GUIDELINES FOR ESTABLISHMENT OF A SAFETY MANAGEMENT SYSTEM IN A FLEXIBLE POLYURETHANE FOAM PLANT

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A. INTRODUCTION

Purpose

These guidelines have been prepared by EUROPUR and EURO-MOULDERS to contribute to aligned high levels of safety and environmental care for the handling of diisocyanates and certain chemicals in flexible polyurethane foam production (slabstock and moulded) in Europe.

They should serve as support to polyurethane foam producers in the creation of site-specific guidelines and support them in risk assessments related to their processes. Products covered are TDI, MDI and their variants, hazardous additives (ex. amine catalysts) and certain polyols. Although the document is structured around the risks linked to chemicals, it also integrates information about the process (equipment, machinery) and a guideline related to Safety Management Systems (including fire risk in both foaming and conversion plants).

Scope

These guidelines cover all important aspects of the foam production process, notably delivery, unloading and storage of raw materials, foam production itself, further processing, equipment and maintenance and post treatment. They also contain chapters about occupational safety, protective equipment and emergency procedures.

They integrate a detailed description of a Safety Management System as described in the Seveso Directive in Europe (actual version Seveso 3, 2012/18). An example of such a system is given in this document.

These guidelines do deliberately not refer to other European or national legislation documents for the simple reason that these are regularly updated. It is the legal obligation of foam manufacturers to follow and apply them (including specific requirements of local authorities). In some chapters and annexes some ISO standards are quoted in their actual version.

All acronyms used are explained in an annexed list. The actual document is version 1/2016. It will be regularly updated in the future as and when needed.

Management Summary

The members of EUROPUR and EURO-MOULDERS, as downstream users of chemicals supplied by the chemical industry, operate under European and national legislation. It should be mentioned that the REACH Regulation belongs to the most stringent legislation on use and handling of chemicals worldwide.

Highest priority for our industry is to assure, by appropriate risk management measures, the safe handling of the chemicals used (mainly diisocyanates) so that the risk to human health and/or environment is negligible.

These guidelines cover all aspects from delivery, unloading, truck handling, storage, blending, foam production, further processing, equipment, maintenance and post treatment. Specific chapters deal also with occupational safety, protective equipment, training, fire safety and how to prevent air, soil and water pollution.

The heart of this document is the description of a Safety Management System which describes the methods to analyse, assess and manage potential risks.

These guidelines should serve as a support for our industry to create their own plant specific guidelines adapted to the structure of their company. They describe the general principles and all aspects of safe handling to be taken into account.

They cannot substitute company specific procedures required by existing legislation, such as for example the Seveso Directive.

EUROPUR and EURO-MOULDERS and their members are well aware of the societal debate on hazards of chemicals. That is why these guidelines are also targeted to inform all stakeholders (political, authorities, civil society) about the attention we pay to the safety of workers and installations and to assure an environmentally safe neighbourhood within the municipality where flexible polyurethane foam plants are located.

We consider continuous dialogue and transparency as essential for the societal acceptance of our activities and products. In this sense this document is also a communication tool.

Disclaimer

EUROPUR and EURO-MOULDERS have made every effort to present accurate and reliable information in this document in order to support the establishment of aligned safety management systems in the flexible polyurethane foam industry.

This document however merely provides advice and guidance, it does not exonerate polyurethane foam producers from implementing their own site- specific safety management systems and from monitoring regulatory or scientific developments they may need to take into account for updating their procedures. The sole responsibility for the implementation of site-specific safety management systems and compliance with all (local) legislation and requirements relies with polyurethane foam producers.

No representations or warranties are therefore made with regards to the completeness, accuracy or reliability of this document and no liability will be accepted by EUROPUR, EURO-MOULDERS nor any of their members for damages of any nature whatsoever resulting from the use or reliance on this document.

Credits

These guidelines have been prepared by the Plant and Workers Issues Working Group of EUROPUR and EURO-MOULDERS. Our organizations would like to thank the following international team of experts for their valuable input. Without them, drafting this document would not have been possible.

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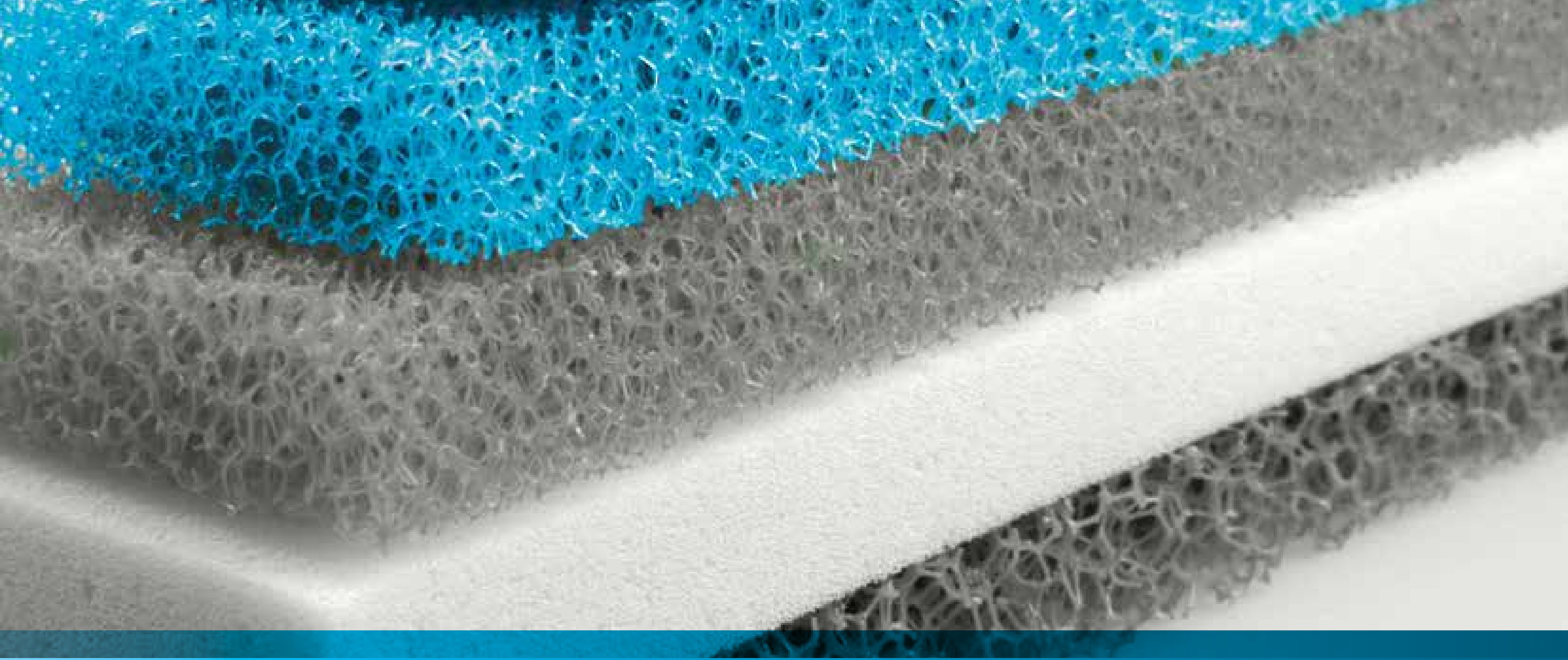


B. PROCESSES

I. SUMMARY PROCESS DESCRIPTION

Flexible polyurethane foam (PU foam) is produced by reacting polyols and diisocyanates (MDI or TDI, or a mixture thereof). The use of additives may be necessary to produce the PU foam, depending on the application the foam will be used for. The expansion of flexible PU foam is obtained by the addition of water or CO2 into the blend; CFCs or HCFCs or volatile organic compounds are not used anymore for foam expansion.

The production processes used in the industry are **slabstock foam** production and **moulded foam** production.

Flexible slabstock polyurethane foams are produced as large blocks using a semi-continuous process with minimal human handling. Although the raw materials are the same, there are different types of machinery being used for producing foam blocks.

- **Commercial box foaming**: This process is rarely used in Europe today. The foam mixture is simply poured into a wood or metal box, which deliver foam blocks of the size of the box once the foam has solidified (polymerized).
- **Continuous foam machines** are the standard in Europe today. While the machinery may be different from one manufacturer to the other, the general principle is always the same: the raw materials are delivered into a mixing head, which pours the foam mixture onto a pour plate, which delivers the rising foam onto a moving conveyor (usually horizontal, sometimes vertical). Both the conveyor and the mixing head are located in a ventilated tunnel fitted for exhausting vapors released during the foaming process.

In contrast to the blocks produced in slabstock foam production, **moulded foam** articles are made one at a time by injecting the foam mixture into moulds. When the foam rises and expands, it occupies the whole space in the mould, solidifies and the produced part can then be removed from the mould, either mechanically or manually.

The final product for both production processes (slabstock and moulded) is flexible polyurethane foam. The diisocyanates are fully consumed during the chemical reaction that creates polyurethane, due to the high reactivity of the NCO group present in the diisocyanates. They cannot be released into the air from polyurethane foam. That is why there cannot be any exposure of consumers to diisocyanates resulting from PU foam[1].

1 Scott M. Arnold, Michael A. Collins, Cynthia Graham, Athena T. Jolly, Ralph J. Pard, Alan Poole, Thomas Schupp, Ronald N. Shiotsuka, Michael R. Woolhiser, "Risk assessment for consumer exposure to toluene diisocyanate (TDI) derived from polyurethane flexible foam", Regulatory Toxicology and Pharmacology, 64 (2012), 504-515.

The table below summarises the different steps in the production process:

Step	Slabstock Foam	Moulded Foam
1: Raw materials delivery	Chemicals are delivered in bulk or in small containers (drums or IBC's) and stored in the corresponding buildings. Usually, diisocyanates are stored in a specific area. Diisocyanates unloading is made by suction and the vapours are returned to the tanker	
2: Raw materials storage	The diisocyanates are transferred directly via a pipework to the wet-side room storage tanks (the room in which the liquids are sent to the machines), without any intervention on the chemicals. Polyols are transferred directly via a pipework to the wet-side room storage tanks. Additives and catalysts are stored pure or blended in smaller day tanks close to the foaming machine	The diisocyanates are transferred directly via a pipework to the wet-side room storage tanks (the room in which the liquids are sent to the machines), without any intervention on the chemicals. Polyols are sent to the blending area for formulation. In the blending process, additives and catalysts are added to the polyols; and the polyols are pumped to the wet-side room, in a specific tank called day tank. One day-tank for each formulation and one for each diisocyanate. In certain cases a day tank might not be necessary.
3: Mixing and pouring	The liquids are pumped to a pouring head and the polyols, additives and the diisocyanates are simultaneously poured and mixed together. The expansion starts almost immediately.	
4: Foam Expansion	The foamable reaction mixture from either a high or low pressure machine is dispensed into a continuously moving conveyor usually with a paper liner. Usual dimensions of foam blocks in the industry are 2m wide by 1m high. The resulting densities range from 15 to 60kg/m³ and belt speed from 2 to 10m/minute.	The production lines are made of a carrousel (oval or circular) on which moulds are placed. The moulds move continuously and are heated up to around 60 °C (cold cure). Before pouring, a wax is sprayed inside the moulds to help demoulding. The liquids are poured in open moulds and the liquids expand during the curing time.
5: Demoulding	At the end of the foaming tunnel the foam liner, a paper or plastic or a combination of these, are removed. When a peelable paper is used, the plastic liner is left on the block.	After a few minutes of initial curing, the moulds are opened and the polyurethane foam removed, manually or automatically.
6: Cutting	At the end of the production line, the foam produced is cut into blocks of up to 120m long.	Not applicable
7: Repair	Non applicable	The foam can be repaired if some minor defects affect the shape of the parts. Afterwards the foam is sent to packaging and shipment.
8: Curing & Storage	The foam is left to cure for up to 24 hours before storage in storage houses. From there it is packaged and prepared for shipment or further transformed on-site into semi-finished or finished products.	The foam is left to cure for a further few hours before packaging and shipment.

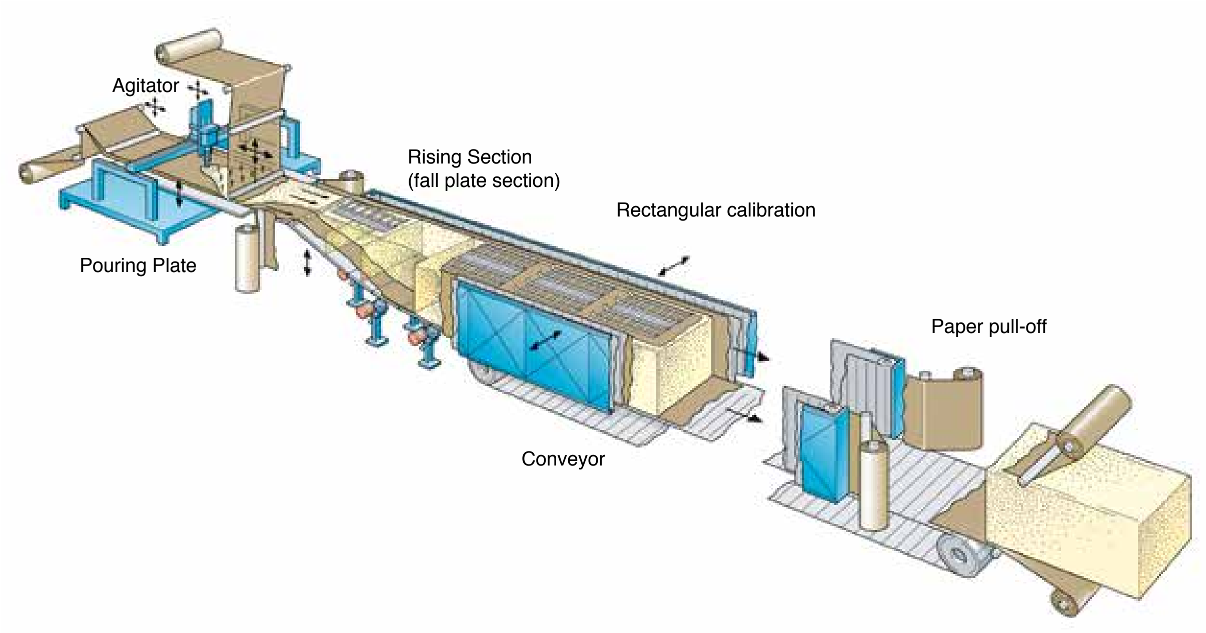


Fig.1 shows the agitator, pouring plate, rising section, conveyor and paper pull-off in a system for continuous production of rectangular flexible foam blocks. 3-D representation of a system – without metering device and cut-off saw – for continuous production of flexible rectangular foam blocks by means of the QFM process (source: Hennecke)

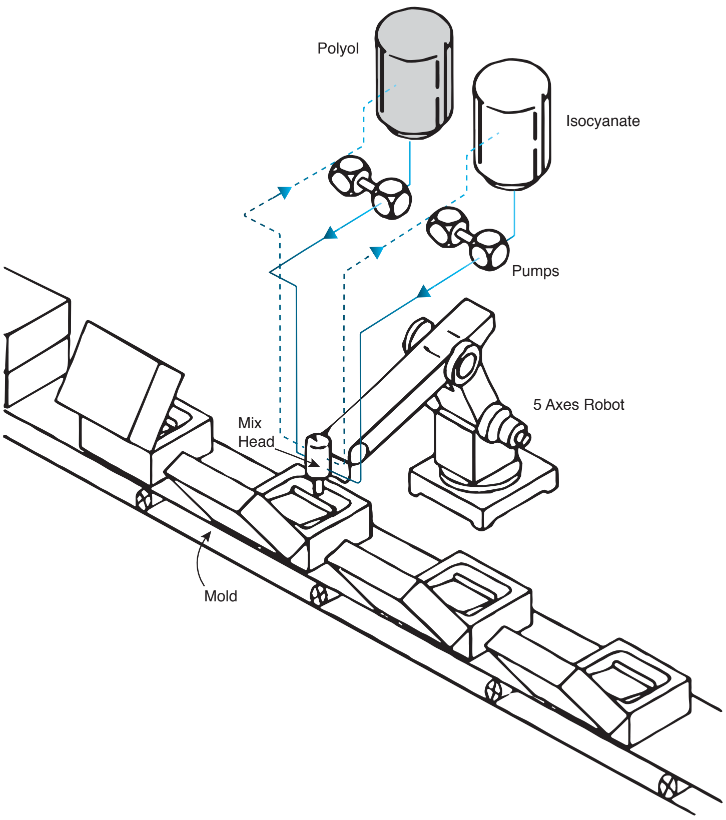


Fig. 2: Schematic view of a moulded polyurethane foam production line (source: Dow Chemicals, 1997).

Further details on polyurethane processing systems are available in Annex 1.

II. RAW MATERIAL: Delivery /Storage/Blending

1. Delivery

Several controls and checks must take place before unloading. These focus on safety mainly, in order to prevent any leak during this operation.

Are to be checked notably:

- Shipping(delivery) documents
- Raw material certification
- Free capacity in the receiving tank
- Condition of truck
- Drivers language
- Hose connections/ Equipment
- Cleanliness of the unloading lines
- RPE (Respiratory Protection Equipment) / PPE
- Emergency equipment (spill kit)

This list is non-exhaustive. It is the responsibility of each company to draft their own procedures. To do so the check list in annex 2 or the ISOPA TDI/MDI Bulk Discharge and Storage Assessment[2] (version July 2015) can be taken as inspiration.

1.1 Unloading / truck handling

Unloading and truck handling should take place in accordance with ISOPA guidelines for the safe unloading of TDI and MDI in bulk (version March 2011). These describe how this can be safely done for road tankers. A separate guideline exists for packaged TDI & MDI (IBC's and drums, version December 2014). These guidelines provide information on the main properties, health and chemical hazards and first aid in case of contact.

More details on such properties are found in the producer's eSDS(extended Safety Data Sheets) which must be carefully read and understood by all people handling these products. eSDS notably mention personal protective equipment (PPE) that needs to be worn.

A specific chapter of the guidelines describes how to deal with spillages. The main distinction is minor or major spillage. A minor spillage can be controlled at plant level without requesting the support of an external emergency response team. A major spillage requires to call external emergency services. Some local authorities may have defined additional

2 The latest, up to date versions of documents of ISOPA referred to in these guidelines are available on the website of the organization (www.isopa.org), some of them in a number of different languages. As these documents are updated regularly, it is recommended to always check the latest version on this website.

rules based on quantities spilled, which have to be complied with. Plants need to make a thorough and in-depth risk assessment to define the appropriate response to an emergency and therefore define the limits in quantities spilled they can safely deal with.

ISOPA has created a mutual aid scheme providing assistance in case of transport / unloading emergencies (phone numbers for all European countries can be found in the above quoted documents and available at www.isopa.org).

Exercises must take place on a regular basis to evaluate the response time of emergency response teams and to define with the emergency provider the type of equipment it can offer.

1.1.1 UNLOADING OF TDI AND MDI IN BULK

1.1.1.1 ISOPA guidelines

Documents available:

- The recommended procedures for unloading and responsibilities of drivers and receiving operators are described in ISOPA guidelines for the safe unloading of TDI and MDI in bulk [3].
- The ISOPA TDI/MDI Bulk Discharge and Storage Assessment to evaluate a receiver's bulk unloading facilities and checklist (version July 2015) can be used as supporting document.

Discharging operations are potentially hazardous. That is why they must be:

- suitably located
- correctly designed and constructed with safe access
- properly used and maintained
- regularly checked for compliance with standards set
- carried out in a bunded area / with spill controls

Receivers should own all discharge hoses and vapor return hoses (technical details are described in the ISOPA guidelines).

The guidelines also describe NON STANDARD OPERATIONS (NSO) which may result in an increased operational risk, such as for example direct discharge from bulk into IBCs or drums.

A risk assessment is critical for mitigating risk.

1.1.1.2 Recommended Principles for Unloading

Unloading is made by suction, usually from the top of the tanker. The liquids are pumped out of the tanker with negative pressure and sent with a pump to a bulk storage. The vapors displaced from the top of the bulk are returned to the tanker via a vent line return, avoiding emissions during the operation.

Unloading by dry air pressure applied onto the tanker is not the preferred solution, due to the risks it entails (over pressurization, moisture ingress, large amount of vapors emitted at the end of the transfer, pressurization of the pipework increasing the flow in case of rupture etc.). It is possible for an implosion to occur if the return hose becomes blocked i.e. due to crystallization.

3 ISOPA Guidelines for the safe unloading of TDI and MDI in bulk, available at www.isopa.org, p. 33-35, version March 2011

An unloading bay is recommended for the unloading of diisocyanates as the risk of leakages increases during that operation. Basic precautions are:

- All hoses are hung over the tanker and not lying on the floor (in order to avoid creating syphons or in case a hose or a gasket would fail)
- All hoses and pipes are properly and clearly labeled
- The tanker staying on a collection sump with wheel shocks (in which the water coming from melting snow is regularly removed during winter time)
- The entire space is placed under fire protection.
- An emergency shower should be located adjacent to the unloading point.

The sequence of operations for unloading is a Critical Task, in which a simple error can lead to a major accident. In order to prevent any accident during unloading, in addition to Instructions and Checklists (which are not sufficient alone in terms of competency or training), additional precautions shall be taken:

- Training and, more important, **competency evaluation** of the operator, who should be able to react in a proper way should a deviation occur during the unloading process,
- **Double checks should be** made by a second experienced operator for any diisocyanates unloading, in order to detect any failure at an early stage. The correct opening of the tanker valves before unloading and their closure after unloading is an example of a point where a double check is necessary. Risks of error can be minimized as well by properly installed safety PLC controlled systems.
- **Regular audits** made by Process Safety Experts, especially focusing on human errors and possible dangerous undetected failures of the Safety System.
- The entire Safety System shall be **regularly tested**, as described in relevant standards (IEC 61-508 or *ANSI*/ISA 84.00.01-2004), by highly experienced and trained operators, able to detect any failure of any component of the Safety System. This applies for each part of the installation which can be possibly a source of accident.
- Specific procedures should describe **how to react to a failure** detected during a check, and audit or a test.
- This comes in addition to **change management procedures** (see the Safety Management System at the end of this document).
- In any case a **robust emergency response** must be put in place and regularly tested in order to adequately respond to any kind of emergency in a very structured manner. The best-in-class solution consists in simple concise documents, affixed in a central point, on which main roles are simply described (see chapter "emergency response").
- The unloading procedure shall be drafted in such a way **that at all times the risk of human error is prevented** (double checks with two operators, efficient design to avoid the most common mistakes like tank collapse during unloading due to a wrong opening sequence of valves, poke-yoke on flanges to forbid an accidental mixture of chemicals).

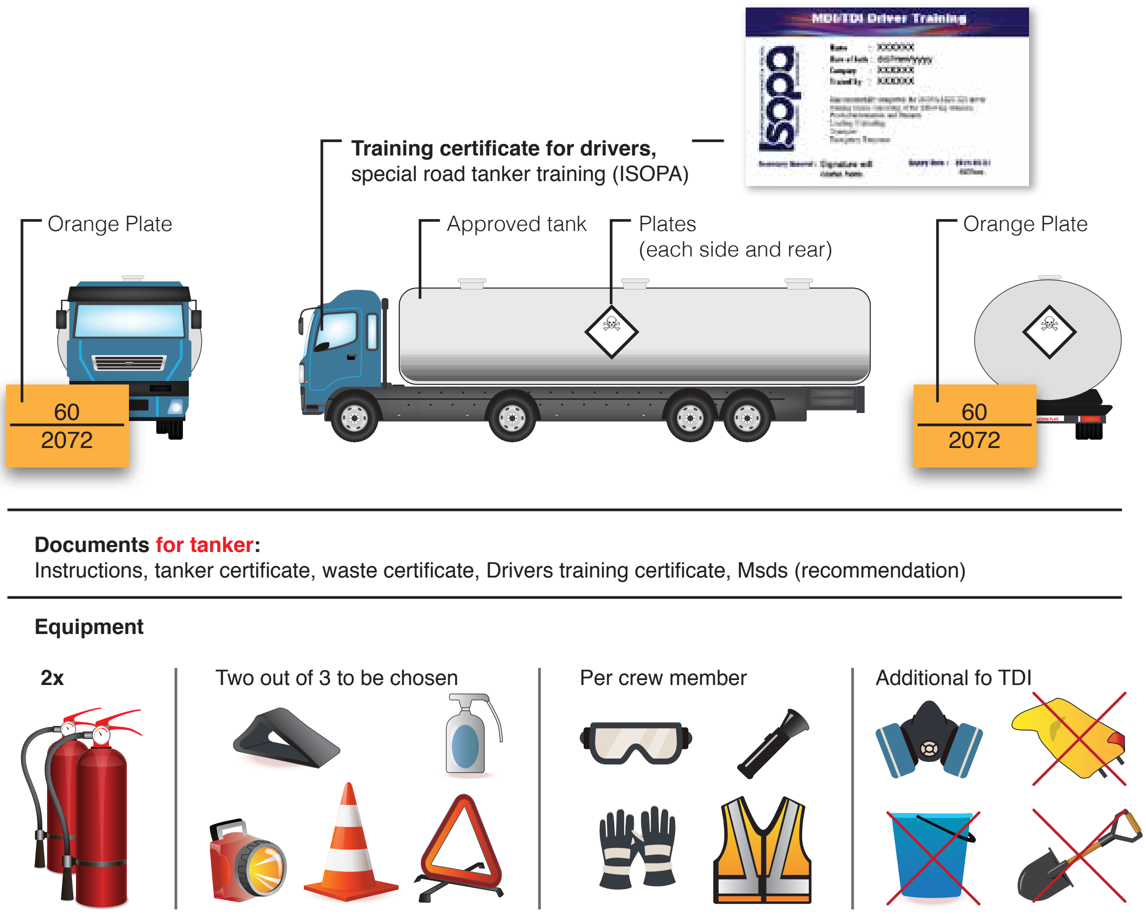


Fig. 3: Example of summary instructions for truck unloading (source: Johnson Controls)

For an example of unloading checklist, please refer to Annex 2.

1.1.2 UNLOADING PACKAGED TDI& MDI

The handling of TDI & and MDI in steel drums and MDI in intermediate bulk containers (IBC's) should take place in accordance with ISOPA guidelines for packaged TDI & MDI (version January 2014).

These guidelines notably require the use of PPE's and trained personal. More information is available in the guidelines themselves or in ISOPA's Walk the Talk safety training program.

In these guidelines detailed procedures for emptying drums, heating (if necessary) and disposal are described.

It is an ISOPA recommendation that **IBC's should NOT be used for TDI transport / storage** (risk in case of spillage).

Like in bulk delivery there are shared execution responsibilities between the driver and the cargo receiver.

2. Storage

These guidelines cannot provide detailed engineering advice on the design of TDI/MDI storage facilities. Only some main requirements are described like tank size, bonding, venting, level indicator, pressure / vacuum protection and temperature control.

Storage of TDI and other toxic substances in quantities over 10 tonnes (one substance or a combination of toxic substances) falls under the provisions of the Seveso Directive. Even if not imposed by the Directive for storage up to 100 tonnes, the implementation of a Safety Management System as described in this document is essential in order to properly manage risks. For storage of over 100 tonnes of toxic substances (Seveso upper tier plants), such a Safety Management System is compulsory.

ISOPA has developed an assessment tool for tank farms which can be used for self-assessment or assessment by ISOPA member companies.

EUROPUR and EURO-MOULDERS STRONGLY RECOMMEND TO THEIR MEMBERS TO HAVE THEIR TANK FARM ASSESSED (INTERNALLY OR BY A THIRD PARTY).

For safe storage of IBC's and drums some requirements are necessary:

- Hazard segregation in storage facilities (a dedicated area for diisocyanates, kept away from flammable liquids)
- Temperature and moisture control
- Rules regarding the number of packages to be stacked.

2.1 General Principles for tank farm design

A tank farm corresponding to best practice must take into account the following principles. Of course all principles mentioned above under "unloading" should be complied with too.

- The diisocyanates tanks are placed in a dedicated compartment, with a segregation should an adjacent fire occur. Usually the tank farm is sprinkler protected and/or placed under fire detection. The appropriate level of resistance of this dedicated compartment against an external fire is linked to a risk assessment.
- Polyols and catalysts are stored in another compartment and not within the same bund.
- The entire storage is bunded.
- Access to the diisocyanates tank farm is restricted (badges or keys). The risk of earthquake, heavy snow fall or flooding are taken into account whenever applicable. The building can be protected against lightening if a risk assessment study shows such a risk.
- Diisocyanates tanks are equipped with a SIL-approved pressure and level protection.
- The use of internal heating inside the tanks is not accepted due to the additional risks it creates. The usage of water-based heating systems is not accepted (risk of runaway chemical reaction, use rather an oil based liquid).
- The unloading bay, adjacent to the tank farm, should be covered or closed in order to avoid the dispersion of toxics if an accident occurs. The tanker should be parked in such a way that it can easily escape the unloading bay. Unloading of diisocyanates is made from the top of the tanker, by suction, and the vapors coming from the bulk tank are returned to the tanker.
- Couplings and fittings as described in the Isopa document must be respected. Different couplings must be used to prevent the risk of confusion between polyols and diisocyanates or any other chemical.

2.2 Tank farm design guidelines

The tank farm is one critical part of the plant, in terms of risks. The design of a tank farm is made on such a way that there is NO emission during the entire process, from unloading to pumping/pre-mixing to production area.

The main process risks linked to a tank farm are:

- An **adjacent fire**, during storage or unloading, this fire heating up the liquid diisocyanates and inducing a tank rupture or a leak associated to a large toxic cloud.
- A **leak** followed by vapors emissions, tied to a rupture of the shell of the tanks or on the pipework, induced mainly by an external aggression, or any failure of the pipe work.
- A **tank collapse** coming from a wrong sequence of operations during unloading.
- A **runaway chemical reaction** induced by water or any incompatible chemical entering the tanks.
- An **over-pressurization** or an **overfilling** of the tanks, followed by a leak.
- **Crystallization** induced by low temperature, or dimerization induced by an excessive heat strength even if both cases have only indirect consequences for safety. An implosion can occur with the offloading vehicle if the return line becomes blocked.
- An **unexpected truck motion**.
- **Risk of falling due to access at height**, for unloading.
- **Exposure to toxics** (remaining liquids in hoses or due to an accidental situation or any leak) by skin contact and/or inhalation.

All risks associated to a tank farm have to be assessed through HAZOP, Bow Ties (Fault trees and Event trees) or equivalent. The foam manufacturer should develop a structure in which the risks assessments are part of a Safety Management System. A number of measures that should be observed to prevent these process risks are listed below.

In order to achieve a good safety standard for the entire installation, complementary precautions may be needed. Precautions should focus on **prevention** of the risks listed above, and not on incident or accident mitigation. This can be achieved only at a design stage or a modification of the existing installation.

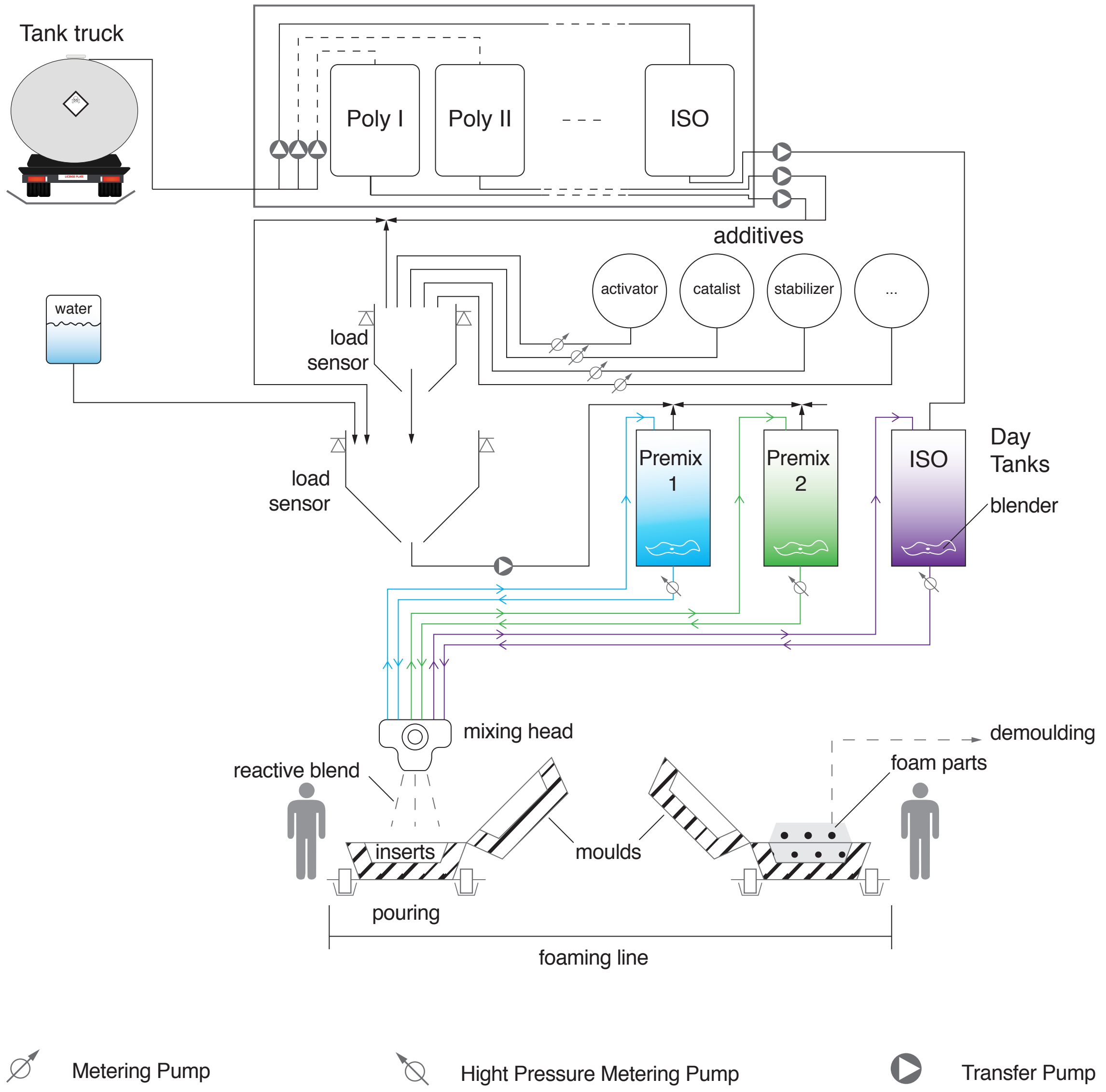


Fig. 4: Example of simplified Piping and Instrumentation Diagram (PID)

MEASURES TO BE OBSERVED:

- After unloading, once the tank is filled up, the vent line is closed via a three ways valve, and air can enter the tank once the liquids are transferred to the plant. Silicagel dryers or dry air / nitrogen curtains are both options. Carbon filters used as dryers are not considered as best-in-class. In any case, a strong inspection scheme of dryers is essential to prevent moisture ingress in the tanks.

- The tanks need to be equipped with a safety system preventing the risk of overfilling and over pressurization. This system must be compliant with the IEC 61 008 standard and should achieve a Safety Integrity Level of 1 or 2 depending on the risks assessment. It is from the highest importance that the Safety System obeys to two conditions simultaneously: the architecture must be based on redundancy for the highest SIL and the choice of components must be based on approved SIL capable components.

- For over pressurization, the usage of Safety Relief Valves or Bursting Disks is requested to reduce the consequence of an accident. In any case, SRV or Disks must be equipped with a sensor, SIL capable, entering the Safety System. In addition, on top of the bulk tank, a 3 ways valve shall direct the vapors to the vent return line and to the tanker before starting the unloading pump. This valve must be monitored via SIL capable sensors and logic.

- The risk of tank rupture must be taken into account, especially if glass sight level monitoring tubes are used. These shall be replaced by magnetic level indicators, able to sustain an overpressure or a predictable external aggression.

- In order to avoid the over pressurization of the tanker, linked to the displacement of vapor from the vapor return line, the bulk tank pressure shall be limited to 0,2 to 0,4 bar maximum. The pressurization of the tanker, in conjunction to tanker valves failures or tanker gaskets failures, created projections and important leaks at the end of unloading, during the disconnection of the tanker.

- Pipework should be made by welding instead of threaded connections: threads represent a risk of leak and the usage of flanges shall be limited to a minimum. Pipes material: stainless steel 304 L is the most efficient especially if a risk of condensation appears under the insulation of the pipework. The pipe thickness is defined by taking into account the maximum pressure given by the transfer pump and the expansion of the organic liquids staying in a pipework if a difference of temperature appears along the pipework. Excess of pressures over 50 bar are frequent and can be prevented with an expansion tank, monitored and entering into a detailed Maintenance and Inspection Scheme.

- Each gasket must be approved for a contact with diisocyanates. This is of high importance knowing that only specific gaskets can resist to diisocyanates. In earthquake risks zones, the hanging of the pipework shall take this risk into account, in order to keep some flexibility of the pipework. In flooding risk areas, the submersion of the bund and the flotation of partially empty tanks shall be taken into account, by increasing the height of the bunds.

- In terms of pumps, the best in class solution consists in magnetic coupling pumps where the risk of leak is reduced for both unloading and transfer pumps. In order to avoid an over pressure induced by a sudden closure of a valve, associated to a concomitant failure of the internal safety relief valve of the pump, external safety relief valves are added as by-pass or to the pump. This solution has been made necessary by several incidents linked to crystallization of the internal safety relief valves.

- The storage building shall be protected from adjacent external fires. The best-in-class standard integrates two separate rooms, one for diisocyanates and one for polyols, with separate bunds, and both integrated into a fire-proofed compartment. A sprinkler protection is compatible with diisocyanates storage. No combustible storage or flammable storage can be allowed in the tank farm. The pumping station shall be located in a closed room, eventually integrated inside the tank farm: the risk of leak and vapors emission is always present at this point.

- The tank farm and the unloading bay are only accessible to authorised personel, adequately equipped with cartridge masks (RPE) and chemical suits if unloading or maintenance operations take place. Sampling of diisocyanates before unloading is not considered as an acceptable practice in terms of risks.

- Low or high temperatures shall be prevented. Heat-tracing and insulation of external pipework (and in addition to water-tight coverage), with SIL-rated temperature control devices can prevent crystallization and its counterpart, dimerization coming from an inappropriate heating of the pipes after crystallization.

- The pipework design is one key to prevent leaks: pipework can be made of stainless steel (L304 grade) or normal steel if the risk of external corrosion is negligible. Any opening shall be capped after use (blind flange). The plant shall keep Process and Instrumentation Diagrams updated at any time.

- Access at height should take place under safe conditions and the unexpected motion of the trailer should be considered. The appropriate solutions are:

    - Platform to access the top of the tanker.

    - Or usage of harness if the precedent solution is not applicable.

    - Wheels shocks, interlocked with access doors.

    - Or a system made of interlocked keys placed on the tanker brakes, unloading hoses and pumps start-up during unloading, and operating in a sequence which prevents human errors.

2.3 Day tanks and wet side rooms

Diisocyanates are usually transferred by pumps to day tanks, usually placed over the pouring booth or adjacent to this one. The pipework obeys to the same precautions as described before. From the day tanks, the liquids are pumped successively through low and high pressure pumps (equipped with magnetic couplings) to the pouring head. Between both pumps, on the pouring head feeding line, a heat exchanger maintains the correct process temperature.

To prevent some residual risks, some modifications should be introduced to standard day-tanks found on the market, as follows:

- The day-tanks feeding valve shall be connected to a safety system made of a safety high level sensor (totally independent from the process), a logic solver and one or two feeding valves. This chain must be SIL-rated. The valves shall be equipped with position sensors to act onto the return loop of the logic solver. Whenever feasible, the logic solver shall act onto the day tanks feeding pumps, as well as on the intake line, to prevent overfilling should a valve fail in partially opened position. The SIL level to be achieved depends on the risk assessment.

- Vertical sight glass shall be replaced by magnetic level gauges more resistant to external aggressions or to an overpressure.

- The safety relief valve (SRV) or the bursting disks placed on top of the day-tanks shall be interlocked with the pumps and trigger an audible and controlled alarm. The outlet of the SRV shall be connected to an exhaust, (and not to a pipe collecting different day tanks together, and NEVER to polyols day tanks). There should be a glass sight placed between the outlet of the SRV and the exhaust, in order to detect a possible condensation or liquid ingress inside the pipe.

- The diisocyanates pressure on the line going through the heat exchanger shall always be higher than the pressure of the cooling system: if an internal leak occurs inside the heat exchanger, the runaway chemical reaction takes place in the water or oil stream, with an excess of water or oil, able to limit partially the consequences of a runaway chemical reaction. The media can be based on oil or water: in this last case, an efficient inspection scheme shall take place to detect a failure of the heat exchanger at a very early stage. The heat exchanger should be brazed, allowing more resistance to internal leaks.

- In case there is a wet-side room the floor shall be bunded. The wet-side room shall be fully enclosed and ventilated. Access shall be secured and allowed only for some approved operators. The Tank Farm storage area needs to be bunded.

- Diisocyanates continuous monitoring is necessary in the tank farm, in the unloading bay and wet-side rooms. The monitors should be centrally controlled and trigger an immediate reaction even if only the first level of detection is reached.

- All Safety Barriers described for day tanks and wet-side rooms must follow the same tests and inspections schemes as described for bulk tanks.

3. Unloading and storage of other chemicals

The precautions which apply for polyols storage are less stringent. There is no need to develop this part here, with one exception. Transportation and deliveries of polyols can be made with multi-compartments tankers, in which diisocyanates and polyols can be transported by the same truck. In such a case, the diisocyanates are stored after an empty compartment and never along any other polyols compartment. The risk of confusion during filling or labeling of the compartments is high, leading to a possible accidental mixing of diisocyanates and polyols.

The release agents are made of combustible or flammable solvents. A dedicated fire resistant room must be used for storage and/or pumping. Grounding, exhaust, bunds, and equipment approved for contact with flammable liquids are some basic precautions. The entire pipework used from release agent distribution must be entirely grounded and labeled.

Catalysts and additives are transported in drums or IBC. Usual precautions apply here as well. Storing toxic catalysts with flammable release agents or solvents must be avoided.

4. Blending and formulation

Blending applies only for the polyols added to catalysts and additives. Some catalysts are corrosive and may present a risk of respiratory tract irritation or sensitization. Furthermore, some additives are combustible or toxic for the environment. Therefore, during pumping and manipulation, air emissions should be reduced to a minimum by the usage of closed batches, efficient local exhaust ventilation and air balance, and seals placed on top of the drums during pumping.

If the catalysts are pumped out of a drum placed vertically, the exhaust tube shall be cleaned after use and stored in a well-ventilated area.

In case there is a dedicated blending room it must be installed in a bund. The precautions usually applied for chemical usage are applicable here as well.

III. FOAM PRODUCTION and SAFETY MANAGEMENT SYSTEM

This chapter is the core of these guidelines. Starting from a number of definitions, it describes essential elements of a Safety Management System. Examples of different methodologies and concrete risks are given here below and in the annexes.

1. Risk Assessment

As a minimum, Risk Management should ensure compliance with the Seveso Directive and local transposition provisions and that all precautions are taken to prevent incidents. Its purpose is the application of management systems and controls (programs, procedures, audits, evaluations) to manufacturing or chemical processes in such a way that process hazards are identified, understood, and controlled, so that process-related injuries and incidents are prevented.

Each plant needs to identify (a) person(s) responsible for the process safety standard at the facility. This person shall directly report to the executive management at group or plant level and not be depending on any other department. It is recommended that this person is skilled in Process Safety and/or Health and Safety and Environment.

DEFINITIONs OF TERMS USED IN THIS SECTION:

Controls: Measures that eliminate or reduce the risk to an acceptable level

Harm: Physical Injury and/or damage to health, property or the environment (or damage)

Hazard: Potential source of harm, with a high probability of occurrence.

Hierarchy of controls: The order in which controls should be considered when selecting methods of controlling a risk, usually based on the efficiency of the safety barriers.

Likelihood or Probability: The chance or the probability of an event occurring over a certain period of time. This is not the same as frequency or exposure.

Process safety: This term generally refers to the prevention of unintentional releases of chemicals, energy, or other potentially dangerous materials (including steam) during the course of chemical processes that can have a serious effect to the plant and environment.

Risk: A combination of the probability of occurrence and the severity of harm (health, property or the environment)

Residual Risk: Risk remaining after protective measures have been taken

Risk Assessment: Overall process comprising a risk analysis and a risk evaluation. Risk assessment is made by the usage of an approved quantitative risk assessment method, like LOPA (Layers of Protection Analysis), Bow Ties, or HAZOP (Hazard Operability Study).

Risk analysis: Combination of the specification of the limits of the machine, hazard identification and risk estimation

Risk estimation: Definition of likely severity of harm and probability of its occurrence

Risk evaluation: Judgment, on the base of the risk analysis, of whether the risk reduction objectives have been achieved

Risk assessment process: Any activity involving a highly hazardous chemical (for ex. TDI/MDI or flammable release agent) including using, storing, manufacturing, handling, or moving such chemicals at the site, or any combination of these activities.

Safety Barriers: Safety Barriers are any technical installation or any human intervention able to either reduce the likelihood of a risk and / or reduce the severity of the consequences.

SIL (Safety Integrity level): SIL is defined as a relative level of risk-reduction provided by a safety function, or to specify a target level of risk reduction. In simple terms, SIL is a measurement of performance required for a safety instrumented function (SIF).

In the European functional safety standards based on the IEC 61508 standard four SILs are defined, with SIL 4 the most dependable and SIL 1 the least. A SIL is determined based on a number of quantitative factors in combination with qualitative factors such as development process and safety life cycle management.

SIF (Safety Instrumented Function): The specific control functions performed by a SIS (see below).

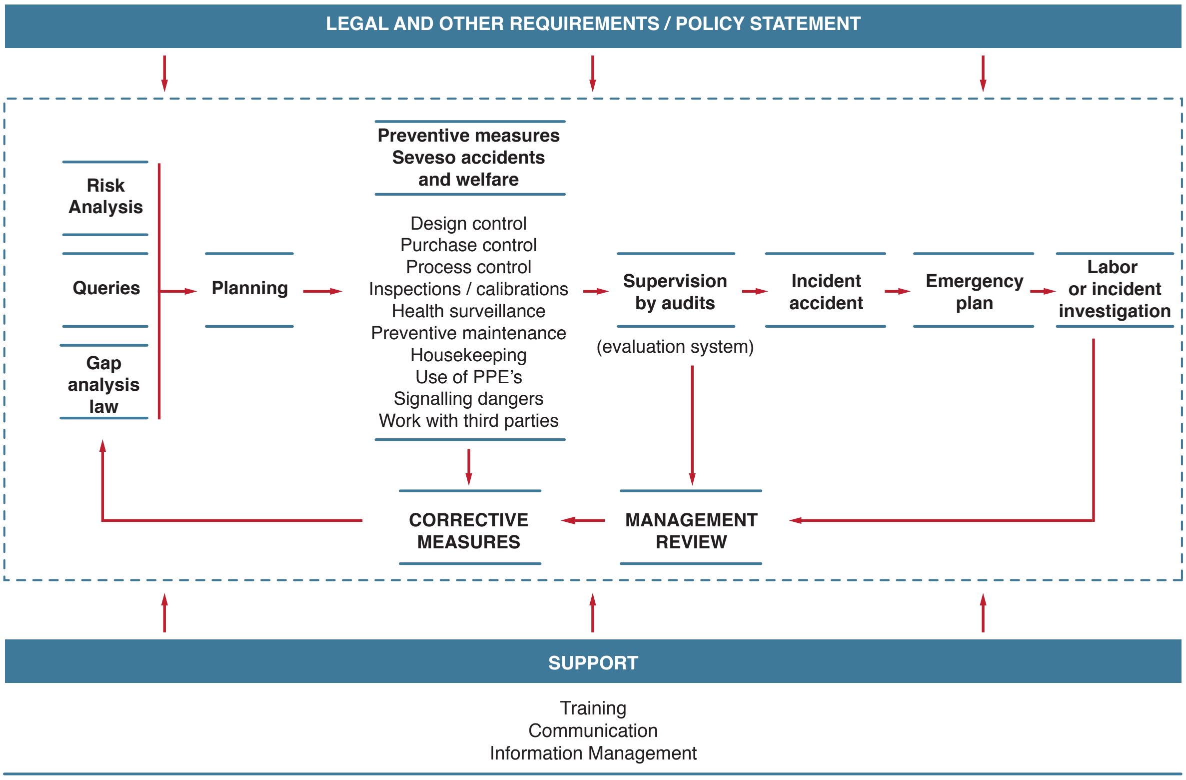
SIS (Safety Instrumented System): SIS consists of an engineered set of hardware and software controls which are used on critical process systems. A SIS is engineered to perform “specific control functions” to failsafe or maintain safe operation of a process when unacceptable or dangerous conditions occur. The SIS must be independent from all other control systems that control the same equipment in order to ensure SIS functionality is not compromised. SIS is composed of the same types of control elements (including sensors, logic solvers, actuators and other control equipment) as a Basic Process Control System (BPCS). However, all of the control elements in an SIS are dedicated solely to the proper functioning of the SIS. This is an important component of safety barriers.

1.1 Underlying principle

- The risk assessment is the starting point of a Safety Management System. Its aim is to define the most efficient actions and methods to reduce risk to its lowest value as described hereunder.

- For that purpose, the risk assessment shall take previous incidents, near misses and accidents into account. It must be implemented under the responsibility of a Risk Assessment Team.

The process model below shows the elements of risk assessment



1.2 Process Risk Assessment

1.2.1 METHODS

Risk assessment has to be performed on all installations that contain TDI/MDI or toxic and harmful chemicals or flammable chemicals according to a method supported by local authorities.

One or more of the following quantitative methods, as appropriate, can be used to determine and evaluate the hazards of the process being analyzed:

- What ifs,
- Bow Ties,
- Hazard and operability study (HAZOP)
- Failure mode and effects analysis (FMEA),
- Fault tree analysis,

B. PROCESSES

They are preferred to other methods (qualitative or semi quantitative methods) because the latter do not provide the same level of confidence as they do not integrate safety barriers.

Risk assessments analysis is best performed by a team with expertise in engineering and process operations, including at least one employee who has experience with and deep knowledge of the process being evaluated. Also, one member of the team must be knowledgeable in the specific analysis methods being used.

At least every 5 years the process hazard analysis should be updated and revalidated by a team meeting the above requirements to ensure that the hazard analysis is consistent with the current process. This update is requested after an incident.

- The results of the risk assessments are made visible and known to all affected people. "Made visible" notably means integration into training, training evaluation and up and down communication.

- The risk assessment focuses on usual working condition but also on each foreseeable abnormal condition or non-routine operation. It integrates the risk of human failures as well as the risk of organizational failures, through a specific assessment of critical tasks.

1.2.2 LEGAL COMPLIANCE (COMPLIANCE REGISTER)

- Compliance with existing legislation must be a given. The starting point is to list all relevant regulations (national and EU regulations) applicable to the plant with regards to health, safety and the environment. These applicable regulations should be listed in a compliance register, stating which provisions are applicable / non-applicable and assessing compliance with the applicable provisions. In case of identified non-compliance, an action plan should be drawn up to urgently remedy to this situation.

- Upcoming regulations are analyzed at an early stage, ideally before their adoption and in any case before their entry into force in view of ensuring compliance when they become applicable.

- However, compliance with existing legislation is not necessarily sufficient to prevent all risks and that is why more steps needs to be included into the risk assessment as outlined below.

1.2.3 SAFETY OBJECTIVES AND OPERATIONAL PLAN

- Based on the outcome of the risk assessment, on a yearly basis, safety objectives should be defined and distributed. The Plant Manager and the plant staff are responsible of the integration of those objectives into the plant's operational plan, that defines the main actions to be carried out during the coming year.

1.2.4 THE MAJOR ACCIDENT PREVENTION POLICY (MAPP)

The Major Accident Prevention Policy (MAPP) is a requirement deriving from the Seveso Directive, also for lower tier establishments. In itself, it does not need to contain a detailed prescription of the safety management system but must as a minimum focus on a certain number of chapters listed in Directive 2012/18/EU and the legislation transposing that Directive in various Member States, as outlined below.

- The Plant Manager is responsible of preparing and signing off the MAPP based on the legal compliance assessment and the risk assessment. Thus, he must integrate the obligation of compliance to regulations, the continuous improvement of the system, a clear statement for major accident prevention, the date and signatures of the management team.

- The MAPP is posted throughout the plant, distributed effectively and explained to the work force and to contractors. It contains the basic principles of major accident prevention, defines meaningful objectives, makes a clear link between the objectives and the yearly program. The MAPP must be kept up to date and the actions it entails be followed-up through management meetings.

- The MAPP should integrate all Safety and Environment Policies in one document.
- The actions described in the Policy are the main targets of the yearly Program.

1.2.5 UPDATE QUANTITATIVE RISK ASSESSMENT

- Risk assessments are updated quantitatively by taking into account actions taken as well as results of analysis taking place after any incident.
- The final risk is then quoted again and, logically, should have been reduced to a lower probability and / or a lower severity (or both) as a consequence of the actions taken, in order to reach an acceptable level of risk.
- If the risk reduction achieved is not compliant with the expected result, an analysis is conducted to understand the reasons for the failure and the validation process must be started again.
- The quantitative risk assessment should be linked to all other schemes and programmes having and influence on health, safety and the environment, such as the maintenance scheme, operational controls, training, communication, accident and incident evaluation and corrective actions, permit-to-work, operational plan…

2. Process and Utility Hazards

2.1 Risk assessment for foam production

The points below list a number of items that must be considered in a risk assessment for PU foam production. It can be read in conjunction with Annex 3 that gives an overview of the main risks existing in a PU foam plant (see also point 2.2 in this section).

2.1.1 RAW MATERIALS

- Combustible or flammable liquids must be closely controlled within the legal limits and placed in an appropriate compartment, especially if the risk of fire may have an impact on diisocyanates usage or storage. This risk must be either prevented or controlled. Good practice consists a fire-proofed compartment for the bulk storage of diisocyanates, and the usage of metal bulk tanks. A sprinkler protection can be an option as well.
- These risks must be prevented:
    - Delivery of wrong materials, which can be prevented by appropriate means of products controls before ordering and unloading.
    - Raw Material entering into the wrong vessel creating a risk of runaway chemical reaction. This can be prevented by using specific coupling and flanges (as described in the ISOPA standard) and strict unloading controls.
    - Spillage or raw material entering to the sewage system. Unloading bays and storages must be bonded, with a capacity equal to the maximum volume stored.

All other precautions described in this document in the corresponding chapter must be applied as well.

2.1.2 FOAM MANUFACTURING (SEE ALSO PRECEDENT CHAPTER)

- Pumps and metering systems must be controlled, so that formulation is respected.

- Hot formulations must be avoided. Hot formulations are foam formulations (polyether-based formulations) in which the temperature can reach 165 °C. Above this, spontaneous combustion may take place. Only frequent temperature measurements can prevent the occurrence of a fire. In addition, very stringent precautions must be applied in order to prevent the dispersion of toxic vapors in such a case.

- Start-stop and intermediate blocks must be stored and monitored in a safe way (fire resistant compartment and/ or additional fire protection). The blocks are stored in such a way that a free space is maintained between each block, and this storage condition is maintained up to 24 hours (this time may vary, depending on the results of a risk assessment). Compression of foam due to mechanical problems may also result in high temperatures during production /curing: this may be prevented by an appropriate design.

- Process safety Indicators may be used to monitor the effectiveness of the appropriate precautions.

2.1.3 CURING

- Fresh foamed blocks should be stored in a curing rack for 24 hours before use and at least a space of 5 cm must be kept between two adjacent blocks in order to release the internal heat of the block. A best practice would be either to locate this storage away from any other building or to install a deluge sprinkler protection in this building.

- Compression of foam due to mechanical problems may also result in high temperatures during production / curing: this can be prevented by an appropriate design.

2.1.4 STORAGE OF FOAM

- Blocks should only be stored in designated areas

- The amount of foam stored and the storage height should be according to the design of the warehouse sprinkler system (if equipped with sprinkler)

2.1.5 CONVERTING AND CUTTING

- Cutting machines must be protected in such a way that the blade cannot be accessed during the process.

- Dust capture and exhaust (LEV) shall be installed with a sufficient capture velocity in order to capture the emissions of the block, in line with legal limits (the EN14886 standard may help designing such equipment). This area is potentially explosive, depending on the particulates diameter, concentration and the ignition risk. A specific risk assessment must evaluate this risk and must define the corresponding precautions. The personal should be adequately trained, including maintenance operators having to modify or repair the explosion-proofed equipment.

2.1.6 INSPECTIONS AND MAINTENANCE

A thorough Maintenance plan must be prepared, in which all Safety Barriers and Critical equipment are listed, with the inspection frequency, the method of inspection, the expected result, and all possible deviations which must be addressed. The aim of such a plan is to detect all foreseeable deviations before they become critical in terms of risks.

2.1.7 OTHER RISKS

Some other risks have to be addressed and integrated into the risk assessment:

- Hydraulic systems (risk given by pressurized equipment),
- Technical Gases (depending on their intrinsic risk)
- Dust and static electricity which is common in block production and cutting section due to friction on an insulating material.
- Battery loading station, as an example, to cite only a few.

The general precautions described in this guideline do apply as well without any difference between block and moulded foam production.

2.2 Process and risk management for foam production

Once a risk assessment has been carried out, it serves as the basis for defining and implementing a safety management system. The following chapters focus on the core elements of risk management for a safety management system in a foam plant.

Annex 3 gives an overview of the main risks existing in a foam plant (possible hazards, their causes and preventive/protective measures), in addition to precautions needed to reduce the risks to an acceptable level. In the table, the cells highlighted in orange show the highest risks called “critical tasks” where a single human failure can lead to a severe accident. Most of the critical tasks are tied to non-routine operations. In addition to critical tasks, special precautions apply as well that do require reinforced trainings, in-depth maintenance and inspection schemes for example.

This annex contains a general part valid for both slabstock and moulded foam and there are tables also for specific risks relating to each of these production processes.

2.2.1 PROCESS SAFETY - OPERATIONAL CONTROLS

Operational control aim at ensuring that day-to-day actions are consistent with established plans and objectives for managing the risks identified under the risk assessment. They typically include items such as a preventive maintenance scheme, lock-out and tag-out, permit-to-work and authorizations, operation descriptions or standard operating procedure sheets for critical tasks.

Operational controls are under the responsibility of each affected manager, depending on their function. A role and responsibility matrix should be developed to supports this requirement.

Controls and corresponding documents should be established for all critical tasks identified in the risk assessment.

Internal work permits may apply if a task is non-usual and a non-routine task, and is presenting high risks. In such a case, a method statement might be needed in order to define all foreseeable risks in advance and define the equipment, method of work, trainings, and permits which might be necessary.

An important part of the operational control is based on mechanical integrity and inspection and should be documented in a maintenance schedule.

Critical process equipment includes:

a. Pressure vessels and storage tanks;
b. Piping systems (including piping components such as valves) and hoses;
c. Safety barriers and SIS controls (including monitoring devices and sensors, alarms, and interlocks);
d. Pumps.

Flexible Foam manufacturing sites should establish and implement written procedures to maintain the ongoing integrity of critical process equipment. Employees involved in maintaining the ongoing integrity of process equipment must be trained to have a deep understanding of that process and its hazards as well as of the procedures which are applicable to their tasks. These employees must understand the possible consequences of an incomplete inspection.

Inspection and testing must be performed on process equipment, using procedures that follow recognized and generally accepted good engineering practices. The frequency of inspections and tests of process equipment must conform with manufacturers' recommendations and good engineering practices, or where relevant by prior operating experience. If an inspection cannot be performed within the defined schedule the Site Manager needs to be informed in advance.

Each inspection and test on process equipment should be documented, identifying the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

Equipment deficiencies outside the acceptable limits defined by the process safety information should be corrected before further use, the information shall be recorded as well and used for risk assessment and shall result in a modification of the inspection frequency if needed.

Information on the equipment in the process should include the following:

- Materials of construction, and the justification of their choice.
- Piping and instrument diagrams (PID's),
- Electrical / pneumatic / and hydraulic design and its justification
- Ventilation system design,
- Design codes and standards employed,
- Safety systems and safety barriers design justification.

A planning of controls and checks (and all legal obligations and reporting), with dates and content is kept up-to date.

A gap analysis is done to define the training needs for the installation, maintenance and checks of the safety barriers.

The "maintenance scheme" document (example available in Annex 4 is used as an input for the inspection schedule.

The deviations seen during the implementation of the controls and checks are reported to site management.

2.2.2 INCIDENTS AND ACCIDENTS

Incidents and accidents are analyzed with a root cause analysis tool and reported. It is essential to verify that the accident was already described in the risk assessment, or, if not, that the risk assessment is updated accordingly.

Each incident or near miss that can lead to an accident (for people, the surroundings or the environment like a start of fire, leak, spill, lack in the procedures applicable to safety barriers, gaps in the safety management system...) is reported.

If an accident possibly affecting the surroundings, called a "major accident", occurs, the plant shall apply its emergency response procedure and seek for assistance through the Isopa Mutual Assistance Scheme, as described in the chapter "emergency response".

Each incident is analyzed with the fault tree tool, "5 why's tool" or any equivalent where the deviations linked to structural and organizational failures can be discovered and corrected. Site management is in charge of collecting the incident report, to prepare and distribute. The plant is in charge of implementing the recommendations.

2.2.3 NEW INSTALLATIONS / SPECIFICATIONS

Each new installation or major modification having an impact on a risk, must be defined by written specifications (new plants and buildings, machines, safety instrumented systems, safety barriers, storages, blending, sprinklers, modification on plant roof / walls, extensions, demolition…). The implementation of these specifications is under the responsibility of the project management team.

If an installation is not described in existing specifications, the project Team including HSE shall be consulted in order to prepare the needed specification.

2.2.4 PRE START-UP CHECKS

Pre start-up checks are under the responsibility of the Project Manager. A double check is carried out by engineers and an HSE Manager when appropriate (for critical tasks mainly).

The checks cover:

- A document review : instruction notice, risk assessment, drawings, specifications, applicable norms and regulations,
- The accuracy of the documents with the existing installation.
- The accuracy between the specifications and the installation.
- The testing of safety systems, with a focus on the reliability under different abnormal conditions (such as for example: lack of energy, inter dependency with the process, evaluation of the worst response time, efficiency after communication failure, tests conducted under the upper and lower acceptable limits).
- An audit of the corresponding trainings and instructions.

A complete specific (=with a detailed instruction and procedure) pre-start-up check is conducted for each installation decommissioned and re-commissioned. Simple calibration cannot be considered as sufficient for re-commissioning.

2.2.5 LOCK-OUT TAG- OUT (LOTO)

The HSE manager and the relevant manager are responsible for the strict application of a LOTO standard.

LOTO is a safety procedure to ensure that machines with a specific risk are properly shut off and not started up again prior to the completion of maintenance or servicing work. It requires that hazardous power sources be isolated, all energies released and rendered inoperative before any repair procedure is started. LOTO works in conjunction with a *lock* usually locking the device or the power source, and placing it in such a position that no power sources can be turned on. The procedure requires that a *tag* be affixed to the locked device indicating that it should not be turned on.

The installation is brought back to operation by using the inverse procedure and commissioning checklists.

Comprehensive permit systems must be developed for the following (list not exhaustive)

- Hot work.
- Confined space entry.
- Critical tasks.
- Working on ATEX installations.
- Working on any safety barrier.
- Working on chemical pipework, tanks and installations.
- Electrical installations.
- Work at height.

2.2.6 DECOMMISSIONING

The Project Manager is responsible for requesting the specific HSE instructions needed before decommissioning equipment and for applying them. Decommissioning is done after a specific risk-assessment and the preparation of a method statement.

Decommissioning shall be done by positive isolation only (the equipment is totally removed).

2.3. Change Management

2.3.1 AIMS & OBJECTIVES

Change management relates to the identification and management of any potential safety, health, environmental or business risks associated with change. This includes changes to aspects of operations such as site arrangements, plant, equipment, buildings, processes, procedures, organisational structure, fire protection, etc.

Changes may be physical or operational, temporary or permanent, and must be assessed in a manner which ensures that all safety aspects have been thoroughly examined, reviewed, documented and implemented, in order to preserve the safety of personnel, plant facilities and the general business.

It is important that safety is not put at risk by initiating significant change without due consideration of the potential hazards. Suitable procedures for the management and control of any modifications are therefore necessary that reflect the degree of likely risk and complexity of the proposed change.

All initiated significant changes must be adequately defined, documented, registered, implemented and subjected to a reasonable review, risk assessment and approval process and ensure that plant, process and other relevant records are updated to reflect changes made.

Adequate and timely consultation with any external authorities, statutory bodies or consultants who need to be involved in the change process must take place e.g. local authorities, regulators, building & planning permissions, insurers, emergency services, specialist consultants / contractors, etc.

Depending on site specific circumstances and the nature of any change, additional controls may be required as identified by stakeholders (e.g. local management, group risk management, competent authority, insurer, etc), to reduce risks to an acceptable level for life, environment, property and business.

2.3.2 TYPE OF CHANGE:

The type(s) of change(s) that are taking place must be correctly identified. The type of HSE review can be tailored to the most appropriate issues that the type of change is likely to create, and thus make the assessment of the change more efficient and targeted.

Risk assessment and effective arrangements for the management and control of any modifications and changes implemented at any site facility represent a fundamental part of good health and safety practice. To be fully effective, the responsibilities of everyone involved in instigating, assessing and implementing changes required should be clearly understood and followed.

As such responsibilities should be allocated at each site in order to nominate the list of responsible and competent persons who will be authorised to initiate, review, approve/authorise, and complete modifications. In general technical and or production managers are most likely to initiate modification requests with more senior site production, engineering, HSE, technical personnel involved in the review and authorisation of change. No person may initiate and review or authorise a level 3 or 4 modification/change.

The degree of change determines the level of review required. Changes are categorised in accordance with the degree of change into one of four types. For each level of change a specific tailored level of HSE review should be considered as appropriate.

- Level 1 approvals will be simple and basic with a maintenance request or similar acting as the initiation and sign off by a competent engineering / production management person acting as review/authorisation and closure.

- Level 2 approvals will be similar however a minimum written record is required to indicate that the change is considered suitable, will not affect HSE materially and the written record will include actioning any necessary records to be updated as required

- Level 3 and 4 changes will require a detailed written assessment including risk assessment revision. Development and use of checklists for each change type is recommended covering a broad range of issues. Marked up records such as procedures, drawings etc. should be included.

When considering level 3 and 4 changes the main points to consider are:

- Completing an appropriate Change Management request and assessing the appropriate level of safety, health and environmental review required.

- Ensuring reviews conducted are sufficiently wide ranging to identify foreseeable hazards.

- Changes are reviewed and authorised by appropriately skilled and knowledgeable staff.

- Tracking of the status of the change and ‘Handover’ of a completed change by the initiator.

- Monitoring the performance of the system.

- Auditing the management of change system.

Change management reviews need to be completed and approved before the execution of any modification or change. For a large project this process should be started before the capital request stage.

When all work associated with the change is completed, including update of documentation and maintenance records, a written record is required to confirm the work is complete, including all appropriate record updating, that modified maintenance regimes are in place etc.

For level 1 changes closure of work orders is sufficient, for level 2 changes an informal change management tracking system is sufficient but for level 3 and 4 changes a clearly documented and auditable Management of Change (MOC) status tracking system should be in place.

When large sections of new plant have been installed then a pre start up HSE review should be conducted and documented before commissioning can take place. The review will verify that the plant is fit for purpose and complies with all appropriate aspects highlighted in design/construction phase HSE reviews.

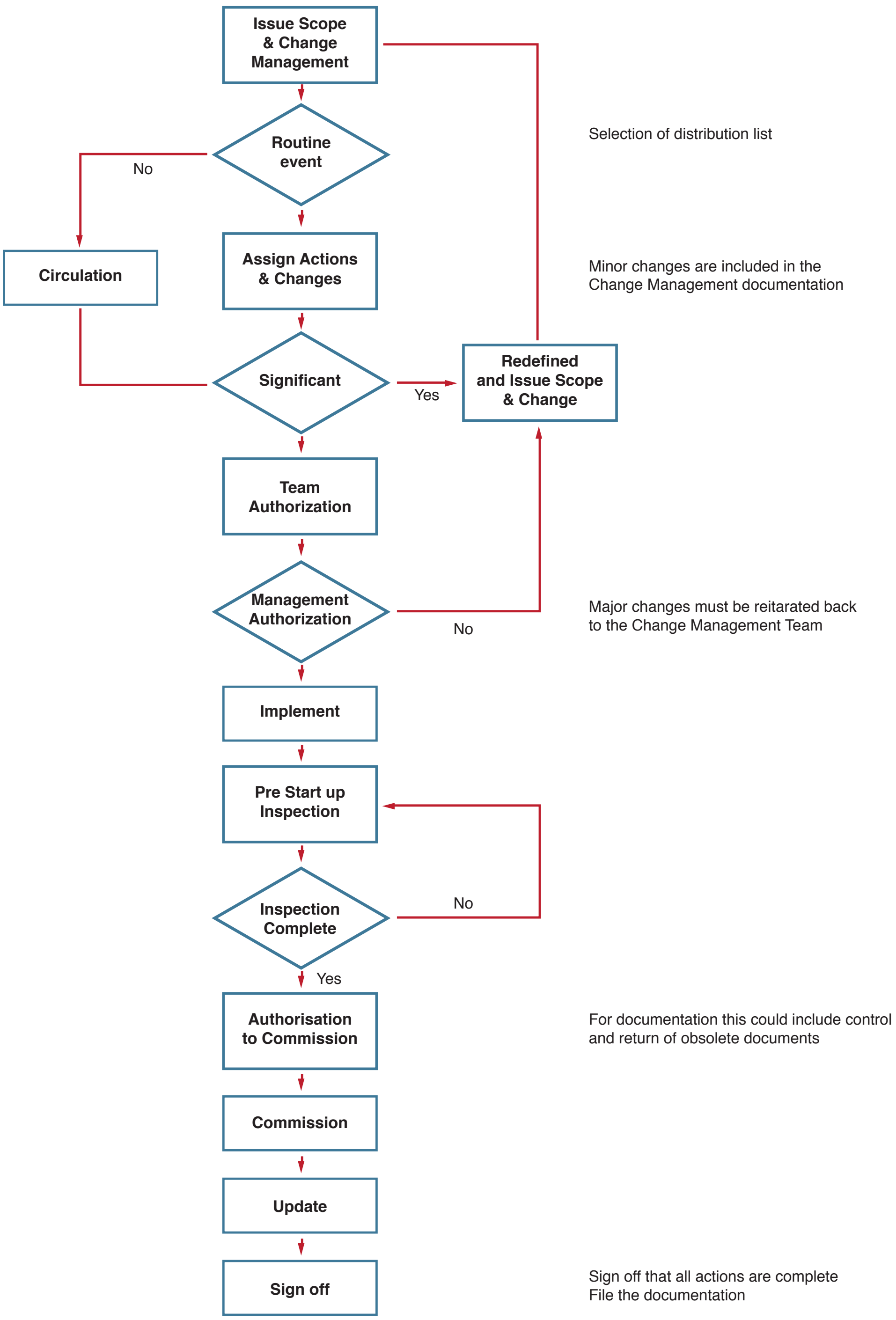
For major projects a Change Management, form is to be completed for the entire project, which will generally indicate the need for a detailed risk assessment/safety studies such as HAZOP (or other) for significant changes on high hazard installations. A modular approach should be adopted, as the Change Management assessment should also consider different safety issues to that of a HAZOP; e.g. access and layout.

The following are amongst the elements suggested for an effective Change Management review:

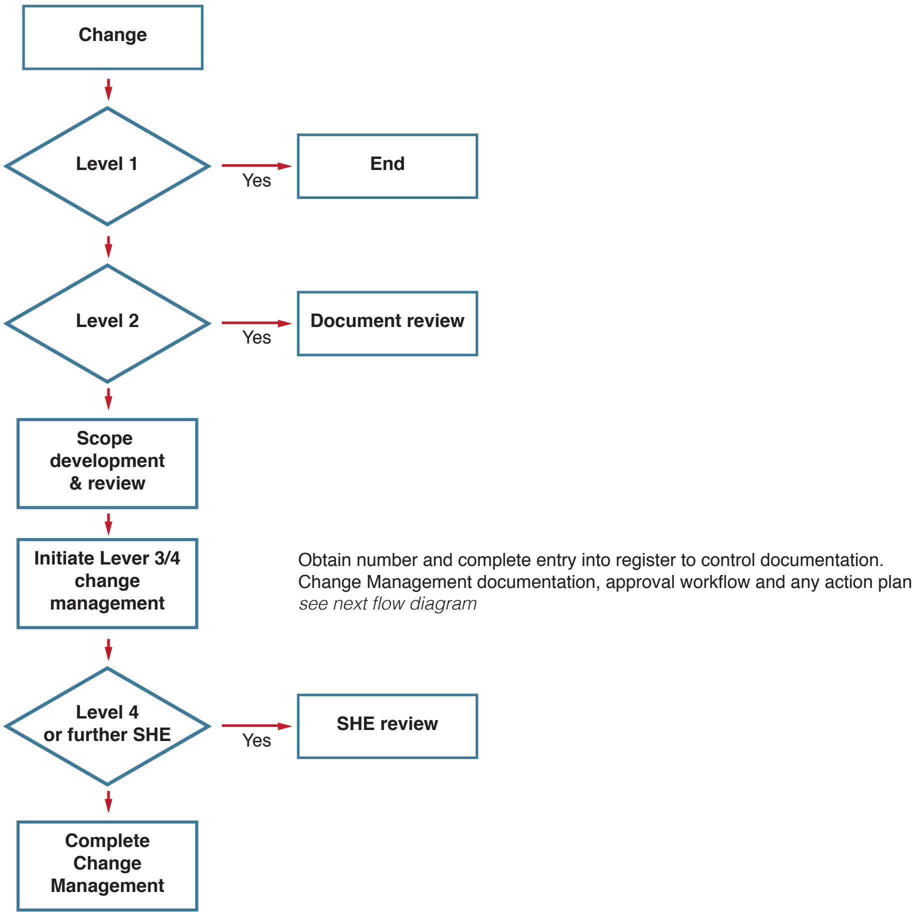
- Control and instrumentation
- Civil and structural factors
- Electrical & Instrumentation
- Human factors
- Fire and explosion review
- Process safety changes
- Safety equipment and PPE
- Mechanical Integrity
- Maintenance/Maintainability
- Functionality e.g. tank farm, offloading, etc.
- Constructability
- Optimal use of floor space

The use of any non-routine or temporary equipment/procedures to complete a change or maintenance task should be covered by a permit to work system.

Change Management Procedure flow chart Level 3 or 4 changes



Change Management Overview flow chart



2.3.3 AUDITING AND REVIEWS

In addition to external audits, the Change Management procedure should be internally audited at least once every two years for High and Medium Hazard processes. The audit will:

- Focus on compliance with the procedure both in the completion of documentation and in its application to changes on site.
- Verify that personnel operating the Change Management procedure are competent.
- Consider if Change Management HSE review are conducted in sufficient detail and change complexity is being appropriately allocated.
- Ensure actions arising are completed in a timely fashion.

Copies of the audit will be filed and held for at least 3 years.

2.4 Communication

External communication with authorities related to emissions and major risks should be approved by experts prior to distribution. It is placed under the responsibility of the Plant Manager.

A register of communications with authorities should be kept up-to date and includes: date of documents received, author, answer timeline, checked when/ by whom, answer date, action plan reference per item.

A specific emergency communication procedure must be set up to prepare for exceptional situations. This should as a minimum – and for each foreseeable type of emergency - define procedures for channeling information with regards to the emergency towards a central communication team. This team, with adequate expertise on the type of emergency encountered and in close cooperation with the emergency response team (see below), is then responsible for relaying the information both inside the company and for communicating with Third Parties.

2.5 Emergency response

The Site Manager and the HSE Manager are responsible for the organization of the Emergency response. The emergency response is based on a document in which all scenarios are evaluated, described and the corresponding actions defined.

A best practice for emergency response scenarios can be described as follows:

- All possible types of emergencies with corresponding scenarios (fire, leak of chemicals, gas leak, flood…) are identified and allocated to trained and experienced managers.
- Each manager, once called, uses a simple summarized document relating to the type of emergency that occurred (short checklist) to start immediate actions. These checklists are made visible on emergency response boards.

The main principle is that tasks are not affected to any specific manager but to anyone who has been trained to deal with the type of emergency that occurred. The term “manager” in the above paragraph does not refer to the Plant Manager but to the first manager on site when the emergency occurs. This manager then takes the lead and distributes roles to others, one after the other.

All managers are trained once a year on emergency response and each new manager within the first weeks after his arrival. A yearly exercise with evacuation exercise and the participation of fire brigades / local HSE authorities is realized and analyzed.

The neighbourhood is informed when an exercise is planned and is invited to participate if they are subject to the risks.

The emergency response plan is updated after each change and reviewed once a year.

Each emergency response exercise or real application is evaluated in order to learn from the possible deviations seen.

2.6 Training and Competency

Each PU foam plant needs to identify (a) person(s) responsible for HS&E Training Programs at the facility. The objective of such trainings is to provide appropriate Health, Safety and Environmental information and knowledge to all employees (including relevant risks) and to comply with legislative requirements.

Each new manager at plant level or in central functions (plant manager, finance, human resources, maintenance, engineering, HSE, logistic, production, R&D…) has to follow a complete HSE training session during the first month of his arrival. Focus is given on possible impacts of major accidents, the risks at plant level, the safety barriers and the safety management system and its importance, roles and responsibilities.

Each facility shall complete a site-specific training needs analysis, based on legal requirements, on the results of risk assessments and critical tasks identification.

The training needs are evaluated as defined in the training matrix and in the responsibility matrix, including the responsibility of the department and the HSE manager. Their focus should be the prevention of the risk of human error.

The training efficiency is evaluated in terms of increasing competency / organizational improvement / risk reduction.

The training matrix or Needs Analysis shall include as a minimum:

- Roles of staff and the knowledge needed to perform their tasks.
- Training Topics (content) and detailed competencies to be acquired.
- Target Audience.
- Frequency of the Training.
- Responsible person for delivering the training and his competency (in the subject, and as a trainer). When the trainer gives a training on the topic for the first time, he shall be evaluated on both points before the training.

Annual training for relevant staff is required for the following topics:

- Emergency procedures (evacuation).
- Control of Hazardous Energy (Lockout) for authorized employees.
- All Critical tasks.
- Interventions on Safety Barriers.
- On-the job trainings for each workstation.
- Specific trainings (chemicals, safety awareness, forklifts, cranes, electricity etc.)

Based on the Training Needs Analysis, an annual training schedule shall be developed. All training shall be delivered in accordance with the established training schedule. Attendance at each training session will be documented and tracked against the annual training schedule to ensure that no-shows are identified and re-scheduled for later training sessions.

A training session shall include documented evidence that the training is understood for example through multiple choice questionnaires to be completed or by a review of the training topic with the trainer.

Orientation training will be conducted for all new and temporary employees prior to commencing work. Content of HSE orientation training will include the following:

- Review of corporate HSE policy
- Plant safety rules, including internal work traffic Management
- Emergency response
- Job safety analysis
- Hazardous substances (hazards from TDI, MDI…)
- Accident/Incident reporting requirements
- Awareness on work equipment safety
- Awareness on control of hazardous energy (Lock out Tag Out)
- Waste and energy management
- Awareness on confined spaces

Based on the function and responsibilities of the new temporary employee, a detailed training scheme shall be developed for the function in coordination with responsible HSE staff. The training shall be delivered and tracked against the scheme by the responsible superior of the new or temporary employee.

Example of a training matrix: see attachment in Annex 5

2.7 Resources

The allocation of resources needed for the HSE tasks is defined at plant level per department, under the Plant Manager's responsibility.

The budget preparation integrates the resources needed to keep the efficiency of the Safety Management System: input is given per department. Budget restrictions having an impact on the efficiency on the safety management system are evaluated prior to any decision. The allocated resources are entering the yearly program.

2.8 Audits

The auditors are in charge of defining the audits frequency and applying the corresponding audits guidelines and instruction:

- At plant level, by each affected manager and HSE, once per month in his area of responsibility, or better, with cross-audits in another department.
- At least once a year by experts in process safety. The audit must focus on all countermeasures in place to prevent an accident, reduce a risk, or limit the consequences of an accident, and reduce the accident consequences in a pro-active way. The audit must focus on the efficiency of the Safety Management System and not only focus on legal constraints.

2.9 Management review

Management review should take place at plant level:

- The safety management system is evaluated during regular reviews. Indicators and reported are presented by the HSE Managers and the content of the review is then described in a corresponding framework document.

- A Steering Committee is established that focuses on the main issues encountered in the application of the safety management system (please refer to section E).

C. MACHINERY

1. Risks

For all machinery that is introduced at the plant, a risk assessment shall be performed. Most of the European standards or Risk Assessment tools define a risk assessment method, based on the exposure, the risk avoidance, the severity and probability of the risk (see methodologies highlighted under "foam production").

Before undertaking a risk assessment, the user shall be familiar with the equipment, its functions, all foreseeable failures and the study shall be conducted for each function of the equipment.

The user shall only use the approved international or EU Standard.

The risk assessment shall be documented and discussed with the Joint Health and Safety Committee or the Steering Committee.

Before any machinery is put into place the project manager shall ensure that: A specific control of hazardous energy instruction will be developed and maintained for each piece of equipment or machinery that contains one or more forms of hazardous energy. The Lock-out Tag-out instruction must highlight the exact sequence of operations needed to release all energies (a general LOTO instruction is not sufficient). See also the chapter "Risk assessment" under "Processes".

A foam production line presents several specific risks which must be taken into account during the entire lifetime of the machinery. Wet-side rooms and day tanks are not part of this chapter (see chapter "storage"). The other risks like electrical risks, slips and falls, access at height or any risk which is not directly linked to the equipment are not described here either but should be taken into consideration using the manufacturer's manuals.

1.1A MECHANICAL RISKS FOR MOULDED FOAM PRODUCTION

Typical mechanical risks in moulded foam production are:

- Rupture of any element of the cassette supporting the moulds
- Failure of mould elements leading to a mould falling in the operators' area
- Unexpected motion of a moving part of a mould (usually triggered by a cylinder)
- Motion of the crushers (roller crushers or vacuum crushers)
- Moulds collisions or collisions with robots
- Robot motion (during teaching or during a flow test)
- Projections of hydraulics

It is a good practice to inspect the moulds, the cassettes and the carriers after each change or on a regular basis for high runners. The weakest points are usually the rollers, the swiveling arm below the bowl, the axis, the lid fixation, and cylinder shafts.

Failures consist in fractures or a risk of rupture due a high mechanical strength. The detection of such defects can be visual, or by non-destructive testing method, defined by a mechanical engineer.

Lids are secured by safety pins and eventually safety cables fixing the lid on the carrier.

The design of these parts must be made by experts, where the constraint applicable to the mould, the cassette and the carrier is simulated.

The risk are listed in the document in annex 6 "risk analysis for machinery".

1.1B MECHANICAL RISKS FOR SLAB FOAM PRODUCTION:

Typical mechanical risks in slabstock foam production are listed below. Most of the risks can lead to production shutdown, spillage or an increased risk of exothermic reactions:

- Foaming line failure
- Failure of paper / polythene fall plate / side wall linings
- Saw failure / broken blades / blades out of guide
- Compressed foam
- Failure of transfer gantries, overhead cranes, transfer conveyors, drive belts, motors, bearings etc.

It is important to have documented safe system of work for managing production start-up.

Personnel must be wearing suitable respiratory equipment, bump cap, safety footwear and hand protection and where at all possible, limit and / or avoid prolonged standing on the conveyor, travelling with the foam block until the start frames removed.

Most of the additional mechanical risks are from the movement of automatic handling of the foam. This involves the transfer long foam blocks from the production line into the curing area and then on to long block storage.

1.2 Risks linked to the chemicals used

1.2A CHEMICAL RISKS WHEN PRODUCING MOULDED FOAM PARTS

The typical risks deriving from machinery processing chemicals in moulded foam production are the following:

- Diisocyanates vapors emissions, and local exhaust ventilation failure;
- Miss-pour (injection of pure diisocyanates in a mould at 65 °C).
- Emissions of diisocyanates, solvents and / or aliphatic amines during pouring, release agent spraying, foam curing, and in crushers. The resulting risk assessment can be made by using expert judgment or specific tools (like ECETOX or any similar developed by the ECHA).
- Failure / rupture of pressure hoses on pouring robots.
- Cross contamination when contaminated tools and/or parts are being handled outside of the pouring box
- Manual handling of freshly moulded foam parts should ONLY be done with suitable chemical resistant gloves.

1.2B. CHEMICAL RISKS WHEN PRODUCING SLABSTOCK FOAM.

The typical risks deriving from machinery processing chemicals in slabstock foam production are the following:

- Access into the tunnel during and post running. This should be restricted and allowed only with the appropriate safeguards (confined space entry, LockOut TagOut procedure, extraction in place and operational, to cite only a few precautions).
- Start-stop operations (significant threat for risk of chemical contact)
- Replacement of PE and paper foils in between runs

1.3 Noise

Noise levels adjacent to the main pumps, mixing head or extraction can be in excess of 80 dB(A). In some cases in excess of 85dB(A).

1.4 Fire

1.4A MOULDED FOAM

The risk of fire is mainly due to the release agents and possibly the usage of electrostatic spray guns. In order to prevent the risks, some guidelines need to be followed. This is explained in the moulded foam production chapter.

1.4B SLABSTOCK FOAM

- Polyether based formulations with an exothermic reaction that exceeds 165° C are considered as a potential source of ignition. The storage conditions (24hours, in a dedicated area, spacing between blocks, fire protection installation) do apply.

- Possibility of uncontrolled exothermic reactions: This justifies the importance of a well-controlled formulation, where each discrepancy in the formulation imposes to not use the blend. The temperature must be controlled all along the process with alarms and interlocks.

- Blocks indicating temperatures above 165°C should be removed from the curing area.

1.5 Machinery Safety:

The design and architecture of the safety system are the most important aspects of machinery safety. For that purpose concepts such as SIS, SIL, SIF referred to in the chapter "risk assessment" should be considered. The entire safety chain (including emergency stops, nip gates, over-filling protection, interlocks...) should reach a performance level that is determined by the outcome of the risk assessment and standard EN 13849-1 on machinery safety.

This includes dual channel inputs and actuators, a feedback loop on the actuators and a safety logic solver, each component being approved as a safety component. This applies to 3 parts tools actuated via a cylinder as well.

The demonstration of the performance level achieved has to be made by the supplier and validated by the users.

MOULDED FOAM:

The positioning of obstacles along the production line, especially obstacles coming from the spray or pouring booths need a particular attention in order to keep enough space between the moving moulds and the obstacles. This spacing shall be calculated in such a way that it leaves enough space for a body part inserted between the moulds and an obstacle, once the emergency stop is triggered and the machine comes to a full stop. A full stop may take some seconds, this must be taken into account.

Access inside the moulding line during production must be totally prohibited. In rare cases, where a direct observation is absolutely needed, the following conditions have to be respected:

- The operator uses a control pendant, equipped with approved safety functions on which he should act continuously during the access inside the line. The line stops in an emergency mode if the pendant does not move for a certain time, remains horizontal, or if any key is released.

- The operator accesses the line after a full stop, and stays at a designated place during the entire operation, he is not allowed to move inside the line.

- He is always visible from a second operator placed at an entry point where an emergency stop is located.

- Both are trained and experienced in this operation.

SLABSTOCK FOAM:

There are a number of specific risks of relating to slabstock foam conveyors. Most are when the machine is being set up / running / and shutdown. The following tasks all require access near to, or with moving parts.

- Machine preparation / set up / shutdown.

- Polythene base and top: loading / take off.

- Paper rolls: loading / take off.

- Side polythene : take off.

- Paper take off.

- Trough handling / positioning / cleaning.
- Gate bar handling / positioning / cleaning.
- Machine (pump and nozzle equipment moving TDI to the foam pouring head).
- Toluene diisocyanate bulk storage, service vessels and associated pipework

To manage the risk linked to these tasks:

- Firstly, acceptable risk tolerability must be determined for the manufacturing site.
- Quantitative risk analysis has to be conducted (such as layer of protection analysis (LOPA), to determine safety device specification which, in conjunction with all other layers of protection built in to the system, offers a risk level which is lower than that accepted by the manufacturing site.
- This may mean that the risk reduction required by the safety device (or safety instrumented function – SIF) has to be one which has quantified, acceptable minimum failure rates. These are known as SIL devices.

1.6 Exhaust and ventilation

REQUIREMENTS IN MOULDED FOAM PRODUCTION

The production line is fully enclosed in order to allow a good capture of the emissions. Exhaust walls are placed behind the lids in demoulding stations, release agent spray booths, inserting and pouring booths.

The design of the exhaust is made in such a way that a minimum capture velocity of 0,5 m/s to 1 m/s is reached in a point located in the middle of the bowl. Compensation allows to enter an equivalent air volume compared to the volume extracted, with possibly heating or partial air cooling or air/ air heat exchangers.

Capture over operator's heads or behind the bowls is not an approved standard.

Crushers must be connected to an efficient exhaust. They must be fully enclosed and the inlet and outlets protected with nip gates to forbid access in the dangerous area.

In order to help the abatement of the Volatile Organic Compounds emitted in the release agent spray booth, specific ducting shall be installed for the spray booth. In this area and in the ducts going to the exhaust or to the abatement installation, the risk of jet-fire has to be taken into account. It is usually induced by electrostatic spray guns failure (contact with a metal part or an insert and an insufficient current decrease of the high voltage generator). Dust build-up present in ducts can then burn and spread the fire inside the plant or over the roofs.

Injection of water inside the ducts (i.e. sprinklers) has to be made carefully, to make sure that the water doesn't lead to ducts collapse under the water weight or to avoid water penetration inside the ceramics if a regenerative thermal oxidizer is used for abatement purposes (A large amount of water entering into contact with ceramics heated up over 900 °C may create a violent overpressure exceeding the exhaust fan flow capacity).

The exhaust air volume inside the spray booth must be calculated in order to keep the concentration of flammable vapors below 25 % of the LEL of the solvents (This dilution has NO effect on the risk of jet-fire).

The flash point of the release agents shall be as high as possible. The presence of metal salts in the wax shall be carefully evaluated, and metal salts substituted to less dangerous substances whenever possible.

REQUIREMENTS IN SLABSTOCK MANUFACTURING:

Critical items to consider are:

- Maintaining Positive / Negative set up of carbon bed that exhaust gases; regular maintenance of pressure necessary for efficiency.
- Pressure drop on the bed (refers to the carbon bed through which exhaust gases are extracte. If there is a pressure drop this can mean that the "bed" is becoming blocked and its efficiency is down. This can lead to increased fume levels within the plant. The same applies to maintenance of the bed.
- Balancing of the system / Fresh air input
- Closing of all doors / roller shutter doors.
- Extraction is required from pouring head to the cut off saw.

The manufacturing line is to be as enclosed as it can be made to be. This means all plant windows are closed when inspection is not taking place and any opportunities to create an enclosed environment at any stage between the pouring of the foam and the foam being cured.

Every foaming line will have significantly different sets of variables influencing the amounts and rates of TDI needing to be removed from the line (and ultimately cleansed through the abatement system) therefore, it is essential that TDI monitors are placed at all areas with a foreseeable risk of allowing free TDI to establish and confirm the suitability of the enclosure design. Where it is known that there is the potential for free TDI, appropriate respiratory equipment (RPE) must be worn in those areas. See TDI monitoring below.

The ventilation shall be interlocked to the production line main drive via pressure sensors: the line can't be started if the exhaust is not properly operating.

Ventilation being an essential safety barrier, maintenance, and tests and monitoring must follow strict instructions, rules, roles and responsibilities definition and audits.

*More details can be found in the document in annex 7 ventilation

1.7 Manual handling, Ergonomics and postures_

REQUIREMENTS FOR MOULDED FOAM PRODUCTION

The best practice consists in the design of the entire machinery: the moulds have an opening angle over 90°, in order to facilitate the access on the lids and in the bowls. The distance between the operators (and guards) and the extremities of the moulds shall be reduced to 700 mm.

Stairs can be placed in front of the work stations to allow an easier access to the lids for demoulding and mould cleaning: they must prevent the risk of fall and guarded whenever needed. The conveyor feeding the crusher shall be placed in the vicinity of the operator and easy to reach.

REQUIREMENTS FOR SLABSTOCK FOAM PRODUCTION

All of the following pose potential manual handling and ergonomic risk even with the assistance of hoists and other aids. Some operations may include some confined space working:

- Machine preparation / set up / shutdown
- Polythene Base and Top: Loading / take off
- Paper rolls: loading / take off
- Side polythene take-off
- Paper take-off
- Start / End block handling on trolleys
- Trough handling / positioning / cleaning
- Gate bar handling / positioning / cleaning

Access inside the line during production must be totally prohibited, except in rare cases, where a direct observation is needed.

1.8 Pouring heads and moulds closing:

MOULDED FOAM:

The usage of pouring robots drastically reduces the risk of direct exposure to diisocyanates during pouring and risks associated to manual handling. Closing robots are reducing the adverse effects of the repetition of manual handling.

Qualified Personnel Individuals who are familiar with the proper method(s) to check the functionality of equipment/ machinery safety. These individuals must know what to look for and what to do if a safety function fails.

SLABSTOCK FOAM:

The protocols for doing any preparatory, cleaning and / or maintenance work on the pouring head system on a slabstock foaming line must follow the operation's isolation procedures ensuring **ALL** forms of kinetic and potential energy are isolated / removed. This includes the ability to pour TDI and operate the high speed mixer.

2. Mechanical Integrity by Inspection/ Maintenance Scheme

Critical process equipment includes:

1. Pressure vessels and storage tanks;
2. Piping systems (including piping components such as valves) and hoses;
3. Relief and ventilation systems and devices;
4. Overfill equipment;
5. Emergency shutdown systems;
6. Safety instrumented system controls (including monitoring devices and sensors, alarms, and interlocks);
7. Pumps.

The site should establish and implement written procedures to maintain the ongoing integrity of critical process equipment. Employees involved in maintaining the ongoing integrity of process equipment must be trained in an overview of that process and its hazards and trained in the procedures applicable to the employee's job tasks (see also chapter 2.2.1 "process safety" under "Foam production").

Inspection and testing must be performed on process equipment, using procedures that follow recognized and generally accepted good engineering practices. The frequency of inspections and tests of process equipment must conform to manufacturers' recommendations and good engineering practices, or more frequently if determined to be necessary by prior operating experience or by the findings of the risk assessment. If any inspection cannot be done within the defined schedule, the Site Manager needs to be informed beforehand.

Each inspection and test on process equipment should be documented, identifying: the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.

Equipment deficiencies outside the acceptable limits defined by the process safety information must be corrected before further use.

In constructing new equipment, the site must ensure that equipment as it is fabricated is suitable for the process application for which it will be used. Appropriate checks and inspections must be performed to ensure that equipment is installed properly and is consistent with design specifications and the manufacturer's instructions.

Information on the equipment in the process should include the following:

- Materials of construction
- Piping and instrument diagrams (PlDs)
- Electrical classification
- Relief system design and design basis
- Ventilation system design
- Design codes and standards employed
- Safety systems (e.g., interlocks, detection or suppression systems)

All machinery and its associated equipment is inspected on a regularly basis as defined in a maintenance scheme, in which the content of inspections and tests, the possible failures that may occur and the way to perform the inspection is precisely described. A list of non-acceptable deviations shall be integrated as well.

The maintenance scheme shall develop the actions needed if a failure is detected, empowering the operator to stop the equipment if needed.

All safety components must be inspected on a regular basis, this according the recommendations of the manufacturer or more frequent if necessary according the findings of the risk assessment and the Mean Time to Failure of the equipment. The inspection report should be signed off by the inspector. Any remarks must be immediately reported to the Maintenance Manager.

On PUR production lines all the emergency stop buttons and emergency pull cords located in working area's for operators must be regularly tested. The reports of these tests should be in writing with each time a signature from the inspector. (It may be in a checklist form or independent forms for each inspection like a work order).

This test frequency should be demonstrated by calculating the performance level or safety integrity level by appropriate software (Pascal, Sistema or any equivalent tool).

3. Purchasing of New or Used Machinery

If new or used machinery needs to be purchased, the responsible project manager must ensure that a specification is defined and given to the supplier.

This may need the input from various departments and functions. The input of the local HSE representative as well as all other interested parties is requested.

The supplier shall provide instructions in the language of the user. The instructions shall take into account the risk of human error and prevent it whenever feasible (by using Poke Yoke, fail-safe system, system tolerant to errors). The usage of PPE's shall be limited to a strict minimum. The supplier shall provide a declaration that identifies to which regulation and standards the machinery complies with (in at least one of the official languages of the country where it is put in service).

Before the machinery is put into service, a competent person shall complete a Commissioning report for safety, based on a detailed risk assessment. Any outstanding action after a risk score above non acceptable risk in this risk assessment must be first completed. If only residual risks are left and further remarks from the commissioning report are finished (with approval from this competent person), the machine may be put in service.

4. Engineering Of New Machinery / Modification Of Existing Machinery

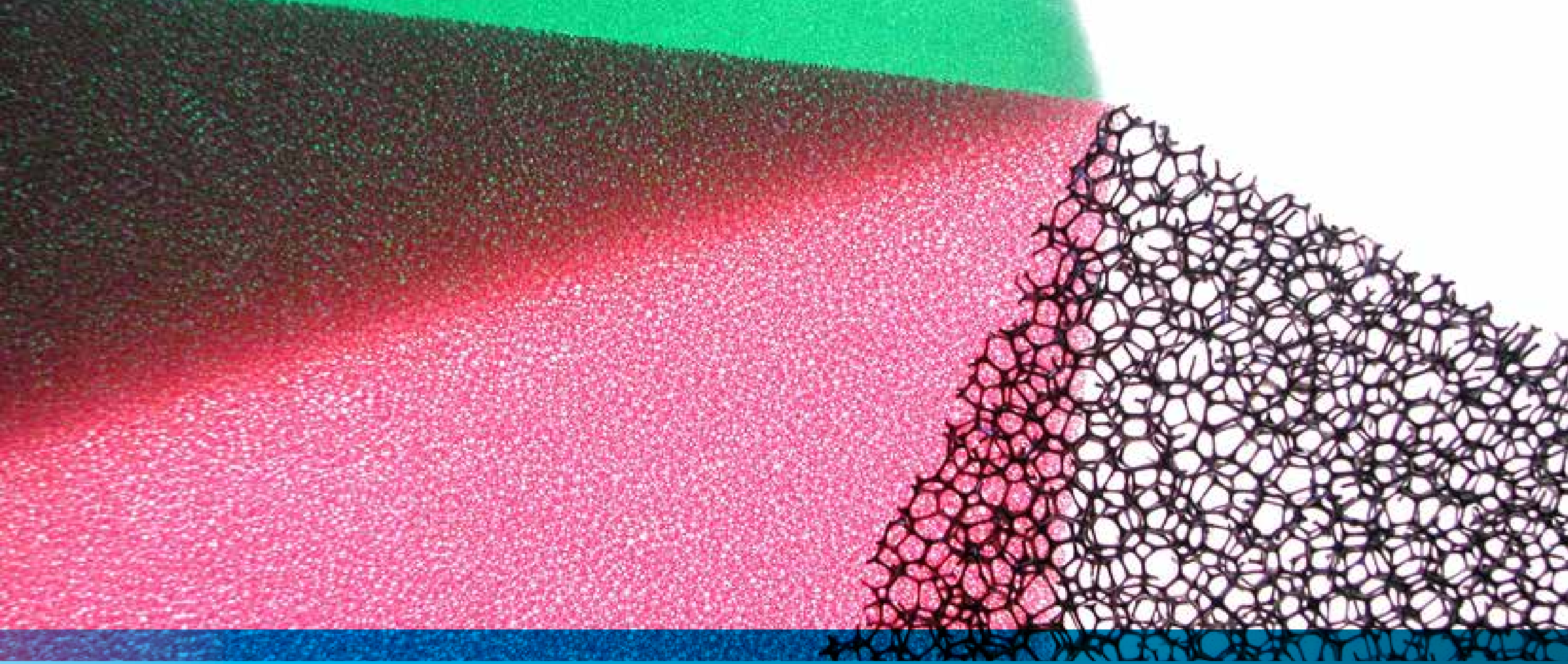
If new machinery shall be designed and constructed or existing machinery shall be modified, the responsible project manager shall ensure the following:

- Implement a Change Management procedure in which all risks linked to the equipment and risks induced by the project with be carefully examined.
- Ensure that all necessary departments are involved when the scope of the project is defined, including the local HSE department Assess and define all legislative requirements and standards that apply to the machinery and ensure that all standards are met.
- Perform a risk assessment design and pre-commissioning in the supplier premises. If more than one piece of the same machinery are to be constructed, a prototype shall be produced and tested before the next machinery is produced.

5. Training

All employees that use machinery shall be trained in the function of the equipment, the specific hazards of the equipment and how to control this hazards, by using the Manufacturer's Instructions. In addition, depending on their function and role, they shall be trained on the early detection of all foreseeable failures, and know how to react in case of an incident or an accident. This is especially important for moulded foam production carrousels and racetracks.

Provide initial awareness training to all employees on the requirements for safety devices and guarding and additional training as per training needs analysis.



D. INDUSTRIAL HYGIENE

PURPOSE:

To ensure a high level of medical surveillance for all affected employees, and apply all precautions needed to prevent or reduce exposures.

REQUIREMENTS:

In most of the countries, the content of the medical examination for people working in polyurethane production is described. Nevertheless some precautions need to be highlighted.

SKIN CONTACT:

The contact with diisocyanates, even partially crystallized, or with catalysts, additives or release agents must be avoided. This is important for maintenance operators, where surface contamination of tools, benches, parts or equipment may represent an important route of exposure and sensitization.

The repair of contaminated parts must be made in a dedicated area, and this area decontaminated at the end of the work. An entry point shall be clearly defined for each room possibly contaminated, and access after this point must be made with protective equipment. Exiting this area must be made only once contaminated clothes have been removed, securely stored in dedicated and clearly identified storage bins. A best practice consists in the allocation of tools used only in contaminated areas and regularly decontaminated. The same precautions apply for the operation of decontamination as for working on contaminated parts.

In addition, manual handling of fresh foam must be made with gloves (PVC, nitrile, and PU coated gloves, with a break-through time compatible with the exposure).

INHALATION:

Full face respirators and air fed masks are the most efficient solutions. Masks must be worn for each access in a wet-side room, pumping station, pouring booths or for flow tests, where a small leak may always occur and may not be detected by air monitoring due to the distance between the leak and the monitor. Face fit tests are a good practice.

MEDICAL ASSESSMENT

The objective is to determine that the applicant or employee is capable of performing the essential duties of the job position, without aggravating any pre-existing or existing medical condition(s).

The facility will locate and utilize an occupational clinic or physician, with specific recognition in occupational medicine, to complete pre-placement and periodic medical assessments. The occupational physician(s) will be offered a tour of the workplace, and subsequent periodic tours as required.

A pre-placement medical exam, must be completed and documented to establish whether the person is fit to do a certain job.

Minimum requirements for all jobs are:

- Medical history and questionnaire.
- Physical examination.
- Contra indications for the job function.

Minimum requirements for jobs in a production plant are:

- Medical history and questionnaire.
- Physical examination with an emphasis on the back, arms and shoulders.
- Audiogram.
- Respiratory examination, including a Pulmonary Function Test (PFT).
- Contra indications for the job function.
- Additional examinations may be required for Fork Lift Truck Drivers, Emergency Response Team members, Maintenance personnel, Machine Operators with Safety Function or performing Critical Tasks or any other function as defined by the Risk Assessment.

The plant in alliance with the occupational physician shall establish a schedule for periodic medical assessments for each job function. Minimum periodic medical assessment requirements in an isocyanate environment include a PFT once every two years or more and after any accidental exposure. Employees working in an area with noise above 85 dB (A) shall receive annual Audiograms.

The attending physician is responsible for informing the facility regarding the employee's ability to perform his/her job as "fit", "fit with limitations" or "unfit", based on a review of all reports and test results, both current and past, and determining an appropriate course of action if medically required.

All employee medical information is confidential and shall be stored separately.

E. HEALTH and SAFETY COMMITTEE

PURPOSE:

To provide a forum for the communication and exchange of information on practical health and safety matters between workers and management, so as to recommend and assist in the implementation of changes and improvements where necessary.

REQUIREMENTS:

1. Each facility will establish a Joint Health and Safety Committee that is comprised of representation from management and workers. The Senior Site (Plant) Manager must be one of the management members on the JHSC.

2. The Committee will define an operating mandate which must include:
   - 2.1. Identification of the Committee leadership responsibilities.
   - 2.2. Identification of the Committee membership roles and responsibilities.
   - 2.3. Identification of the frequency of meetings (monthly as a minimum).
   - 2.4. The stated purpose and objectives of the JHSC.

3. An agenda must be issued to all JHSC members and posted prior to the meeting.

4. The following items are to be discussed, as a minimum, at each meeting:
   - 4.1. Review details of all accident/incident investigation reports from the previous month.
   - 4.2. Accident/incident experience (year-to-date).
   - 4.3. Workplace inspection findings (for the month and follow-up of previous inspections).

5. Outstanding or unfinished business must be maintained on the minutes until resolved.

6. Minutes and attendance from all JHSC meetings will be kept by a designated person and retained on file.

7. Establish the communication methodology for JHSC business. This methodology will include provisions for the setting, distribution, and filing of meeting agendas and minutes. It will also outline to whom the minutes are to be distributed to and will require the posting of the minutes on Safety bulletin boards.

8. The names of the Committee members will be prominently displayed on the appropriate bulletin boards.

9. Identify the mechanisms in place to enable corrective action and follow-up.

F. CHEMICAL AGENTS

PURPOSE:

To protect the employees for the potential hazards of the chemicals which are used in the workplace. To minimize the environmental impact of the hazardous chemicals according to the legal requirements and beyond when feasible. A specialized employee, trained in the basics of toxicology, shall be in charge of evaluating the risks of the chemicals used at plant level.

REQUIREMENTS:

1. A list (or database) of all chemicals used in the workplace must be maintained.

The list should include:

1.1. Product or trade name.

1.2. Chemical components and CAS numbers.

1.3. Hazards (R phrases or H sentences).

1.4. S – Phrases or P sentences.

1.5. Flashpoint and auto ignition temperature.

1.6. Location used.

1.7. Location stored.

1.8. Type of container.

1.9. Maximum allowed storage capacity.

1.10. Supplier.

1.11. Date of SDS or eSDS.

1.12 Exposure limits, like DNEL, LOAEL, NOAEL, PNEC, IOELV, others (as prescribed at national level)

2. Current Safety Data Sheets in the language of the users, must be available for all chemicals present at the facility. They must be readily accessible to all employees. A simplified SDS can be provided to give an easier access to the most relevant information and they can be displayed at the work place.

3. All chemicals, prior to receipt at a facility, must be formally approved for use by the person designated as responsible. This assessment must evaluate if the substances are entering any list of restricted substances or any list showing an unacceptable risk (Substances of Very High Concern, Persistent, Bio-accumulable and Toxic substance, Carcinogenic, Mutagenic and Toxic for Reproduction, Substances restricted on the customers' market (especially in Automotive Industry).

The SDS must be carefully evaluated in order to detect possible mistakes and errors and the supplier contacted to correct it when necessary

Whenever feasible, the most dangerous chemicals shall be substituted to less dangerous ones. Each chemical prior to receipt will be reviewed and evaluated to determine the appropriate measures that need to be taken for safe handling and use of the material (risk assessment) and the equipment modified in order to minimize the risks. This includes chemicals used by contractors.

All substances with a registration number in the eSDS need to be in compliance with REACH within 1 year of receiving the registration number.

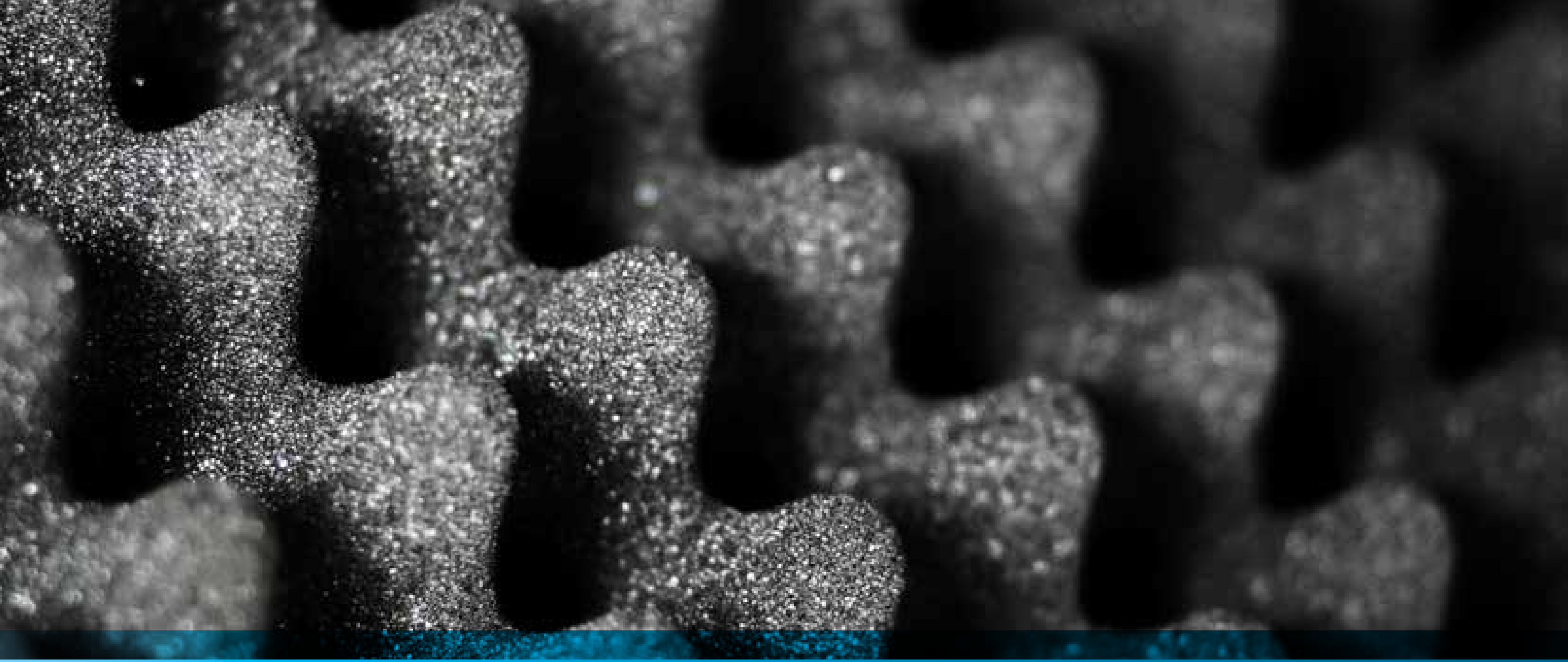
Compliance check needs to be done per eSDS (for all suppliers) and at each legal entity in writing. The check requires:

- Verification that uses are covered.
- Verification of the operational conditions are covered.
- Verification if the risk management measures are followed as described in the extended SDS.
- A labeling system, which includes the name of the material and the hazards associated with the material, shall be used. All chemical containers and piping shall be labeled in accordance with the established system and local legal regulations.

A hazard communication training program shall be established and implemented which includes:

- Overview of the facility hazard communication program.
- Any specific legislative requirements.
- Use and purpose of eSDS's.
- Labeling system.
- Safe handling of hazardous chemicals.
- Responsibility of the employee in handling hazardous materials.

All employees, who have the potential to come in contact with a hazardous material in the workplace, even accidentally, shall be trained in safe handling prior to beginning work (this may also be part of the work instructions). This includes temporary and contract employees.



G. WORK PLACE INSPECTIONS

PURPOSE

To identify and correct hazardous conditions and practices through routine inspection of the workplace.

REQUIREMENTS

Each facility need to identify (a) person(s) responsible for Work Place Inspections at the facility.

The Inspection Report is a tool to record potential and existing hazards, recommendations for corrective actions, responsible persons, and completion of target and deadlines set by the Joint Health and Safety Committee

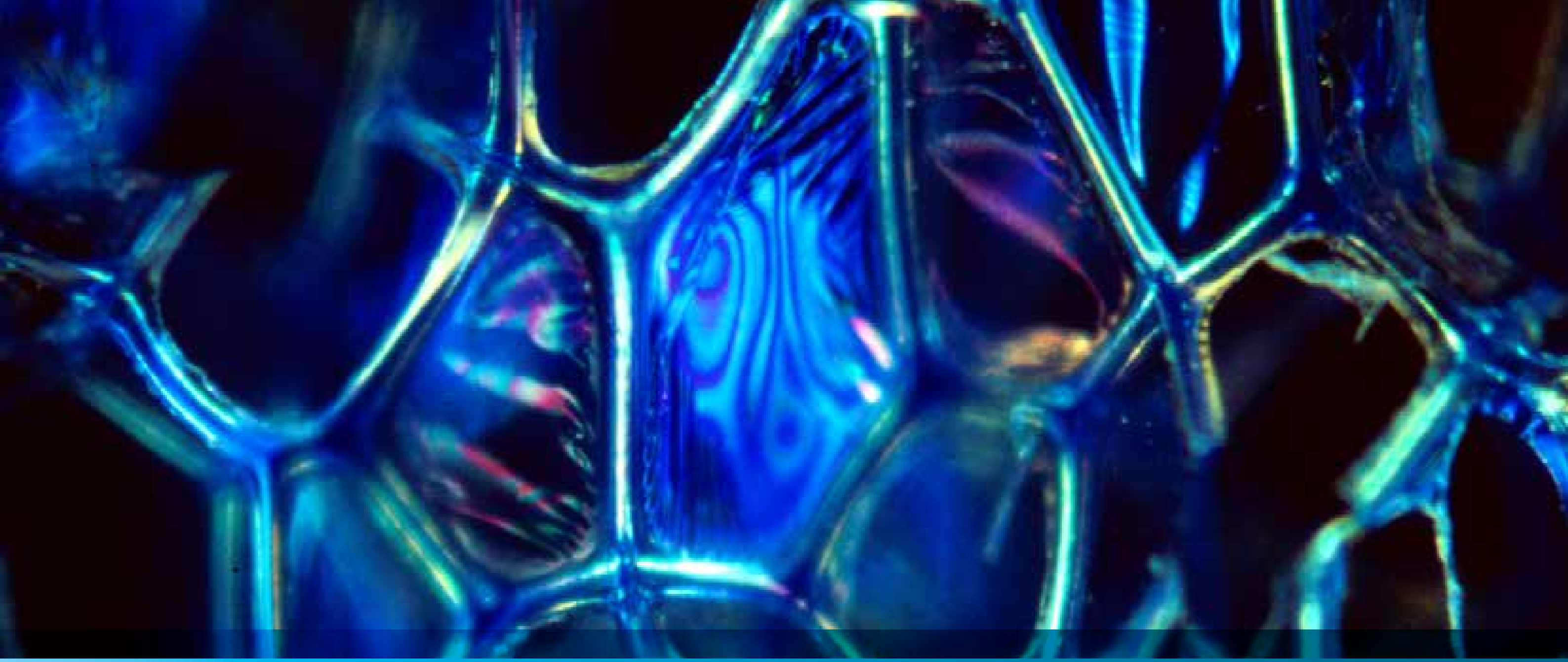
The entire facility should be inspected regularly. The entire facility can be segmented, if so required. The inspection should be conducted jointly by the management and hourly employees. The inspection team should consist of at least one manager and one hourly employee. Each manager should participate in at least one workplace inspection per year. The Plant Manager should lead at least one workplace inspection for the entire facility on a semi-annual basis.

A standard workplace inspection form should be used that includes all information contained within the Workplace Inspection Form. All hazards identified during inspections should be classified in accordance with the degree of risk they pose i.e. “A”, “B”, or “C” (A-Major; B-Serious; and C-minor).

The hazard rating should be clearly identified opposite each hazard identified on the workplace inspection form.

Copies of completed workplace inspection forms should be sent to all personnel responsible for corrective actions. Initiation of corrective action(s) should be taken on a priority basis in accordance with the assigned hazard rating, A, B or C (i.e. for A – immediately to within 1 day; for B – within 3 days; and for C – within 2 weeks).

Responsible individuals should be designated to initiate the appropriate corrective action for the hazards identified within their respective area of responsibility. The responsible individual should ensure that they are completed on time.



H. DIISOCYANATE MONITORING

PURPOSE:

To provide continuous monitoring of the work environment, so as to protect workers from potential exposure to diisocyanates and detect any abnormal emission. Identify a person responsible for implementation and maintenance of diisocyanate Monitor Use/Alarm at the facility.

DEFINITIONS OF TERMS USED IN THIS SECTION:

Chemcassette : A cassette containing a paper tape that is chemically treated to elicit a specific color (pink) reaction upon exposure to diisocyanates:

LCD : Liquid crystal display.

LED : Liquid electronic display.

ppb : Parts per billion.

MOULDED FOAM:

Stationary continuous diisocyanate monitors will be installed in accordance to the following requirements at the following areas: pouring booth, demould, wet side room, tank farm and unloading bay.

Best practice: monitors equipped with a duty cycle, connected to a remote alarm display, and able to record the concentrations over a period of time.

The monitors shall be placed between 1,2 to 1,5 m high.

Racetrack TDI tank farm - A unit is to be located inside the tank farm, within close proximity to the most likely source of a potential leak or spill (e.g. filter). The unit must be mounted no higher than 1.5 m above the level of the tank farm floor.

Due to the low vapor pressure of MDI, air monitoring of MDI at ambient temperature, in vapors form, is usually not needed. If MDI is present in aerosol or with a possibility to form warm vapors, the appropriate monitoring shall take place.

A noticeable remote audible and/or visual diisocyanate concentration alarm as well as a visual end of tape alarm, must be placed externally near all entrances to the tank farm, in a conspicuous place, so as to provide adequate warning to all persons requiring entry and to indicate when the monitor's chemcassette has been depleted.

Demould - A unit is to be placed in the demould area, prior to the first working position if the risk of miss-pour exists. The unit will be situated in an open area with adequate ventilation that is typical of the work environment. The flow of ventilation near the sample tube inlet, is to be verified periodically to ensure that there is an adequate flow and that there is no interference (e.g. cross-drafts, turbulence). The unit will be mounted in the open area adjacent to the line enclosure, and the sample inlet located just within the normal work envelope.

Wet side rooms - A unit is to be placed in the day tanks area. The unit will be situated in an open area with adequate ventilation that is typical of the work environment. The flow of ventilation near the sample tube inlet, is to be verified periodically to ensure that there is an adequate flow and that there is no interference (e.g. cross-drafts, turbulence). The unit will be mounted in the open area adjacent to the line enclosure, and the sample inlet located just within the normal work envelope.

The monitor alarm must be easily seen and/or heard. Where production lines are utilizing both TDI and MDI on the same line, the monitor must be configured to monitor for TDI vapors. There is no need to add a second monitor.

Pour Point - A unit is to be placed along the line within approximately 50 cm prior to the pour robot enclosure to detect leaks, spills, mispours, etc. As in the case of the demould unit/ wet side unit, it should be situated in the open with adequate ventilation, and the ventilation flow verified on a periodic basis. The unit should be with the sample inlet located just within the normal work envelope.

The monitor alarm must be easily seen and/or heard. If the pour point is dispensing MDI in an aerosol form, then the monitor must be configured to monitor for MDI (and aerosol) instead of TDI. There is no need for a second monitor to be installed if two carousel lines are within close proximity to each other, a single monitor will suffice. The facility must determine by ventilation flow testing that the monitor is situated directly upstream from the flow of ventilation towards the first working position on the line.

All diisocyanate monitoring equipment is to be calibrated and maintained in accordance with the manufacturer's specifications.

Individuals charged with responsibility for servicing, i.e. changing chemcassette tapes, calibration, and maintenance of the monitors must receive training from the manufacturer/distributor, or someone qualified to do so.

Each facility will develop and implement an alarm procedure that requires the evacuation of the immediate area, and a subsequent investigation during monitor alarm situations.

The Alarm level is set to 5 ppb and must be accomplished with *an external stack* light *and an external audible alarm*. At this level, the line is stopped automatically and the alarm situation shall be investigated.

If the monitors show concentrations above 20 ppb, the production area shall be evacuated as per Emergency Response Plan. The procedure must require that if the level of diisocyanates cannot be confirmed prior to investigating the alarm, it must be assumed that the level is unsafe and air-supplied equipment must be worn.

All monitors shall be checked for function on a daily basis. *The external visual and audible alarms must be checked on functionality at least monthly.*

These checks shall be documented.

SLABSTOCK FOAM:

A procedure for monitoring TDI in the atmosphere in and around the foaming line is summarized below as an example.

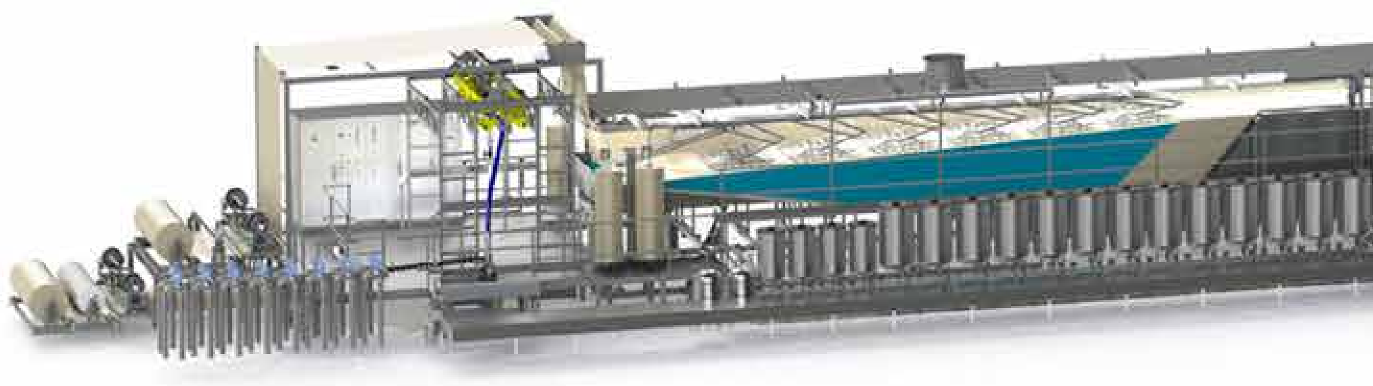
- TDI check rounds needs to be performed during production and at the minimum interval of once per month at all foam production, TDI storage and curing/cutting workstations.
- In case of readings above 0, the following sequence needs to be implemented.
    - For readings > 0 and < 4 ppb - once a week till actions taken resulted in 0 readings again.
    - For readings > 4 ppb – each production run/day till actions taken resulted in 0 readings again.
    - At any workstation where readings > 0 ppb are measured, PPE (gas mask) is required.

- Depending upon local site layout, at measuring location 5b, TDI readings could occur regularly. For this location, the above mentioned intensified sequence does not apply. However, clear PPE instructions should be given to all operators working in this area and should be checked during test rounds if there are used.

LOCATIONS FOR REGULAR CHECK ROUND MEASUREMENTS

1. Working platform	(location: operator panel)
2. Site paper rewinder, left side	(location outside closed door/tunnel)
3. Site paper rewinder right side	(location outside closed door/tunnel)
4. Cut off foam unit	(location operator panel)
5. (depending upon your local site lay out)	
a. Curing area, cut off long block	(at workstation if present)
b. Curing area offloading	(at workstation)
6. Location TDI pumps	(next to pump)
7. TDI Storage location(s)	(only when no continuous TDI monitoring is performed, on your site drawing, please continue adding nbrs along the locations you need to monitor on your local site drawing).

Each site need to add a local site drawing and indicate with numbers where static checks are performed (numbers 5 and higher).

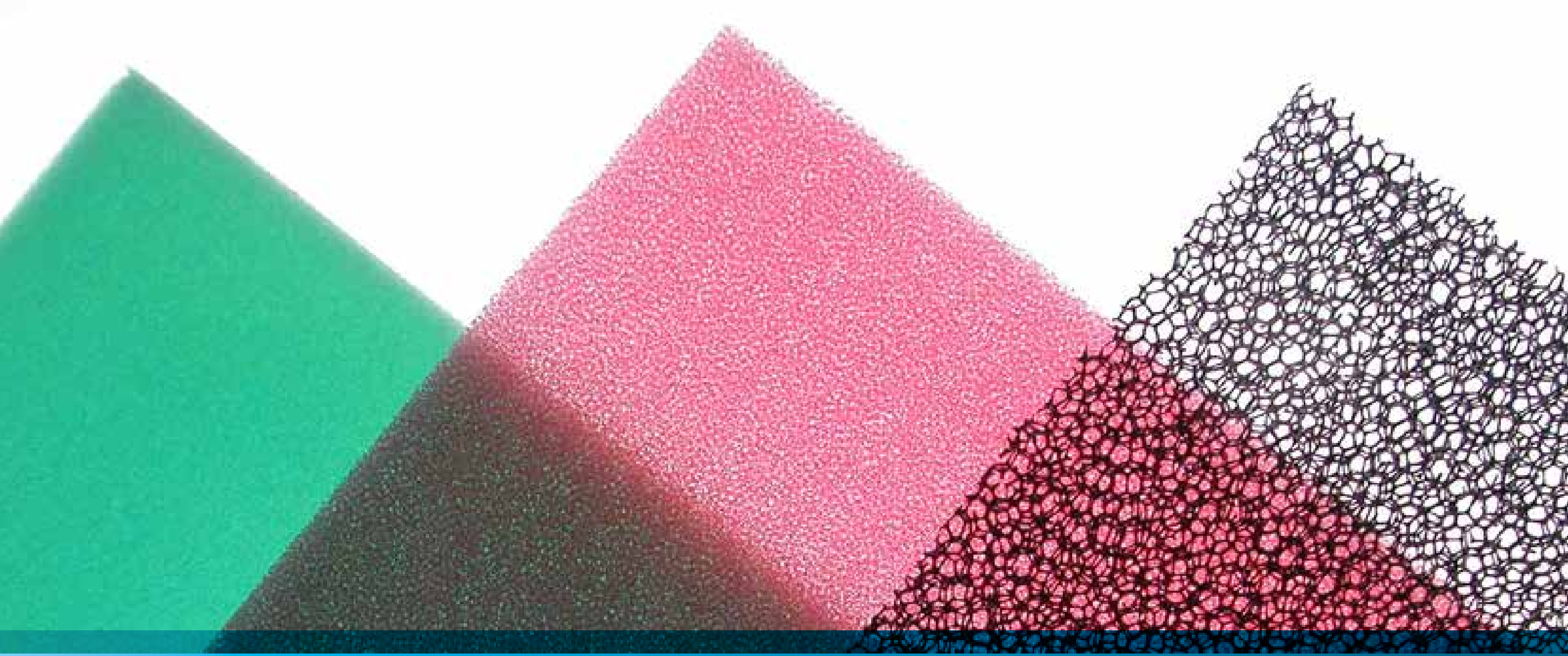


TESTING PROCEDURE REGULAR TESTROUNDS

- The Regular Check rounds should be performed during production.
- See operations manual how to use the device.
- Make sure when starting readings, have the device on a static location.
- Do not move device during measurements.
- Stay out of the direct vicinity of the air inled, do not cause extra airflows since it disturbs readings.
- Make sure, for the regular check rounds, you always do your readings at the same location & sequence, since this makes data logging in excel easier.
- After startup, a properly operated foam machine no TDI levels should be read.
- Doors & any windows should be closed during running.
- With all operating access points closed (doors/windows), the ventilation system should be capable to extract all fumes involved.
- When reading TDI levels around the foam unit, check all access points to the foam tunnel and give instructions to close!
- If still TDI readings are recorded, take further actions, discuss with management, have ventilation system checked and take further actions.
- In case of TDI readings at storage locations & pumps, take the necessary actions, block off area and inform management to take action.

Inability to control TDI levels to less than 5pbb irrespective of RPE wear results in plant shutdown to remedy the failure.

Multimax Slabstock Foam Machine (Source: Laader Berg)



I. AIR POLLUTION CONTROL

PURPOSE:

To ensure compliance with all environmental legislation related to control of air emissions. To ensure that air emissions from facilities do not adversely affect the surrounding community and the natural environment.

REQUIREMENTS:

- Identify the appropriate environmental regulatory authorities or agencies responsible for air pollution control, including address and telephone number.
- Keep and maintain the following records:
    - Current drawings of the facility that show the location of all stacks and sources of air emissions.
    - Current air emission inventory that includes identification of emission sources, rates and contaminants.
    - A current copy of the appropriate authorization documentation (i.e. permit, license, and certificate of approval) from the applicable regulatory agency to operate all air emissions sources at the facility must be maintained at the facility.
    - The original applications and any subsequent modification requests, including all backup information such as emission calculations and throughput estimates.

Each plant should make written procedures that:

- Describe how to maintain any emission or operating information required by the appropriate legal authorization such as a permit, license, or certificate of approval.

- Describe a management of change procedure for making operational modifications that effect air emissions or controls. This procedure should address all regulatory requirements for operational changes related to air pollution control legislation that are applicable to the facility.

- Describe how discrepancies or exceedances of legislative or permit requirements are reported to. (The appropriate environmental regulatory authorities or agencies as a minimum). Discrepancies or exceeding must be considered as Non Conformities.

- All facilities will operate within the limits and conditions of their specific legislative requirements and authorizations (i.e. permit, licenses, or certificate of approval).

J. WATER/SOIL POLLUTION CONTROL

PURPOSE:

- To ensure compliance with all environmental legislation related to control of discharges to water and soil protection.
- To ensure that water discharges from facilities do not adversely affect the surrounding community and the natural environment.
- To protect the natural environment and the health and safety of our employees while loading/unloading tank trucks, drums, totes, bulk storage, pre-mix and surge areas containing liquid chemicals.
- To prevent and/or mitigate chemical releases, through engineering and administrative controls, in the event of their occurrence.

DEFINITIONS USED IN THIS SECTION:

Water discharge: The release of any contaminants to water.

Primary Containment: The vessel in which a liquid chemical is either shipped in or subsequently stored.

Secondary Containment: A secondary container is an approved structure to temporarily contain a liquid chemical release. A secondary containment could be a dike, a tray or a floor depression.

Berm/Bund: A raised barrier or dike designed to contain liquids within its confines.

Chemical Release: A release of a pollutant(s) or hazardous material(s) originating from a process, structure, vehicle, or container that is/are abnormal under normal operating conditions.

REQUIREMENTS

Plants should maintain:

- A water discharge inventory that includes identification of discharge sources, rates and contaminants.
- A report containing rates and contaminants of the soil investigation, if a soil investigation is legally required.
- A site plan of the facility that identifies the location of all drains, secondary containment areas, water discharge points and underground storage tanks.
- Identification on a site plan of all measuring points for soil investigation.
- A map that identifies all waterways within 2 km (1.5 miles) radius of the facility.
- A current copy of the appropriate authorization documentation (i.e. permit, license, and certificate of approval) from the applicable regulatory agency to operate all discharge points and certificates if required by legislation, of approval of the secondary containments.
- Documentation of all correspondence with the regulatory agency pertaining to water pollution and soil pollution control including inspection reports, notices of violation and requests of information. This includes all discharge monitoring records if applicable.
- A written procedure for making any operational modifications that affect water discharges or water/ soil pollution controls is needed. This procedure must address all regulatory requirements for operational changes related to water/soil pollution control legislation that is applicable to the facility.

All processes should be operated in accordance with the applicable local environmental legislation. All facilities will operate within the limits and conditions of their specific legislative authorizations (i.e. permit, licenses, or certificate of approval).

Chemical release controls:

Each facility will have engineering and administrative controls in place to prevent chemicals from being released during any part of the transfer or storage process.

Minimum requirements are:

- Level control devices on storage tanks.
- High level alarms on storage tanks (and SIS with SIL1 according IEC 61511 for diisocyanate tanks).
- Pressure relief (conservation vents) on storage tanks (and SIS with SIL1 according IEC 61511 for diisocyanate tanks).
- Check valves in dry air lines (diisocyanate storage tanks) moisture content in air controls on diisocyanate storage tanks.
- Control valves at chemical unloading points.
- Chemical Loading/Unloading Procedures according Isopa guidelines.
- Inventory control procedures.

Existing regulatory design standards (e.g. ANSI, ASTM), are to be considered when modifying existing chemical transfer/storage equipment and/or installing new chemical transfer/storage equipment. Also a risk assessment needs to be conducted before modifying existing chemical transfer/storage equipment and/or installing new chemical transfer/storage equipment.

Secondary containment systems (i.e. berms/bunds, trenches, sumps, pallets) must be provided at all interior and exterior chemical usage, storage, and transfer points. Areas where containment is required, but not limited to, include:

- Surge area.
- Premix.
- Bulk Storage.
- Tank Truck Loading/Unloading.
- Container storage (pails, totes, & drums of raw materials).
- Chemical/liquid waste storage areas.

Secondary containment systems must meet at least the following capacity criteria (unless legislation dictates a larger capacity):

- Interior: All Single Containers: 100% of the largest volume container within the containment area.
- Interior: Mixed storage of Containers: 150% of the largest volume container within the containment area.
- Exterior: Tank Truck: 110% of the volume of the tank truck container
- The capacity of each containment area will be quantified to ensure that it meets the above criteria.
- The storage tanks need to be checked by an authorized body on regular basis according to local legislation.

REFERENCE DOCUMENTS:

Isopa guidelines for safe loading / unloading, transportation, storage of TDI and MDI in bulk (www.isopa.org)

K. FIRE and EXPLOSION SAFETY

PURPOSE:

- To ensure the safety of all employees and preservation of corporate assets from fire loss, and to be in compliance with all regulatory/insurance requirements.
- Identify a person(s) responsible for implementation and maintenance of the Fire and Explosion Prevention Program.
- Investigate the fire and explosion Hazards by conducting a risk assessment.
- Get the advice of the local fire department and also from the Loss Prevention Officer of your insurance company which fire protection measures need to be in place. Take the necessary precautions to eliminate or reduce the risk to an acceptable level.

REQUIREMENTS:

Precautions must be taken in account which:

- Eliminate the risk.
- Reduce the risk.
- Reduce the damage.

All flammable materials (materials with a flash point below 60 °C) must be stored in fireproof solvent containers/cans or in an explosion protected room. Storage in the workplace should be limited to no more than the daily usage.

Adequate ventilation to prevent the presence of explosive atmospheres should be provided. The minimum ventilation capacity shall keep the concentration of flammable vapors below 15% of the lowest explosion limit of the solvent with a safety correction factor taking into account build up in ducts, or loss of efficiency of filters. The proper working of the extraction should be ensured by technical and organizational controls. Checks should take place on avoiding blind spots in the exhausting boot.

Prevent all possible ignition sources and certainly these by static electricity: by earthing all elements and the use of electrostatic hoses.

Smoking must always be prohibited:

- Where flammable liquids, gases, combustible dust and fibers are present.
- In all production areas.
- In all storage areas, packaging and dispatch departments and areas where there may be accumulations of waste such as loading bays.
- In areas, which are not visited frequently such as archive storage areas etc.

This strict interdiction must be displayed very clearly, at every entrance, and repeated in other sections of the plant where it is considered to be necessary. The non-smoking policy must also be implemented to all third parties: visitors, drivers, (sub) contractors…

It may be or become possible to implement a total non-smoking policy for the whole site. No exception to this strict rule can be allowed, and stringent measures have to be taken in case of negligence.

Areas where smoking is allowed, must be clearly marked. In these zones no combustible materials are allowed. Ashtrays should be present in this area. Only self-extinguishing waste bins are allowed to empty the ashtrays.

Battery charging areas should preferably be housed in separate buildings or in compartments enclosed by partitions. If this is not possible or practicable, clearly defined areas must be established and no combustible materials should be stored within 3 m thereof. Battery charging areas should be well ventilated.

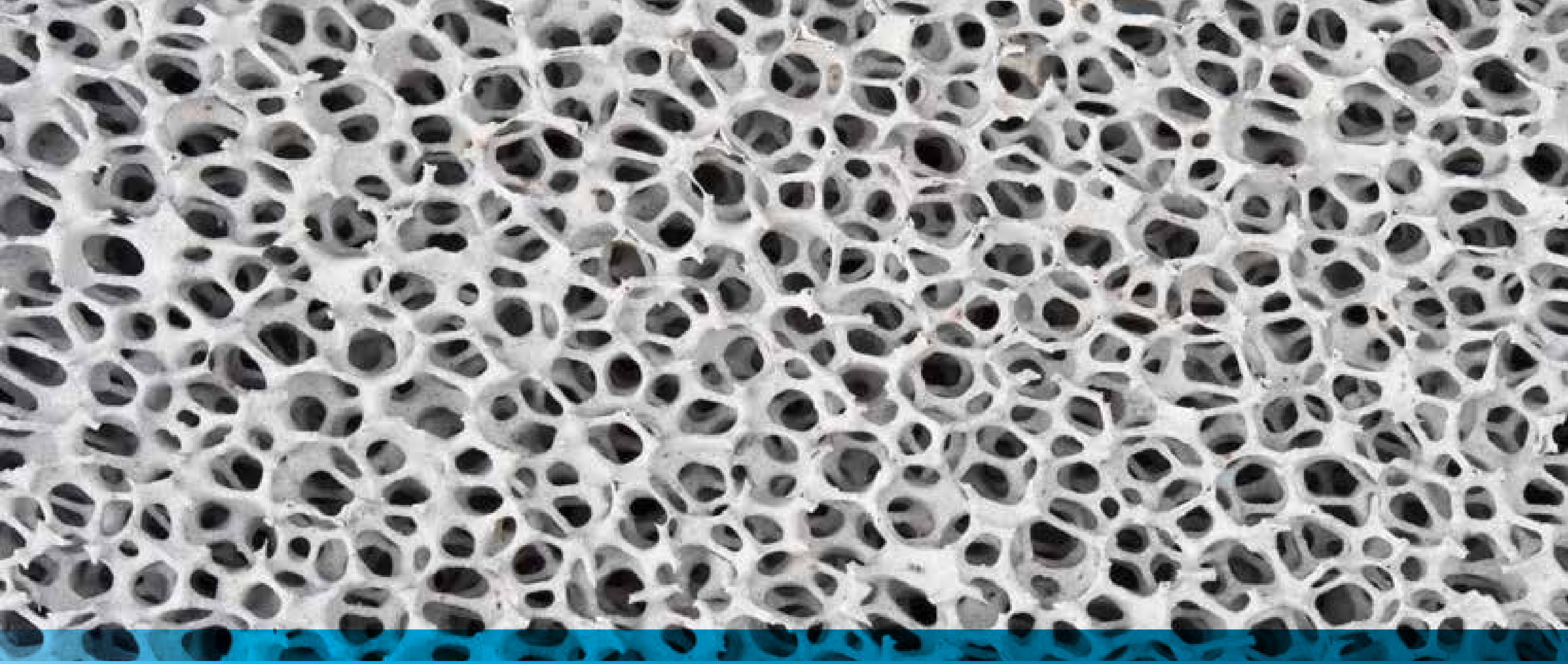
Electrical equipment should be kept in accordance with local legislation. At least yearly an infrared thermo-graphic investigation on all electrical cabinets should be conducted.

The Plant needs to insure that good housekeeping practices are met:

- Storage of flammable gas bottles need to fulfil following requirements: securely chained or strapped in the upright position bottles/cylinders must be shut off, removed and stored outdoor, protected from direct sunlight.
- Hot work/welding permit: “Hot work” means the use of any open flames or the production of sparks, e.g. welding, burning and cutting, as well as grinding. For all such works a special work permit is mandatory.
- Appropriate firefighting equipment and alarm system needs to be in place. The type, the number and location of fire extinguishing equipment must be in agreement with the company policy (regarding sprinklers, smoke detectors), recommendations from the insurance company and the authorized fire brigade, the local legal requirements.

Firefighting equipment may include:

- The portable/manual and wheeled fire extinguishing tools.
- Hose and hydrants (internal or external).
- The equipment of the private fire brigade.
- The electronic alarm systems.
- The automatic/manual fire alarm (push buttons).
- Sprinkler system.



L. PERSONAL PROTECTIVE EQUIPMENT

PURPOSE:

To establish the minimum requirements for the supply, use and maintenance of Personal Protective Equipment (PPE) to protect employees from potential and existing hazards and to identify appropriate PPE for specific tasks and work areas.

Identify a person(s) responsible for implementation and maintenance of Personal Protective Equipment at the facility.

When necessary training should be provided to properly wear and use PPE as part of the overall safety training program.

DEFINITIONS OF TERMS USED IN THIS SECTION:

Fresh Foam: Polyurethane foam manufactured in the plants (less than 3h)

PPE Equipment: Worn on the body to protect the eyes, face, head, skin, extremities, trunk, or respiratory system and any other organ from injury due to chemical/ biological exposure and/or physical hazards.

SCBA: Self-Contained Breathing Apparatus.

REQUIREMENTS

Each Plant should conduct a Risk Assessments Risk Management to define the necessary PPE for each task.

Personal protective equipment should be used when the risks cannot be avoided or sufficiently limited by technical means of collective protection or by measures, methods or procedures of work organization.

PPE shall be provided free of charge to the employees.

PPE must be worn at all times while performing tasks where PPE is required.

All PPE shall be used and maintained in accordance with legislative and manufacturer requirements.

Safety glasses:

General: At all production (PU production, EPP production and metal component production), process and chemical storage areas, the wearing of safety glasses is mandatory. Exceptions for production areas are cut and saw operations and assembly operations, on the condition that they take place in a separate room or are located more than 10 m from other production areas. These exceptions can be given if the risk assessment demonstrates that it is safe to give this exception.

If employees can be exposed to following hazards, specific safety glasses must be worn if identified by the risk assessment:

- Radiation from welding: welding cap with suitable screen/ glasses according to the applicable standard.
- Laser: safety glasses according to the applicable standard or for adjusting (depending on the risk) glasses according to the applicable standard.

Safety gloves:

Chemical hazards:

For tasks requiring repeated contact with fresh foam (not older than 24h), the following protective measures must be taken:

- Work clothing appropriate to the task shall be worn to cover any exposed skin (i.e. upper and lower arms).
- In moulded foam plants, all employees who handle fresh foam, will wear cotton gloves as a minimum. Gloves worn at demould must have at least the palm and bottom surfaces of the fingers coated with an impermeable material such as nitrile, natural or butyl rubber.
- Other chemicals, safety gloves according to the applicable standard must be used that are impermeable for at least 480 minutes for these substances

Mechanical hazards:

For tasks requiring the use of trim knives or scoop knives, cut resistant gloves or chain mail gloves must be worn

- Welding hazards: gloves according to the applicable Standard must be used.
- Electrical hazards: gloves according to the applicable standard must be worn.

- Vibration hazards (depending on risk assessment): gloves according to the applicable standard.
- When working on diisocyanate storage or transfer equipment, and when responding to and cleaning up a release of diisocyanate, where there is a risk of exposure through inhalation or skin contact, the following protective measures must be taken:
- Protective clothing shall be worn to cover the body from exposure. This protective clothing shall consist of a full body suit with hood, constructed of a material impermeable to diisocyanate liquid (e.g. Saranex-coated Tyvek).
- Protective respiratory equipment shall be worn. This respiratory equipment shall be a full face, airline or self-contained breathing apparatus (SCBA) with the regulator operating in pressure demand mode.
- Protective gloves shall be worn. These gloves shall be constructed of a heavy gauge material impermeable to diisocyanates (e.g. nitrile or butyl rubber), with a least a 30 cm long gauntlet.
- Protective footwear shall be worn. This footwear must be constructed of a material impermeable to diisocyanates (i.e. natural, nitrile or butyl rubber boots).

Noise hazards:

Each Plant shall provide suitable hearing protection for employees working in areas above 80 dB (A). For Employees working in areas above 85 dB (A) the wearing of hearing protection is mandatory.

Safety shoes:

Except for visitors and people remaining on safe pedestrian roads, all people entering the plant must have safety shoes according to the applicable Standard with toe caps (S1 or S1P).

All employees will receive initial training prior to being assigned work involving the use of PPE, as well as periodic training. The training shall cover:

- Correct Usage.
- Cleaning and Maintenance.
- Disposal of PPE.

A written procedure to establish the process for employees to obtain the required

PPE should be made available.

When new PPE is introduced at the Plant, this shall be presented and discussed at the JHSC meeting.

REFERENCE:

See PPE Requirement matrix attached (annex 8).

LIST OF ACRONYMS

ISOPA	European Association of Diisocyanate and Polyol Producers
TDI	Toluene Diisocyanate (building block of flexible foam)
MDI	Methylene diphenyl diisocyanate
ANSI	American National Standards Institue
ATEX	Directive on Equipment for use in Explosive Atmosphere
BOW TIE	Methodology for Risk Management
COMAH	Control of Major Accident Hazards
DNEL	Derived No Effect Level
EXIDA	Certification System of products and processes
FMEA	Failure Mode and Effects Analysis
HAZOP	Hazard and Operability Study
HSE	Health Safety Environment
IBC	Intermediate Bulk Container
IEC	International Electotechnical Commission (standard)
LEV	Local Exhaust Ventilation
LOPA	Layer of Protection Analysis
LOAEL	Lowest Observed Adverse Effect Level
LOTO	Log –Out Tag-Out (=safety procedure)

MAPP	Major Accident Prevention policy
MTTF	Mean Time To Failure
NOAEL	No Adverse Effect Level
NSO	No Standard Operation
OCRA	Occupational Repetitive Actions (=index describing risk factors)
OIL	Open Issue List
OREDA	Off Shore Reliability Data (= Data for maintenance optimization)
OSHA	Occupational safety and Health Administration (=US regulation)
PFI	Piping Fabrication Institute (= Standard for piping dimensions)
PPE	Personal Protection Equipment
SCBA	Self Contained Breathing Apparatus
eSDS	extended Safety Data Sheet
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SRV	Safety Relief Valve

LIST OF ISOPA DOCUMENTS

TDI/MDI Bulk Discharge and Storage Assessment:
http://www.isopa.org/media/2011/assessement-final-version-july-2015.pdf

Safe Loading/Unloading, Transportation, Storage of TDI and MDI in Bulk:
http://www.isopa.org/media/1092/final-version-bulk-guidelines.pdf

Safe Transportation, Unloading & Storage of Packaged TDI and MDI:
http://www.isopa.org/media/1604/en_final-version-december-2014.pdf

Emergency Response Telephone Numbers:
http://www.isopa.org/product-stewardship/logistics/emergency-response/

Walk the Talk :
http://www.isopa.org/product-stewardship/walk-the-talk/

The latest, up to date versions of these documents are available on ISOPA's website (www.isopa.org), some of them in a number of different languages.

As these documents are updated regularly, it is recommended to always check the latest version on this website.

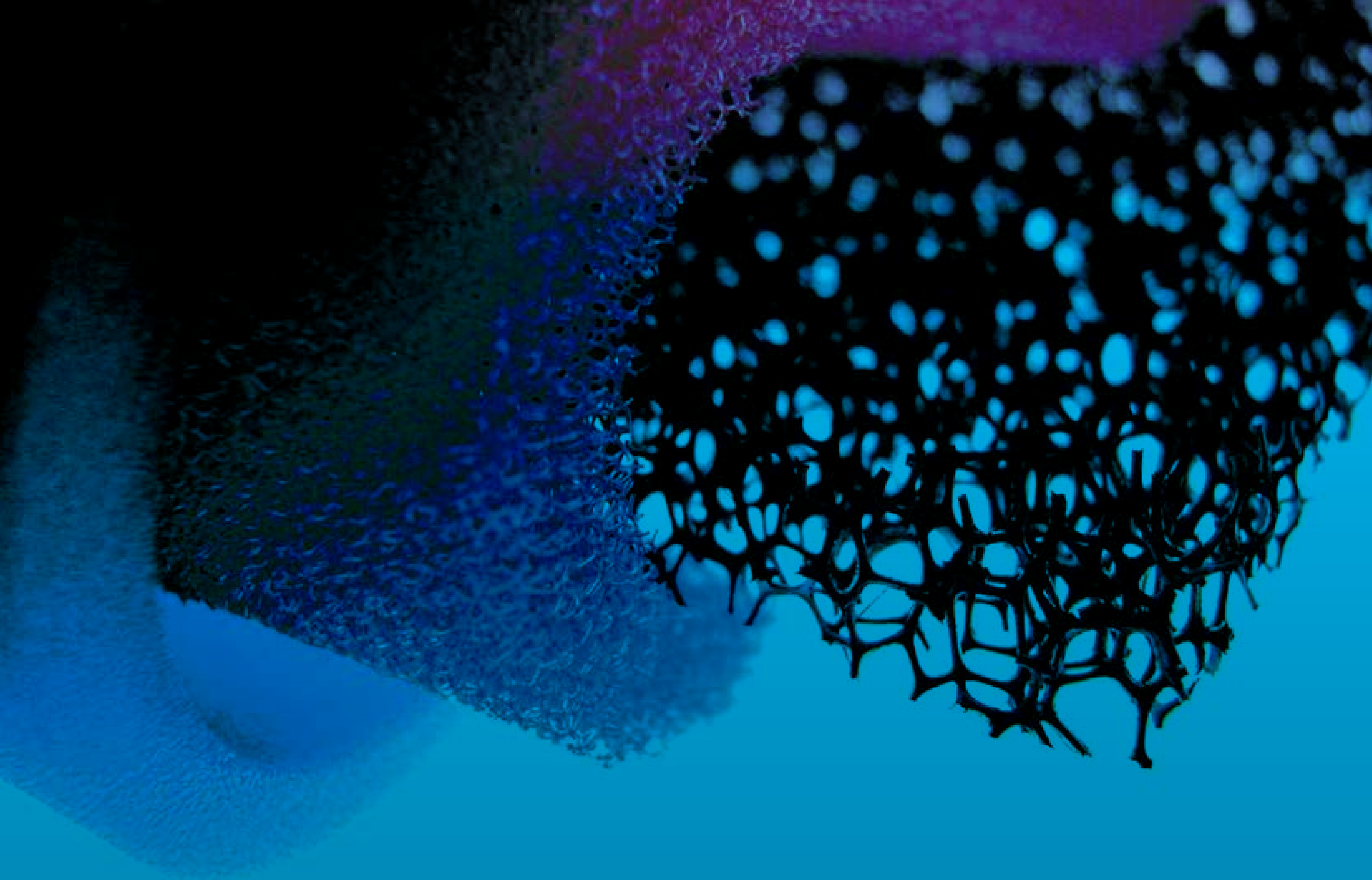
ANNEXES

All documents quoted below should be considered as illustrative examples to the related chapters

1. Processing foam systems
2. Unloading check-list
3. Risk assessment for foam plants
4. Maintenance matrix
5. Training matrix
6. Risk analysis for machinery
7. Ventilation
8. PPE Requirements matrix

LITERATURE

For more detailed information, a good resource is the booklet "Safe use and storage of cellular plastics" edited by the UK's Health and Safety Executive. References: Booklet HSG92, ISBN 978 0 7176 1115 7 available for free download at www.hse.gov.uk



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