



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

[www.aise.eu](http://www.aise.eu)

*The information set forth herein is furnished free of charge and is based on technical data that the AISE and the participating member companies believes to be reliable. It is intended for use by persons having technical skill and at their own discretion and risk. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information. Nothing herein is to be taken as a license to operate under or a recommendation to infringe any patents.*



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

[www.aise.eu](http://www.aise.eu)

Good Afternoon. It is my great pleasure to welcome you to the first in a series of AISE webinars that will be run over the next 6 months. The objective of these webinars is to disseminate the combined knowledge, expertise, and guidance that the Enzyme Safety Task Force, together with its predecessors and other collaborative committees and experts, have accumulated and published over the last 40 years.

This first session will provide you with some background to the Enzyme Safety Task Force, and the subject in hand, and introduce the content of the remaining sessions which will run until approximately May 2016.

It is intended to record the sessions and make them available for download from the AISE web site; as a resource for further training, development and information.

In the interests of time I will invite questions at the end of the session, so please note any that you have as we go.

## Session 1: An Introduction to Enzyme Safety

Mark Fieldsend  
Global Industrial Hygiene Manager  
Ecolab Ltd



Our first session will cover an introduction to enzymes, the history of their use, and the problems encountered along the way.

To be clear why we are here today; enzymes are hazardous materials but the risks are only associated with incorrect handling and use. If they are handled for example in a way that results in inhalation of dust or aerosol; or if spillages are dealt with carelessly, then employees may be exposed to them. But before we get into that first I will introduce myself.

My name is Mark Fieldsend, I am an Industrial / Occupational Hygienist and I have worked within the detergent industry for the last 25 years. During that time safe handling and use of enzymes has been a considerable part of my role; developing standards of operation, best practices for risk management, and designing control systems.

I have been fortunate to chair the AISE Enzyme Safety Task Force for many years, and together with a team of experts from across the enzyme manufacturing sector and the detergents industry we have promoted the safe handling and use of enzymes, and developed guidance, specifically for the members of AISE which has been adopted and recognized globally.

In addition the expertise of the individual members of the AISE Task Force is recognized not only within the AISE, but globally in the detergents industry and by other similar organisations and committees.

### Objectives of This Webinar

- **Introduce The AISE Enzyme Safety Task Force & The Upcoming Series of Webinars covering Enzyme Risk Management**
- **Describe Why Enzymes Are So Important In Detergent Products**
- **Raise Awareness of the Hazards Associated With Unsafe Handling Practices and Use of Enzymes**



4 •

[www.aise.eu](http://www.aise.eu)

The objectives of our first webinar are to

- introduce the Enzyme Safety Task Force,
- provide the background about enzymes; why we use them
- Consider the hazards of enzymes & history of use, the health issues, and
- To introduce the upcoming webinars that will cover safety and risk management of enzymes in much more detail

This is an introductory session to ensure everyone starts on the same page; the upcoming webinars which I will describe later will contain a lot more practical and operational detail and will be presented by various experts from the companies represented on the AISE Enzyme Safety Task Force

## AISE Enzyme Safety Task Force

### AISE is the Official Representative of the Detergent Industry in Europe

#### The Role of the AISE Enzyme Safety Task Force is;

- To provide guidance and training to AISE Members
- To promote the application of good practices in the safe handling of enzymes
- To promote the safe use of enzymes in consumer and in industrial products
- To prepare responses to challenges against the application of enzymes
- To communicate & collaborate with other trade associations & stakeholders re: enzyme safety and regulation
- To support legislation compliance.

#### Current Company Membership

- AB Enzymes
- DuPont
- Ecolab
- Henkel
- Novozymes
- Procter & Gamble
- Reckitt Benckiser
- Robert McBride



5 •

[www.aise.eu](http://www.aise.eu)

The AISE is the official representative of the detergent industry in Europe and has many committees and task forces that are dedicated to ensuring safety in everything that the industry does, for employees, consumers, and the environment. Sustainability is also a large part of the AISE mission.

The Enzyme Safety Task force is a small team of dedicated experts from across many companies whose focus is specifically enzyme safety; you will meet, albeit virtually, some of these experts during the future webinars

Our ambition within the task force is essentially to promote the safe and responsible use of enzymes in detergent products, be they for consumers or for Industrial and Institutional use.

We have, for example, published best practice guidance, which is widely accepted throughout the world as such, and we have worked to support the registration of enzymes under REACH via the development of generic exposure scenario's. Our deliverables over the years have been in many fora including input into regulatory committee's and scientific publications.

We work very closely with other committees and groups such as the ACI and AMFEP which have very similar aims.

## Why Use Enzymes in Detergent Products ?

- Enzymes...

- Catalyze the break down of stains and fats on clothes and other surfaces
- Provide fabric care benefits that can increase the wearable life of clothes
- Reduce the temperatures required for effective cleaning [15-20°C]
- Save energy and reducing cleaning times
- Reduce the need for mechanical cleaning effort
- Clean delicate equipment and instruments without heat
- Are extremely weight efficient, often effective at <1% of a formulation
- Are environmentally friendly, non toxic and rapidly biodegradable



6 •

[www.aise.eu](http://www.aise.eu)

So why do we use enzymes ?

Because

- They are fantastic ingredients for cleaning soils, stains, and grease from a wide range of surfaces
- Tackle difficult and stubborn stains and soils that surfactant alone cannot remove
- They extend the life of garments through effective stain/soil removal, low temperature care washing, protecting/renewing color, and providing fabric care benefits
- They save us energy by allowing effective low temperature washing / cleaning
- They are very weight efficient / cost effective, present in most formulations as very minor ingredients, often at less than 1%
- Highly and very quickly biodegradable, and
- They are Non toxic

Unfortunately during the manufacture of enzymes and formulation of products some people may develop specific allergies to enzymes if they are inhaled as a dust or aerosol; as we will now describe.

- The human immune system can respond to foreign proteins that are in our natural environment when they are inhaled e.g.
  - Pollen from plants
  - Animal fur
  - House dust mites [insects]
- Sometimes exposure to these natural proteins also results in an allergic responses, you will be familiar with “Hay Fever” or “Asthma”
- Unfortunately enzyme proteins can have the same effect if people are significantly exposed to them by inhalation...because enzymes are classified as respiratory sensitizers [R42 / H334]
- Consumers / Users are not at risk because the raw materials, finished products, and applications are designed to minimize exposure during intended use



7 •

[www.aise.eu](http://www.aise.eu)

Enzymes are present in all living things; they are biological catalysts that speed up biochemical reactions. They are essential for all life  
 We could not digest our food without them, nor could we move or function as we do, without enzymes to speed up the biochemical reactions in our bodies.  
 However, proteins that are foreign to our body, for example natural proteins such as pollen and house dust, can trigger the human immune system to produce antibodies if they are inhaled – this process is known as sensitisation and we will discuss that process in more detail in the next slide  
 You will all be familiar with common allergies such as Hay Fever, or Asthma, well some people who are exposed to enzymes by breathing in dust or aerosol that contains them may become sensitized to them, and they may develop respiratory allergy in exactly the same way as they might for pollen or house dust.  
 These types of allergenic materials are called respiratory sensitizers, and they can in some cases elicit an allergic respiratory response such as Rhinitis [like Hay Fever] or Asthma.  
 End users of products that contain enzymes are not at risk because the products and their application are designed to minimize exposure – that specific topic will be covered in detail in a later webinar.

Let us consider for a moment what “sensitization” means in a little more detail

- The human immune system is designed to protect the body from foreign proteins particularly those associated with pathogens / diseases.
- When a protein is inhaled and absorbed into the blood stream the immune system *might* respond by producing antibodies – in a similar way as it would to an invading pathogen\*
- The presence of antibodies in the blood has no health effect – people who are “sensitized” do not suffer any symptoms
- Many of us on this call have antibodies to proteins in our blood that we are unaware of – because they cause us no problems / result in no symptoms
- This is “sensitization”; the presence of antibodies in the blood as a result of being exposed to and inhaling an airborne protein



\* The process is not the same but most people understand the concept of antibodies and disease so it will suffice for our descriptive purpose.

8 •

A foreign protein circulating around the body in the bloodstream can trigger the human immune system into defending the body against that protein. This is the function of the immune system. It works by producing antibodies which target the protein in some way and effect it's removal from the body, it's destruction, or it's exclusion.

Enzymes, just like pollen or house dust, can trigger the immune system to produce antibodies that are absolutely specific to that protein. As we have discussed already many of us already have antibodies to foreign proteins in our bodies and we are completely unaware of them, they cause us no problem.

Sensitisation to enzymes is similar in that just the presence of antibodies in the blood has no effect, no symptoms, it does not cause any ill effects, the person is unaware of their presence

Similar to natural proteins, not everyone who inhales an enzyme will become sensitized.

Our own genetics can make us more or less susceptible to being sensitized.

However problems may subsequently occur in a sub set of sensitized individuals if significant exposure to enzymes continues or occurs after this point.

We will consider what is a significant exposure level a little later on ...but first let us discuss respiratory allergy

- The first sign of allergy due to exposure to an airborne protein may be *Rhinitis*
- These symptoms are typical of “Hay Fever” that some people experience in the summer months due to airborne pollen
- Symptoms are similar to a common cold and include;
  - Watering / Itchy Eyes
  - Runny Nose
  - Coughing
  - Sneezing
- The same symptoms can occur due to respiratory allergy as a result of inhaling airborne dust or aerosol from detergent enzymes, or enzyme containing products
- It is important to recognize that any such symptoms that are suspected to be work related could point to the development of occupational respiratory allergy



Just like the development of sensitisation differs from person to person, the link between sensitisation to enzymes and allergy also varies and is extremely complex. It is different for every person.

Some sensitized people will never develop any symptoms even if exposure is significant. Our own genetic make up dictates our response to a sensitizer, that is why it is impossible to set absolute no effect levels, which we will discuss in a while.

The first symptoms of allergy to enzymes that may develop in some people are called Rhinitis; these symptoms are like the common cold, or “Hay Fever” in the summer months.

Watery itchy eyes, runny nose, sneezing, etc.

If an employee has these symptoms, and it appears to relate to their presence in the working environment, then it must be reported to occupational health for further investigation. Symptoms related to the workplace often disappear at weekends, during time off or away from work, during holidays, etc. but return when the person comes back to the workplace, or shortly after.

If the this rhinitis is due to enzyme allergy, then the risk of progressing to the development of enzyme asthma is high.

If exposure to enzymes by inhalation continues in excess of the exposure limit then some sensitized individuals may go on to develop Asthma

- Asthma due to agents encountered in the workplace is called Occupational Asthma
- In the case of enzymes the antibodies already present in the blood as a result of sensitization can stimulate the production of *Histamine*
- *Histamine* makes the airways of the lungs contract and this restricts breathing
- Breathlessness, tightness of the chest, wheezing are symptoms of an Asthmatic attack
- Asthma is a very serious and debilitating disease, and we must protect employees by preventing exposure to enzymes that we use within our manufacturing processes
- This is not an inevitable consequence; only a proportion of sensitized individuals will progress to develop Occupational Asthma



10 •

[www.aise.eu](http://www.aise.eu)

Occupational Asthma can develop if the antibodies in the blood trigger the release of histamine – this may follow a significant exposure to the sensitising agent, that is a continued exposure above the exposure limit, or one or more very high peak exposures.

Histamine effects the airways, just like it does if a person suffers asthma from a natural cause such as pollen, animal fur, house dust. The airways in the lungs constrict , plug with mucus, and breathing becomes very difficult.

Asthma can be controlled, but once established it is a very serious disease  
Health surveillance, sensitisation, asthma and management of employees with respiratory allergy will be discussed in detail a future webinar  
Next we will look very briefly into the experiences of the detergent industry when enzymes were first introduced and the realisation that they were respiratory sensitizers

- Enzymes were first introduced into everyday consumer products in 1965
- This was made possible by industrial scale fermentation processes
- Before 1965 enzymes derived from animal extracts were only present in a few specialist products
- In 1965 Enzymes were dusty powders – they were thought to be natural and therefore non toxic and safe - they were supplied in and tipped from sacks
- By 1967 cases of work related respiratory disease [Occupational Asthma] were evident in many workforces, and in particular across the UK
- By 1970 significant numbers of employee's had developed “Enzyme Asthma” and up to 60% of employees had been sensitized [but showed no symptoms]
- The need for Safe Work practices was clear.



Enzymes were first used in large scale commercial products from about 1965. Once large scale fermentation processes were developed the availability of enzymes in bulk and their effectiveness as a cleaning agent made them an attractive ingredient to include in detergents

Initially enzymes were dusty powders, tipped manually from sacks. Being a “natural” product it was assumed they were safe / non toxic – this was before the legal requirement to provide MSDS’s

Enzyme products were extremely popular with consumers and volumes grew, but by 1967 the first cases of respiratory disease were recognized being due to exposure to enzymes.

By 1970, this had reached “epidemic” proportions for an occupational disease. Enzyme Asthma was diagnosed in many employees, and in UK up to 60% of employees were found to be sensitized – but they showed no symptoms.

It was clear that something now needed to be done very quickly to protect employees if use of enzymes were to continued

- The UK SDIA [Soap & Detergents Industry Association] was formed in 1969 and the first industry guidance was published in 1971
- A combination of successful risk management measures were implemented to reduce and quantify employee exposure to airborne enzyme, including;
  - Enclosure of Process & Stricter Dust Control
  - Improved Process Ventilation Control
  - Additional Respiratory Protection
  - Agglomeration of Enzyme Powders to Minimize Dust
  - Airborne Dust and Enzyme Monitoring
  - Employee Health surveillance [including lung function tests]
  - Exclusion of atopic employees [i.e. already sensitized to something else]
- Note: Exclusion of atopic people is no longer required, nor is it legal in many places.
- The SDIA continued this work up to about 2000 at which time the European AISE Enzyme Safety Task Force was formed and continues to this day.



IN 1969 the UK industry responded by forming the soap and detergents industry association – the SDIA

Many parallel activities were initiated by the founding members to

- Reduce the dustiness of powders
- Improve engineering containment and ventilation control
- Define safe operating practices
- Implement regular health surveillance, and
- Measure airborne enzyme within the factories

In 1971 the first detailed guidance was issued and was regularly updated every few years. Since 2000 this has been a function of the AISE Enzyme Safety Task Force.

Initially people who were atopic – that is more likely to develop allergy – were excluded from any contact with enzymes / production of enzyme products - but experience showed that this was unnecessary, and would now be illegal due to disability and discrimination regulation. It is no longer required.

Risk management measures have developed continuously since 1970, but the overall strategy is still valid. Enzyme encapsulation has replaced simple agglomeration of powders to provide very low dust solids - but even the low level of dust in modern encapsulates still presents a significant risk of exposure necessitating the defined controls. We will return to this in a later webinar.

- The ACGIH [American Conference of Government Industrial Hygienists] set an exposure limit for pure subtilisin [a protease] at 0.00006 mg/m<sup>3</sup>\* [1975]
- Such low limits could not, and still cannot, be measured by personal sampling; so high volume static samplers are used – to measure airborne enzyme in the workplace
- However because of a synergistic effect between surfactants and enzymes an even lower workplace exposure limit was required for detergent manufacturing
- The UK SDIA and US SDA [Soap and Detergent Association] both adopted a limit of 0.000015mg/m<sup>3</sup>\* for subtilisin [circa 1985]
- Examples of current legal limits for pure subtilisin are;
  - OSHA [US] 60ng/m<sup>3</sup>
  - HSE [UK] 40ng/m<sup>3</sup>
  - DOSH [Finland] 15ng/m<sup>3</sup>
- The most current “in house” workplace exposure limits in the detergent industry are in the 5 – 10 ng/m<sup>3</sup> range;



Note: 0.00006 mg/m<sup>3</sup> = 60ng/m<sup>3</sup>  
 0.000015 mg/m<sup>3</sup> = 15 ng/m<sup>3</sup>

Another activity which lasted for many years was the development of occupational exposure limits.

The detergent industry experience demonstrated that despite there being a recognized limit for pure enzyme, set by ACGIH, employee occupational asthma was still occurring. It was established that the presence of surfactants in the dust inhaled by employees had a synergistic effect and increased the potency of the enzyme – subtilisin – and thus a lower limit was set by both the SDIA and the US ACI.

0.000015mg/m<sup>3</sup> or 15 ng/m<sup>3</sup>

Legal limits still apply to pure enzyme protein and do not account for the presence of surfactants.

It is not possible to measure personal exposure to enzymes because of these very low limits, personal sampling technology just cannot achieve the required limits of detection. So high volume static sampling is undertaken.

The webinar on air monitoring will provide far more detail on this subject.

With increasing enzyme activity, multiple enzyme classes, and higher potency enzymes, and the output of health surveillance programs many companies have set increasingly lower exposure limits. The majority of exposure limits for enzymes now fall into the range of 5 - 10 ng/m<sup>3</sup>.

Maintaining workplaces at or below these limits has largely eradicated enzyme asthma from those companies that have adopted the industry best practices, as published by AISE.

Occasional cases still occur through accidental exposures, failure of controls, or poor operating practices, etc. But fortunately these are very rare.

- We know now that there is no absolute limit that will protect everybody from being sensitized to a respiratory sensitizer following inhalation
- Some people will virtually always become sensitized to an enzyme no matter how low is their exposure.....but sensitization is not a disease and has no symptoms
- In the general global population about 25% of people are already sensitized to a protein in their natural environment.....However very few ever know it, or experience any symptoms of allergy
- We do have effective “in house” exposure limits; and a DMEL\* has been defined under REACH by the AISE Enzyme Safety Task Force as a starting point for defining exposure limits
- In the workplace we can control exposure to enzymes to the required limits, minimize the numbers of employees sensitized, and prevent the development of respiratory disease [i.e. Occupational Asthma]
- This series of webinars from AISE will further describe how to do that in detail, but let us take a brief look.....



\*DMEL = Derived Minimal Effect Level of 60ng/m<sup>3</sup> for a pure enzyme

Even though we can prevent the development of asthma / respiratory allergy, we know that employee sensitisation can still occur at a low level despite the best practice controls in place.

Some people are more susceptible to being sensitized at extremely low levels and we cannot predict who that will be.

This does not mean that these employees will develop occupational asthma, although they may be sensitized by low level exposures, the exposures are not significant enough to progress to symptomatic respiratory disease / asthma.

Under REACH the required DNEL [Derived No Effect Level] cannot be set for a sensitizer, and the AISE Task Force has defined a DMEL [Derived Minimum Effect Level] for pure enzyme as starting point for setting limits in the detergent industry. You will hear more about this at a later date.

- Enzyme solids used in detergents are encapsulated and designed to be low dust...but even “low dust” raw material remains hazardous....such is the potency of enzymes
- Physical containment and gentle handling is the key to preventing exposure to enzymes – do not damage encapsulates, or create dust or aerosols [from liquids] during processing
- Containment may be a combination of physical enclosure supplemented with ventilation control - to allow for any gaps or deficiencies in the enclosures.
- Enzyme supply units should connect directly to the process – limit manual handling, manual weighing, or tipping to the smallest quantities [a few kg] under stringent controls, backed up by respiratory protection [as secondary protection]
- Spillages of raw material or product must be cleaned up promptly; do not walk through spills of powders or liquids, push trolleys over them, etc.
- All processing must be enclosed; particularly transfer points
- Process ventilation control must be checked and regularly monitored



15 •

[www.aise.eu](http://www.aise.eu)

It would not be right to leave this session without some further but brief discussion on risk management and engineering controls – although we will devote detailed webinars to both of these topics, beginning on November 12<sup>th</sup> 2015 with a session on Risk Management.

Safe handling and use of enzymes, both solids and liquids, and manufacturing and packing of those products requires stringent controls, well defined operational procedures, and monitoring via air sampling. Health surveillance is the final step to ensure that what we are doing is actually protecting employees.

We have already discussed low dust solids, but we must not forget that we also use liquid enzymes and that these can form aerosols – sub micron liquid particles that can be inhaled and that can have the same effect

Gentle processes [to prevent dust and aerosol] and a high level of engineering containment will ensure that any dust or aerosol produced will be physically contained. Process ventilation control will ensure that airborne dust or aerosol will not escape the process through gaps or deficiencies in containment, in addition to removing them from within that containment and allowing safer access should it be needed.

Spillages of raw materials and products must be prevented, and if they occur dealt with promptly.

Manual handling of enzymes must be avoided for all but the smallest volumes and always with stringent control measures.

For any potentially high risk task employees must utilize respiratory protection just in case an exposure occurs – afterwards is too late !

- Detergent enzymes are very effective ingredients in cleaning products; they are non toxic and environmentally friendly but they are potent *respiratory sensitizers*
- Exposure to enzymes by inhalation of dust or aerosol from raw materials or products may result in *sensitization* and eventually to *respiratory allergy*
- This was the experience of the detergent industry between 1965 and 1985 ; many employees developed *occupational asthma* as a result of inhalation exposure
- The enzyme manufacturers and the detergent industry have since developed and published *best practices* to handle and process enzymes safely.
- Best practice continues to be *refined and updated* in Europe by the AISE Enzyme Safety Task Force, and we continue to work very closely with our colleagues in the US ACI [American Cleaning Institute]



Before I take any questions I would just like to summarize this session.

Enzymes are valuable and extremely beneficial ingredients in detergent products, they are safe for the environment, and have a great sustainability profile.

Unfortunately they are respiratory sensitizers and can trigger a response from the human immune system, sometimes resulting in respiratory allergy – just the same as many natural proteins in our environment

The experiences of the detergent industry in the early days of biological detergents has led to the development of best practices to manage the risk of handling and processing with enzymes. These continue to be refined as our knowledge and exposure control technologies develop, and they are now maintained and published by AISE.

Enzymes can be safely handled and processed if best practice is implemented; this has been clearly demonstrated and has been the recent subject of a joint publication by ACI/AISE covering the last 10 years of the industry experience when following best practice.

Those best practices will from the content of future webinars

**Any Questions ?**



## What is next.....Future Webinars

A·I·S·E

This webinar from the AISE Enzyme Safety Task Force has introduced you to the hazards and risks of enzymes used to manufacture detergent products.

Future webinars will focus in more detail on;

- Risk Management Measures – For Site Management, Safety & Technical Managers, Employees
- Engineering Controls – For Safety and Engineering Teams
- Safe Work Practices – For Management, Leadership teams, Safety teams & Employees
- Exposure Monitoring – For Safety, Laboratory & Quality Managers, Laboratory staff
- Health Surveillance – For Site Management, Safety Managers, Occupational Health
- Performance Monitoring – For Site Management, Safety Managers, Occupational Health
- Laboratory Safety – For Safety, Laboratory & Quality Managers, Laboratory staff
- Consumer Safety – For Product Development, Product Safety, R&D

Next Webinar: "Risk Management Measures" 12th November 2015 @ 14:00-15:00 CET  
Presenter: Anthony Panepinto [Procter & Gamble]



18 •

[www.aise.eu](http://www.aise.eu)

The remaining webinars are curriculum based and will suit different audiences; but there is no restriction on who can attend them; feel free to join them all if you wish, or to download them when they are available on the AISE web site.

The topics as you can see cover everything from Risk Management Strategy, engineering controls and operational practices, through to workplace and performance monitoring, laboratory safety, health surveillance and consumer safety.

AISE will advise the dates for 2016 as soon as possible, but note that the next webinar is on 12<sup>th</sup> November 2015 at 14:00CET and will cover Risk Management Measures. That session will be presented by Anthony Panepinto from Procter & Gamble.

We strongly encourage you to join the live events because there will be opportunity for you to ask questions at the end of each session, and those questions will help the AISE team to further develop the training and guidance...so please take every opportunity to book the dates in your diaries as soon as they are published.



**•On Behalf of the AISE Enzyme Safety Task Force**

**Thank You For Attending Today**

**We Will Appreciate Your Feedback or Further  
Questions to:**

**[webinar@aise.eu](mailto:webinar@aise.eu)**



19 •

[www.aise.eu](http://www.aise.eu)

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