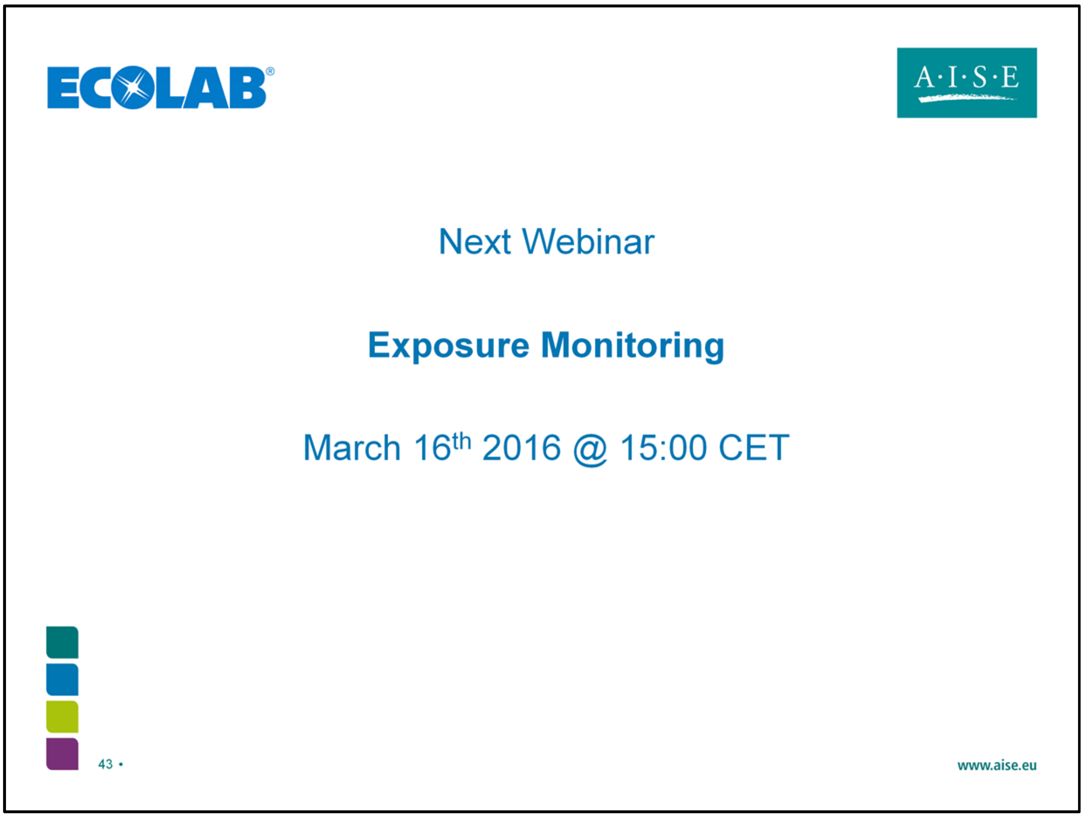
That brings us to the end of this session; it is not possible to cover every conceivable process / task in such a short time but hopefully what is contained here provides a good baseline. In addition the latest AISE guidance document "**GUIDELINES FOR THE SAFE HANDLING OF ENZYMES IN DETERGENT MANUFACTURING 2015**" is available from the AISE web site.




There is also some good free guidance on ventilation design available from UK HSE and some examples from laundry processes in the 28th edition of the ACGIH Industrial Ventilation Manual


Thank you for attending today and I hope that you will join some or all of our future webinars.

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