FEDIOL
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FEDIOL Guide to good practice on safe operation of Hexane extraction units to limit the likelihood of explosions caused by flammable vapors (applicable as from 01 January 2007)

Terminology used: ISO-9001:2000; ILO-OSH 2001.

1. Definitions

1. Condensate: any material that has been condensed from the vapor state to the liquid state.
2. Condenser: a piece of equipment that lowers the temperature of a vapor to the point where it changes to a liquid.
3 Conveyor: equipment that transports material from one point to another either pneumatically or mechanically, by means of a moving belt, a chain, buckets, or flights.
4. Desolventized Material: material from which all absorbed solvent has been removed.
5. Desolventizer: equipment that removes the absorbed solvent from the material being processed.
6. Easily flammable liquid (European Directive 67/548/EEC):
   * substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or
   * solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or
   * liquid substances and preparations having a flash point below 21º C, or
   * gaseous substances and preparations which are flammable in air at normal pressure, or
   * substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities;
7. Evaporator: equipment that vaporizes the solvent from the oil-bearing miscella.
8. Extraction Supervisor: the person in charge of the extraction process
9. Extraction Process: the curbed area that contains the operations involving the extractor and the desolventizer, together with pertinent equipment such as heat exchangers, evaporators, and strippers, and which are contained in an enclosed building or in an open structure and the separation sump.
10. Extractor : equipment that removes oil and fat from oil- or fat-bearing material by means of a suitable solvent.
11. Flakes : oil- or fat-bearing material that has been rolled in preparation for the extraction process.
12. Flaking Mill : a piece of equipment that utilizes smooth rollers to prepare material for the extraction process.
13. Flame Arrester : a device that prevents the transmission of a flame through a flammable gas/air mixture by quenching the flame on the surfaces of an array of small passages through which the flame must pass. The emerging gases are sufficiently cooled to prevent ignition on the protected side.
14. Flammable liquid (European Directive 67/548/EEC) : liquid substances and preparations having a flash point between 21º C and 55º C;
15. Heat Exchanger : equipment that transfers heat from one vapor or liquid to another vapor or liquid.
16. Hydrocarbon : a chemical substance consisting of only hydrogen and carbon atoms.
17. Inert Gas : a gas that is noncombustible and nonreactive.

18. Inerting : a technique by which a combustible mixture is rendered nonignitible by adding an inert gas.
19 Lower Flammable Limit (LFL) : that concentration of a combustible material in air below which ignition will not occur.
20. Miscella : a mixture, in any proportion, of extracted oil or fat and the extracting solvent.
21. Noncombustible Material : a material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C and in accordance with European Directive 89/106/EEC (the Construction Product Directive with links to standards for testing and approval), shall be considered noncombustible materials.
22. Preparation Process : the operations involving the equipment used for the preparation of the material for the extraction process.
23. Purging : the process of displacing flammable vapors from buildings, equipment, or piping.
24. Separation Sump : a containment basin that is used to separate oils, miscella, or solvent from water by means of the immiscibility of the liquids and their differing densities.
25. Site Extraction Management : the management in charge of the complete extraction from seeds to processed products.
26. Site Management : the management in charge of all operations of several units on the same site.
27. Solvent : any standard flammable hydrocarbon liquid that has the ability to extract oils or fats from animal or vegetable material.
28. Spent Material : material from which the oil or fat has been extracted but which has not been desolventized.
29. Stripper : a distillation column or tower, usually operated under vacuum, that is used to remove residual solvent from the extracted oil or fat.
30. Toaster : equipment that is capable of producing the desired cooking, toasting, and modification of protein by means of heat and moisture.
31. Upper Flammable Limit (UFL) : that concentration of a combustible material in air above which ignition will not occur.
32. Vapor barrier : a noncombustible vapor tight construction of at least 1.2 meter high that is designed so that vapors have to travel at least 30 meters to a possible source of ignition.
33. Vapor Recovery : the process of reclaiming solvent by means of condensation or absorption.
34. Vapor Scrubber : a device used to wash entrained dust from a vapor stream by means of a liquid spray.
35. Vapor Seal : equipment or material that prevents the escape of solvent vapors from process equipment or conveyors.

2. Scope and Limitations

2.1 Intention of this guide

This guide has been established to give FEDIOL members a code of practice for making safety and health risk assessment for explosive atmospheres in hexane extraction plants required by local legislation through the European Community Directive 1999/92/EC.

The potential dust explosion hazard in some areas of a solvent extraction plant will be handled in a separate document.

2.2 Basis for safety

The basis for safety for vapors in hexane extraction (including D-T, desolventiser/toaster) as used throughout this document is:

1. Prevention of explosive mixtures
2. Avoidance of the ignition sources under normal operation conditions.

Normal operation conditions will include start up phase, in production, shutting down phase and while the plant is down under load (hexane, miscella and/or meal still present).

2.3. Limits and liability of the codes

2.3.1 The following chapters will define normal operating conditions for existing or new solvent extraction plants.

2.3.2 This guide establishes rules and procedures to be developed around the risk analysis. This code was developed with the active involvement of members operating solvent extraction plants in Europe and in agreement with solvent extraction equipment suppliers.

2.3.3 The requirements of this guide reflect a consensus of what is required to provide an acceptable degree of protection from the hazard of explosions at the time the guide was issued.
Unless otherwise specified, technical and constructional requirements should be applied to facilities, equipment, structures or installations that existed or were approved prior to the effective date of this code of practice. Where not possible due to constraints the risk control measures are within the ALARP concept (as low as reasonably possible). Alternative prevention methods may have to be developed to meet this level.

2.3.4 However, FEDIOL does not assume any responsibility and/or liability for any site claiming to adhere to the FEDIOL guide to good practice on ATEX for solvent extraction.

2.3.5 This guide of practice has been developed in accordance with EU legislation, best practices and currently applied technology. Any additional national requirements are the responsibility of the individual operator.

3. Organization of the operations

3.1. Responsibility and accountability

3.1.1 Allocation of Responsibility and Accountability for :

3.1.1.1 Safe operating practices, including but not limited to documented and detailed operating procedures and procedures for start-up and shutdown and while plant is idle under load, shall be the responsibility of the Site Management for installations put into operation for the first time before 2003. For installations put into service after 2003 the Site Management and the Main Equipment Suppliers will be responsible through the instruction manuals provided.

However, in case of turnkey projects put into service since 2003, the main supplier will be solely responsible until 'handing over' to the Site Management. Deviations from this approach may be agreed in the contract.

3.1.1.2 Repair Authorization. When it is necessary to make repairs to the areas covered by this standard, the work shall be authorized by the Site Extraction Management or its approved delegate before the work is started. Where hot work is required, this authorization shall be in writing.

- A hot work/ sparking/ ignition work permits system (only after full air and steam purging) shall be at least the responsibility of the Site Extraction Management.
- The opening of equipment that contains or is likely to contain solvent shall be authorized in writing by the individual in responsible charge of the plant before the work is started.

3.1.2 Procurement

3.1.2.1 Site Management has put practices in place to ensure that materials and equipment to be used in the zoned areas will comply with the conditions as specified in the explosion risk assessments.

3.1.3 Contracting

3.1.3.1 Site management has put practices in place to ensure that companies and persons supplying services in zoned areas are informed of the risks as documented and appropriate control measures in the risks assessment to avoid or reduce the risks of an explosion.

3.1.4 Monitoring and measurement

3.1.4.1 Site Management has allocated responsibilities for planned inspections and maintenance of all equipment identified as critical (4.3.3.4) used in the zoned areas

3.1.4.2 Site Management has allocated responsibilities to conduct task observations of employees and others in the zoned area for adherence to the work- and operating instructions as well as using the appropriate control measures.

3.1.4.3 Site Management has allocated responsibilities to conduct

verification of rules and work permits of activities in zoned areas.

3.1.5 Investigation of incidents

3.1.5.1 Site Management ensures that all unplanned events in the zoned areas are investigated and that corrective or preventive measures are taken to avoid re-occurrence.

3.1.6 Audit

3.1.6.1 Site management has put a plan in place to ensure that all elements as listed in this document are yearly audited and where required improvements are made.

3.1.7 Management review

3.1.7.1 Site Management yearly conducts a review of the system in place and uses information from investigation of incidents, audits and other sources to develop and initiate actions to improve the system in place.

3.1.8 Action for improvement

3.1.8.1 Site management ensures that a plan is present that includes the preventive and corrective actions and monitors the progress of execution.

3.1.8.2 Site management has established a system to monitor developments outside their location that will lead to continual improvement of the prevention of explosions.

3.2. Competence and training

3.2.1 Operating and maintenance employees shall be instructed in plant operations.

The instruction or training includes, and adheres to, the following:

- identity of dangerous substances that present risks to safety and the area where they are used;
- Extent and type of risks and factors that increase the risks as smoking or other ignition sources (MSDS contain most of this information and employees are to have access to these);
- the significant findings of the risk assessment ;
- the control/ mitigation measures implemented, including work instructions, the reason for them and how to use them properly;
- procedures to deal with accidents, incidents and emergencies;
- includes theory as well as practice;
- the way of supplying information and instruction is appropriate and can be done by: class or group tuition, individual tuition, written instructions as leaflets, courses, etc...;
- the training is appropriate to the knowledge and experience of the employees ;
- is updated when changes or reviews deem this necessary ;
- is refreshed when deemed necessary ;
- is suited for employees not mastering the language.

3.3. Records and documents

3.3.1 Proper systems are maintained to keep proper records and documents such as on training, permits, equipment classification, and risk assessment.

3.4. Communication/ Coordination

3.4.1 The content of the information that is communicated to all parties that are present in zoned areas meets the requirements as listed in 3.2.

3.4.2 When two or more employers share a workplace, management responsible for the workplace is required to coordinate the implementation of measures to protect employees and others from the risks of explosive atmospheres. The aim of the coordination is to :

- alert other employers, employees and others of the presence of hazardous places or substances;
- ensure suitable control and mitigation measures are in place;
- ensure that everybody has had sufficient training
- facilitate emergency arrangements in case of an incident.

4. Planning and implementation

4.1. Identify applicable legislation

This guide includes references to or made use of :

89/106/EEC	**Construction Product Directive**
89/391/EEC	**Introduction of measures to encourage improvements in the safety and health of workers at work**
94/9/EC	**Equipment and protective systems intended for use in explosive atmospheres**
97/23/EC	**Pressure Equipment Directive**
98/37/EC or 2006/42/EC	**Machine Directive**
1999/92/EC	**Protection of workers potentially at risk from explosive atmospheres**
COM (2003) 515	**Non-binding guide of good practice for implementing Directive 1999/92/EC**

Also the following standards are referred to :

EN 1127-1 Explosive atmospheres- Explosion prevention and protection - Part 1: Basic concepts and methodology

EN 13463-1 Non-electrical equipment for potentially explosive atmospheres; Basic method and requirements

NFPA 36 Standard for Solvent Extraction Plants 2004 Edition

4.2. Identify and assess risks

4.2.1 Avoiding process conditions or failures resulting in the release of substances that could create an explosive atmosphere. For this several methods are available, such as: hazard and operatability study (HAZOP); What if; EN 1050; Fault tree analysis (for an overview of methods see: The RASE Project report Methodology for the risk assessment of Unit operations and Equipment for use in Potentially Explosive Atmospheres. March 17, 2000 www.safetynet.de Library area).

4.2.2 Avoiding hazardous situations due to human interference. Their tasks and activities will have to be risk assessed and where required procedures or instructions have to be developed to avoid loss, as well as injury, damage to health or release of substances that could create an explosive atmosphere. Assessment method for this are: Task risk analysis, Job safety analysis.

4.2.3 Areas with a potential for explosive atmospheres have to be identified and documented. This guide provides proposals in Chapter 5 for this as well as requirements.

4.2.4 Avoidance of occurrence of explosive mixtures (this can be achieved by applying the details as described in this document).

4.2.4.1 **Hexane**

Hexane is a relatively volatile liquid with a flash point below ambient temperature. Therefore it readily forms a flammable (explosive) atmosphere in air. It is also of low electrical conductivity and immiscible with water, which means that it can easily build up dangerous levels of electrostatic charge, particularly when processed as a two phase mixture with water. Given its low MIE the risk posed by incendive electrostatic discharges is therefore high.

Its vapor is heavier than air and vapor will therefore tend to form flammable atmospheres at low levels.

Generic data is readily available from a range of published sources. This data is presented below.

Flash Point :	-21 to -23°C
Minimum Ignition Energy (MIE):	0.24mJ
Auto Ignition Temperature (AIT):	225 to 260°C
Lower Flammable Limit (LFL):	1.0 to 1.2%
Upper Flammable Limit (UFL):	7.5 to 8.4
Maximum Experimental Safe Gap (MESG):	0.93mm
Vapor Density:	2.97 (relative to air)
Electrical Conductivity:	10^{-5} pS/m (may change in the time)

4.2.4.2 **Miscella**
Miscella is a solution of oil in hexane, typically 25-30% oil. For the purpose of this assessment it has been conservatively assumed that the flash point of miscella is the same as for hexane. However in reality its flash point is likely to be higher.

4.2.4.3 **Oils** (only applicable for oils recovered by solvent extraction)
Hexane free oils have high flash points, which may vary slightly dependent on the degree of purity. They are extremely unlikely to form flammable (explosive) atmospheres unless heated significantly above ambient temperature.
Flash point data
Crude extraction oil > 121 °C and preferably > 150°C
Refined oil usually > 285°C (related to process conditions)

4.2.5 Avoidance of ignition sources
Sources of ignition are listed below as identified in the standard EN 1127-1, which distinguishes 13 types of ignition sources :

4.2.5.1 **Hot surfaces** Explosive atmospheres can be ignited by contact with hot surfaces, if the temperature of a surface reaches the atmosphere's ignition temperature.
If hot surfaces can come in contact with explosive atmospheres, a safety margin should be ensured between the maximum surface temperature and the atmosphere's ignition temperature.

4.2.5.2 **Flames and hot gases** Both flames and incandescent solid particles can ignite explosive atmospheres. Even very small flames must generally be eliminated from hazardous places. Flames should occur only if they are safely enclosed. Naked flames from welding or smoking must be prevented by organizational measures.

4.2.5.3 **Mechanically generated sparks** Friction, impact and abrasion processes, such as grinding, can give rise to sparking. Ingress of foreign materials, e.g. stones or tramp metals, into equipment must be considered as a cause of sparking.

4.2.5.4 **Electrical apparatus** Even at low voltages, electrical sparking and hot surfaces may occur as source of ignition in electrical apparatus (e.g. on making and breaking circuits and as a result of stray electrical currents).

4.2.5.5 **Stray electrical currents, cathodic corrosion protection**

4.2.5.6 **Static electricity** Separation processes involving at least one material with a specific electrical resistance or objects with a high surface resistance may under certain conditions give rise to incendive discharges of static electricity capable of igniting most gases or solvent vapors.

4.2.5.7 **Lightning** Provisions shall be made for protection against lightning.

4.2.5.8 **Electromagnetic fields in the frequency range from 9 kHz to 300 GHz**

4.2.5.9 **Electromagnetic radiation in the frequency range from 300 GHz to 3 million GHz** or wavelength range from 1000µm to 0.1 µm (optical spectrum)

4.2.5.10 **Ionizing radiation**

4.2.5.11 **Ultrasonic**

4.2.5.12 **Adiabatic compression, shock waves, gas flows**

4.2.5.13 **Chemical reactions** which develop heat (exothermic reactions) can cause substances to heat up and thus become a source of ignition.

4.3. Prevention and control measures

The control measures which have been listed here are essential in order to use the zone classification as given in Chapter 5.

4.3.1 Design and construction requirements

The basis of safety is given in 2.2. In order to avoid explosive mixture or contact of the mixture with ignition sources the following general requirement should be adhered to:

Develop processes and equipment so that the high risks are reduced by engineering to safe design levels, as to allow further risk reduction by means such as:

1) Safety distances as mentioned in this section
2) Vapor barrier
3) Safety devices
4) Any other solution providing the same level of safeguards, while avoiding ignition sources

4.3.1.1 **Bulk solvent Unloading Site and storage tanks**

4.3.1.1.1 Bulk solvent unloading facilities shall be located so that ignition sources presented by locomotives or tank vehicles are preferably 30m from the extraction process and at least 7.5m from any building or any property line that is or can be built on.

4.3.1.1.2 The fill connection to the storage tank shall be at least 7.5m from the extraction process. A procedure must be present to ensure safe unloading of solvent from a transport device into the solvent bulk storage.

4.3.1.1.3 Bulk solvent storage tanks shall be located outside of any building.

4.3.1.1.4 Underground solvent storage tanks shall be located away from any building foundation or support and at least 0.9m, and preferably 5m, from the nearest property line that is or can be built on. The loads carried by the building foundations or supports shall not be transmitted to the tanks.

4.3.1.1.5 Aboveground solvent storage tanks shall be located at least 7.5m from any important building and at least 7.5m from any property line that is or can be built on.

4.3.1.1.6 Aboveground storage tanks shall be enclosed by a fence.

4.3.1.1.7 Unloading Stations. Unloading structures and platforms shall be constructed of noncombustible material and shall be designed and installed in accordance with accepted practice.
The pipe connection shall be provided preferably with automated shut off valve assuring proper earthing and spill containment shall be provided.

4.3.1.1.8 Storage tanks shall be designed, constructed, installed, and tested in accordance with Directive 1997/23/EC, when applicable. According to this Directive, hexane is defined as group 1 material.

4.3.1.1.9 The bulk solvent storage tanks shall be designed interconnected and large enough to contain all hexane and miscella from the plant.

4.3.1.2 **Extraction process**

4.3.1.2.1 The extraction process shall be located in the open or in a building suitable for the purpose. The building shall be a light construction. Existing buildings not meeting this requirement will be provided with areas of light construction.

4.3.1.2.2 Enclosed plants shall have sufficient ventilation to change the volume of air at least six times per hour. This ventilation shall be accomplished by exhaust fans, preferably taking suction at floor levels however avoiding the immersion of the section line in the liquid from the containment and discharging to a safe location outside the building. The arrangement shall be

such that all portions of solid floor areas are subjected to continuous positive movement of air.

4.3.1.2.3 Ventilation fans intended to handle solvent vapors shall be designed with the increased horsepower necessary to handle higher density vapors and complying with 4.3.7.1.

4.3.1.2.4 Access control. Either an industrial-type fence or a vapor barrier shall be secured to prohibit unauthorized entrance. Provisions shall be made for emergency ingress and egress.

4.3.1.2.5 The zoned areas shall be posted with signs EX (triangular shape yellow with black surround) around the perimeter warning of the possible explosion hazard.

4.3.1.2.6 Basements, tunnels, pipe trenches, and pits shall be prohibited within either 30m of the extraction process or within the vapor barrier.
Exception : this requirement shall not apply to separation sumps and the drainage troughs connected to them.

4.3.1.2.7 Except as permitted in 4.3.1.2.9, the extraction process shall be 30m from any public way, any building, or any property line that is or can be built on.

4.3.1.2.8 The slope of the terrain and the prevailing winds shall be considered in locating the extraction process.

4.3.1.2.9 Structures and equipment essential to the operation of the extraction process, other than boilers and other open flame operations shall be permitted to be located less than 30m but not less than 15m from the extraction process, provided a vapor barrier is erected in accordance with the requirements of 4.3.1.2.10, 4.3.1.2.11 and 4.3.1.2.12 is provided.

4.3.1.2.10 The barrier shall be located between the extraction process and the possible source of vapor ignition and shall be preferably 15m or more from the extraction process.

4.3.1.2.11 The barrier shall be of noncombustible vapor tight construction without openings other then vapor tight gates and shall be at least 1.2m high and designed so that there is at least 30m of vapor travel around its ends to possible sources of ignition.

4.3.1.2.12 If the barrier is alongside a public road, the barrier shall be at least 2.5 m high.

4.3.1.2.13 The building or structure housing the extraction process shall be of fire-resistive or noncombustible construction with the ground floor at or above grade.

4.3.1.2.14 An extraction building or open process structure over two stories in height shall be provided with at least two remotely located means of egress from each floor, one of which shall be enclosed or separated from the process by a wall that is blank except for doors.

4.3.1.2.15 The enclosure or separating wall shall be of masonry or other noncombustible construction.

4.3.1.2.16 Self-closing, noncombustible doors, normally kept closed, shall be provided for access to the means of egress.

4.3.1.2.17 Solid sections of upper floors of the extraction process and concrete pads under the entire extraction process shall be curbed and sloped to drain preferably directly to an outside separation sump.

4.3.1.2.18 Drainage lines under the ground floor slab of the extraction process shall be prohibited. For existing installations, where removal may not be feasible, double walled pipes shall be used.

4.3.1.3 **Venting**

4.3.1.3.1 The extraction process shall be a closed system and shall be vented to the outside atmosphere through an approved flame arrestor installed in accordance with the conditions of its approval.

4.3.1.3.2 Manifolding of vents upstream of the flame arrestor shall be permitted.

4.3.1.3.3 Vents shall terminate at least 6 m above ground level and shall be located so that vapors will not re-enter buildings.

4.3.1.3.4 Flame arrestors shall be protected against freezing and shall be accessible for inspection and repair.

4.3.1.3.5 Vessels or tanks containing solvent, including extractors, solvent work tanks, miscella tanks, and solvent-water separating tanks, shall be protected with emergency venting to relieve excessive internal pressure in the event of fire underneath or at the bottom. If the calculated required emergency vent capacity is less than that provided by the normal vent, no additional emergency venting shall be required. Excessive pressure from the process must be controlled in another way.

4.3.1.3.6 The total capacity of both normal and emergency venting for vessels and tanks in the extraction process, which are protected, shall not be less than that given in the following Table.

Minimum Total Emergency Vent Capacity in m3 of Free Air/Hr (1 Bar and 16°C) for Vessels and Tanks.

Exposed Surface * Area (m2)	**Vent Capacity (m3/hr)**	**Exposed Surface * Area (m2)**	**Vent Capacity (m3/hr)**	**Exposed Surface * Area (m2)**	**Vent Capacity (m3/hr)**
1	95	16	1500	100	4700
2	190	18	1700	120	5000
3	285	20	1900	140	5150
4	380	25	2150	160	5400
5	475	30	2375	180	5750
6	570	35	2600	200	6000
7	665	40	2800	250	6200
8	760	50	3250	and over	
9	855	60	3600		
10	950	70	3850		
12	1130	80	4150		
14	1320	90	4400		

* Exposed surface area means the exterior surface of a vessel or tank less that portion resting on a solid earth or concrete pad.

Note :
Interpolate for intermediate values. If tank or vessel is protected by approved insulation in addition to water spray, deluge system, or equivalent protection, the flow capacities can be reduced by 50 percent.

4.3.1.3.7 All emergency relief vents shall terminate at least 6 m above ground level to a safe location and shall be located so that vapors do not re-enter the building.

4.3.1.3.8 The extractor shall be provided with means to remove solvent vapors so that the concentration of vapors inside the unit in the area where work is required can be maintained at or below 25 percent of the lower flammable limit.

The purge fan system shall take suction from the lower sections of the extractor to facilitate removal of vapors (provide for dilution or hexane concentration monitoring in line with design and zone of the fan) and shall discharge to a safe location outside the extractor building and shall be capable of changing the air in the empty extractor at least 20 times per hour.

4.3.1.3.9 **Vent Vapor Recovery System**

All pieces of processing equipment are vented to a common vent header. This header containing hexane vapor, water vapor, and air, flows into the final solvent recovery system. The solvent recovery system consists of a water-cooled shell-and-tube condenser and a mineral oil absorption recovery system. The non-condensable components are scrubbed in a mineral oil absorption column and are discharged through a flame arrester to the atmosphere by a vent fan or vent removal system. The mineral oil is heated, stripped of its hexane, cooled, and returned to the absorption column. The recovered vapors are condensed and returned to the solvent separator.

4.3.1.3.10 **Wastewater Evaporator**

Water is continuously removed from the solvent-water separator and sent to a vessel called the wastewater evaporator, where direct steam is introduced to raise the temperature to at least 85°C (185°F). Often, the direct steam is provided by the final stripper vacuum ejector (and possibly other ejectors in the process). The purpose of this wastewater evaporator is to heat the wastewater well above the boiling point of the solvent, thus evaporating any remaining solvent in the wastewater stream. This wastewater (after cooling) flows to a large outdoor separation sump that is also connected to the floor drains of the extraction building. This sump serves two purposes:

(1) It provides an additional level of safety by separating any remaining oils, solvents, and miscella from the wastewater prior to its discharge.

(2) It provides containment for any spills.

4.3.1.3.11 The fully counterflow Desolventiser-Toaster has been introduced. In this unit, the trays have a relatively uniform pattern of perforations that allow the passage of steam through each upper level tray and bed of material. Most or all of the direct steam is introduced at the bottom of the Desolventiser-Toaster and flows up through the beds in counterflow to the downward flow of material. This method desolventizes and toasts effectively, reduces the danger of solvent escaping from the bottom of the D-T, and is more energy efficient. The start up, shutdown and normal operation procedure must be properly defined in the instruction manual.

4.3.1.3.12 The distillation system of an extraction plant provides the means for evaporating and stripping the solvent from the oil. The oil after distillation shall have a flashpoint of at least 121°C and preferably 150°C or more. Numerous methods are available for accomplishing this, from the early pot-type batch stills and pan-type evaporators to the currently popular long-tube rising film evaporators, followed by high vacuum stripping.

At this time, nearly all extraction plants use two long-tube rising film evaporators, with or without recirculation. The first evaporator usually operates under vacuum, while the second operates either under vacuum or at atmospheric pressure. Heat from the desolventiser vapour is recovered and used to supply heat to the first evaporator, while indirect steam

supplies heat for the second evaporator. The choice of the type of oil stripper used depends on a number of factors, including the design and the size of the other components in the system and the material being processed.

Stripping columns commonly used are either the packed column type or the disk-and-doughnut type. The stripping column distributes the oil into a very thin film on a large surface are with a relatively high velocity of dry steam passing over and through the film. A counter-current flow is established by introducing the oil at the top of the column and allowing it to pass downward through the tower against the flow of the steam, which is introduced at the bottom of the tower.

The mixture of steam and solvent vapour passes from the top of the tower to a condenser from which the condensate is pumped to a solvent/water separator. The solvent flows from the separator to a work tank. Water flows from the separator to the wastewater evaporator.

4.3.1.4 **Conveyors**

4.3.1.4.1 The air intakes of pneumatic conveyors shall be located at least 7.5m outside of any area that is zone classified.

4.3.1.4.2 Conveyors and spouts shall be permitted to be enclosed in adequately supported, noncombustible bridge structures equipped with open grate floor sections for ventilation.

4.3.1.4.3 Conveyors and spouts from or to other buildings shall be located and protected so that passage of solvent vapors or liquid to other areas is prevented.

4.3.1.4.4 **Preventing hexane traveling to the preparation :**

4.3.1.4.4.1 Conveyors shall have, near the extraction process end, provisions for continuous air aspiration with visual indication of blower operation and both visual and audible indication of blower failure; or

4.3.1.4.4.2 Conveying systems to the extraction area shall have one or more openings (adequately dimensioned relating to pressure in the extractor and the volume released) on the outside of the extraction side of the system, after the highest point of conveyance entering the 15 m area around the extraction to allow dense solvent vapors to escape rather than flow back to the preparation area (however, the presence of one or more openings will result in a higher zone classification, see chapter 5) ; or

4.3.1.4.4.3 Alternate means of vapor removal shall be permitted if an equivalent degree of safety is provided.

4.3.1.4.5 At least one automated valve shall be provided to isolate the preparation from the extraction for extractors provided with a dry feeding hopper. The valve shall be located between plug screw and feed hopper.

Other types of extractors (e.g. protected exclusively with a plug screw) shall have two automated isolation valves.

4.3.2 Develop flow sheets and P&ID

4.3.2.1 Provision shall be made for emergency shutoff of steam and shutdown of process equipment. This may be accomplished automatically but manual operation shall be provided both near the process equipment and at a safe remote location.
Exception: smothering steam, cooling water to condensers, building fan, final fan and lights shall not be shut down during an emergency.

4.3.2.2 All motor controls for process equipment shall be interlocked so that the stoppage of any piece of solids-handling equipment will also stop feed of material to the stopped equipment and so that equipment conveying material away from the stopped unit will continue to operate. This interlock system shall be designed to require the proper start-up sequence and shutdown procedures.
Exception: where hazardous conditions would be created by stopping process equipment.

4.3.2.3 Centrally located audible alarms, visual alarms, or both shall be provided to indicate abnormal and hazardous conditions such as loss of steam, loss of cooling water pressure, failure of process pumps and aspirating and ventilating fans, fire, and stopped motors. Automatic systems may be recommended as a result of the risk analysis.

4.3.2.4 Temperature-sensing devices arranged to activate audible and visual alarms shall be installed in the desolventizer and the water outlet from the wastewater evaporator to indicate when the temperature drops to a point where solvent carryover could create a hazard. Automatic systems may be recommended as a result of the risk analysis.

4.3.2.5 Automatic systems shall assure no meal or water is discharged at temperatures below which there would be a significant hazard.

4.3.2.6 Automatic systems shall be provided to prevent excess pressure in the extractor or the desolventizer-toaster from leading to a hazardous condition. This shall be accomplished by both of the following methods:

(1) Pressure-sensing devices shall be installed on both the extractor and the desolventizer-toaster. These devices shall be arranged to activate audible and visual alarms if the pressure in the extractor or desolventizer-toaster rises toward a point where the release of solvent vapors from the process can create a hazard.

(2) Automatic systems shall be provided on both the extractor and the desolventizer-toaster that will reduce the excess pressure and lead to a safe condition if the pressure in the extractor or desolventizer-toaster reaches a point where a significant hazard is created.

4.3.2.7 Solvent tanks shall be equipped with adequate overflow return lines. Solvent flow from bulk storage to the work tank shall be remotely controlled by a device that prevents overflow of the tank.

4.3.2.8 Proper desolventizing (flash point compliance of finished oil) of the miscella is secured by safety devices resulting from the assessment, such as vacuum, temperature, sparged steam.

4.3.2.9 Solvent water separators must be developed 'safe by design' and be further protected by safety devices as to avoid any water flowing to hexane side or hexane flowing waterside in line with the risk assessment.

4.3.2.10 The Desolventiser-Toaster has proper safety devices to assure residence time /heat supply and sparged steam.

4.3.2.11 Sight glasses should be minimized. Where sight glasses are installed, they shall be of the high-pressure type protected against breakage and loss of product. Preferably, no sight glasses shall be regularly or permanently immerged in solvent/miscella.

4.3.3 Develop standard operating procedures

In this paragraph we distinguish between :

- Operating the equipment under various conditions,
- Good housekeeping standards and
- Maintaining the critical equipment.

All to ensure avoidance of potential explosive atmospheres.

4.3.3.1 **Operating the equipment under various conditions**

4.3.3.1.1 Documented procedures for **extractor start-up** shall be established to minimize the hazards resulting from passing through the flammable range. The instruction manuals of the equipment supplier and their recommendations are incorporated in the various procedures. Inerting shall be permitted to be used to reduce the oxygen content and meet this requirement. However inert gas as nitrogen is a risk to the operator. There is also the risk to pressurize the equipment and to generate a vapor flow to equipment installed outside the extraction unit.

While passing through the flammable range all potential ignition sources must be eliminated – no mechanical equipment or moving parts will be started until safe conditions (above UFL) have been reached.

The equipment shall be operated in line with suppliers' instructions, such as keeping pumps under liquids. Air from the equipment will be removed while heating the vapor phase inside the equipment above 38 °C, where possible. In other cases the site will assess the procedure and include steps assuring safe transition. O_2 monitoring could provide a safe alternative.

4.3.3.1.2 A similar approach will developed at **shut down of the process**.

Isolation from upstream and down stream equipment shall be secured.

Once the temperature inside the solvent containing equipment with moving parts is dropping below 38°C (or as assessed locally) all mechanical and rotating equipment shall be shut down.

Many years of operations have proven that start up and shut down can be conducted as a safe process.

4.3.3.1.3. Documented procedures for other operating conditions shall be established to minimize the hazards of the flammable liquids. The instruction manuals of the equipment supplier and their recommendations are incorporated in the various procedures.

4.3.3.2. **Purging for Shut down activities**

4.3.3.2.1 Before purging is initiated, the following steps shall be taken :

(1) All mechanical or moving equipment shall be locked out – only fans required for safe purging may remain in operation

(2) All connections to equipment installed in buildings adjacent to the extraction process shall be fully isolated

(3) Tanks, vessels, piping, and traps shall be emptied of all materials. All such material shall be removed to a safe location.

(4) Emptying will consist usually of 3 steps under closed conditions to avoid any spills or leak to the extraction floor or skimpit

i. Draining main amount of liquids through fixed drain lines to safe storage

ii. Draining of residuals amounts through flexible hoses to safe storage

iii. Manual draining of minor residues by safety canisters and poured in safe storage tanks using adequate earthing protection and safe clothing

(5) All piping and other connections to solvent/miscella storage facilities shall be disconnected, plugged, or blanked off.

(6) Storage tanks – located in a fenced area - will be vented though local flame arresters

Once the temperature is below 38 °C (or equivalent safe level defined) purging shall be accomplished by one of the following methods - once extraction unit management has verified that all flammable liquids have effectively been removed.

4.3.3.2.2 **Steam.** Vapor removal shall be permitted to be accomplished by the introduction of steam into the equipment. All of the following requirements shall be met :

(1) The equipment shall be adequately vented to prevent damage from excessive pressure or vacuum.

(2) Steam supply lines –properly spread over the equipment to assure all places are well purged - shall be bonded to the equipment.

(3) The rate of supply of steam shall exceed the rate of condensation so that the equipment is heated close to the boiling point of water.

(4) The equipment shall be steamed long enough to vaporize the residues from all portions of hexane. Equipment surface temperature will provide good guidance for the period of steaming.

(5) After steaming, the procedures outlined in the next paragraph 'Purging with air' shall be followed when hot work is to be performed.

4.3.3.2.3 **Purging with Air**. Vapor removal shall be permitted to be accomplished by purging with air (assure proper grounding) once the temperature was reduced below 38 °C (or any other validated level). Continued purging shall be permitted to maintain a safe atmosphere

in the ducts (e.g. < 25 % LEL). All of the following requirements shall be met :

(1) Where fixed ventilating equipment is not provided, air movers shall be permitted to be attached so that air is drawn in and discharged through the air mover, or air can be introduced through the air mover and discharged through another opening.

(2) Discharge shall be to a safe location.

(3) Air movers shall be approved for the locations in which they are used (zone classification).

(4) Precautions shall be taken to ensure that the air mover is bonded to the equipment to minimize the hazard of ignition by static electricity.

(5) In poor weather conditions (lightning) purging will be postponed.

(6) Any traffic inside and outside - within the 'restricted area' - the vapor wall shall be fully suspended.

4.3.3.2.4 **Purging with Inert Gas.** Vapor removal shall be permitted to be accomplished by purging with inert gas instead of air and then ventilating with air.

4.3.3.3 **Good housekeeping standards**

4.3.3.3.1 Flammable liquids not contained in process equipment, including materials for sampling shall not be stored in the extraction process area except in small quantities, which shall be stored in approved safety cans.

4.3.3.3.2 Waste materials, such as oily rags, other wastes and absorbents used to wipe up solvent, paints, and oils, shall be deposited in approved waste cans and removed from the premises not less than once each day.

4.3.3.3.3 Dust originating from material in process shall be kept to a minimum.

4.3.3.3.4 The space within the restricted and controlled areas shall be kept free of dry grass, weeds, trash and all combustible materials.

4.3.3.3.5 Any spills of oil, solvent, or deposits of solvent-bearing material shall be cleaned up immediately and removed to a safe place.

4.3.3.3.6 The discharge or removal of solvent-bearing material shall be recognized as a severe hazard, and operating procedures shall be established to minimize such occurrences.

4.3.3.4 **Maintaining the critical equipment**

4.3.3.4.1 All equipment identified as critical shall be included in a preventive maintenance program. The program indicates frequency, description and criteria for the maintenance to be conducted.
Equipment is critical when one of the criteria below is valid:

(1) leak tightness is lost more then twice/year and the equipment can't be taken out of service immediately

(2) the assessment according to EN 13463-1 indicates that a certain periodical replacement or attention is required to avoid an ignition source

(3) equipment is considered essential for preventing the occurrence or detection of an potentially explosive mixture (such as detection and or ventilation equipment)

(4) equipment is used to avoid propagation of an explosion or to limit effects.

4.3.3.4.2 **Power Tools.** Maintenance operations involving the use of power tools that can produce sources of ignition shall be prohibited
Exceptions:
Hot Work. Any repairs or alterations to preparation and meal finishing equipment that require welding, cutting, or other hot work shall be permitted, provided that either of the following applies:
(1) The extraction equipment has been shut down and cooled to prevent the release of vapor.
(2) The equipment being repaired has been isolated from any conveyor or duct through which a fire might be conveyed to or otherwise brought into contact with solvent vapors.

4.3.3.4.3 **Electrical Equipment**. Repairs on live electrical wiring or equipment shall be prohibited. If it is necessary to replace or repair electrical wiring or equipment, the power shall be disconnected completely and the switch shall be locked in an open position. Exception is made for EXi equipment when in accordance with suppliers' recommendations and installation.

4.3.3.4.4 **Repairs or alterations** to equipment or buildings that can produce ignition sources shall be performed only when the plant has been shut down and completely purged and has been declared safe by Extraction unit management. Safe conditions must be documented.

4.3.3.4.5 **Test for presence of flammable vapors** To ensure a safe condition, even on units out of order, tests for the presence of flammable vapors shall be made with a combustible gas indicator under each of the following conditions :
(1) Before commencing alterations or repairs, including welding, cutting, or heating operations ;
(2) Immediately after starting any welding, cutting, or heating operations ;
(3) Frequently during the course of such work.

4.3.3.4.6 All such work shall be stopped immediately when the presence of flammable vapor is indicated. The source of the vapor release shall be located & removed and the tests required -as specified above- shall be repeated before the work is recommenced.

4.3.3.4.7 Upon completion of repairs or alterations, the plant shall be checked by the extraction unit management to ensure that operations can be resumed safely.

4.3.3.4.8 **Testing.** After installation and before covering or painting, all piping systems, including suction lines, pressure testing might be required as per 1997/23/EC or recognized standards.

4.3.4 Provide for leak tight hexane containment

Quantification of leak tightness not to endanger classification of zones as given in Chapter 5.
A piece of equipment, flange connection etc. is considered leak tight when a leak has a flow of less then 1 gram of flammable substance per second (see Annex 1).
For an enclosed building the amount of leaks, as described above, is limited to : 1 leak per 150 m^3 of remaining air space (building volume less volume occupied by equipment and installations).
For an open building the amount of leaks, as described above is limited to: 1 leak per 0.5 m^2 of open area on the side where the wind is coming from.

4.3.4.1 **Solvent and Miscella transfer equipment**

Working pressure above 5 bar shall be avoided.

4.3.4.1.1 Pumps shall be designed for the solvent, the working pressures, and the structural stresses to which they will be subjected. The risk of vapor generation shall be evaluated.

4.3.4.1.2 Positive displacement pumps shall be provided with bypasses with pressure relief valves discharging back to the tank or to the pump suction.

4.3.4.1.3 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:

(1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.

(2) Safety and operating controls, including pressure relief devices, shall be provided to prevent overpressure of any part of the system.

(3) Only inert gas shall be used to transfer solvents.

4.3.4.2 **Piping, Valves and Fittings**

4.3.4.2.1 General. All pressure equipment shall comply with Directive 1997/23/EC when applicable. All piping, valves, and fittings shall be designed for the working pressures and structural stresses to which they will be subjected and shall be of steel or other material approved for the service intended.

4.3.4.2.2 Pipe Systems. Pipe systems shall be substantially supported and protected against physical damage caused by expansion, contraction, and vibration.

4.3.4.2.3 Piping shall be pitched to drain to avoid trapped liquids, or suitable drains shall be provided.

4.3.4.2.4 Armored hoses shall be permitted to be used where vibration exists or where frequent movement is necessary.

4.3.4.2.5 Aboveground solvent pipe sections 50 mm (2 in.) in size or over shall be welded and flanged. Welding shall conform to good welding practice. Pressure testing might be required as per 1997/23/EC.

4.3.4.2.6 All piping and equipment shall be coded for identification.

4.3.4.2.7 Drain valves shall be provided with plugs to prevent leakage.

4.3.4.2.8 Pipe connections 50 mm (2 in.) and larger to all tanks and vessels shall be bolted flanges that can be opened and blanked off.

4.3.4.2.9 Flame arrestors shall not be required in discharge lines from emergency pressure relief valves that are provided for vessels and tanks covered by 4.3.1.3.5.

4.3.4.2.10 Shutoff valves shall not be installed in normal or emergency vent lines.

Exception: An automatic pressure control valve shall be permitted to be installed to regulate the pressure in the extractor if all of the following requirements are met:

(1) The valve shall be located in the vent line from the extractor or in the vent line from the extractor condenser.

(2) The valve shall be actuated by the extractor pressure controller.

(3) The valve shall be installed so that it fails in the open position.

(4) The valve shall have a mechanical stop, a parallel small vent, or an equivalent feature to prevent complete shutoff.

(5) The valve shall provide a safe minimum venting capacity.

4.3.4.2.11 Shutoff valves shall not be installed in overflow lines from vessels and tanks.

4.3.4.3 **Pressure Vessels and Tanks.**

4.3.4.3.1 Unfired pressure vessels such as desolventizers and evaporators shall be constructed in accordance with the Pressure Equipment Directive 1997/23/EC.

4.3.4.3.2 All large vessels shall be equipped with bolted and gasketed plates for inspection or repairs.

4.3.4.3.3 Where sight glasses are installed, they shall be of the high-pressure type protected against breakage and loss of product.

4.3.4.3.4 Hydraulic transmission or hydrostatic gauges shall be used for remote observation of liquid levels.

4.3.4.3.5 Tanks shall be equipped with manual shutoff valves at the bottom.

4.3.4.3.6 Armored-type liquid level gauges shall be used.

4.3.4.4 **Heat Exchangers, Condensers, and Flash Drums.**

4.3.4.4.1 Provisions shall be made to ensure safe shutdown in the event of loss of primary cooling water flow. This shall be accomplished by one or more of the following methods :

(1) An automatic emergency gravity water supply tank of sufficient capacity ;

(2) A connection to an equally reliable water supply ;

(3) A provision to automatically shut off steam other than smothering steam, to immediately reduce steam-heated jacket pressure to atmospheric pressure, and to stop the flow of miscella to the distillation system.

4.3.4.4.2 All steam condensate from the extraction process that is to be returned to the boiler shall be reduced to practically atmospheric pressure in a vessel where any entrained solvent will be flashed off.

4.3.4.5 **Conveying Systems for Solids.**

4.3.4.5.1 An adequate vapor seal designed to prevent the escape of solvent or solvent vapors shall be provided at the point where the solids enter the system (such as a filled plug screw with seal tightness related to extractor pressure) see 4.3.1.4.4 and 4.3.1.4.5.

4.3.4.5.2 An adequate vapor seal shall be used on the final discharge of material from the extraction system.

4.3.4.5.3 Gaskets, if used in these systems, shall be of a material that does not decompose or soften in the presence of oil, solvent, or steam.

4.3.4.5.4 Pneumatic systems for handling solids shall be permitted to be used when material and air being handled are solvent-free.

4.3.4.6 **Miscella Filters**

4.3.4.6.1 Only totally enclosed filters shall be used. After isolation from the other hexane containing equipment, ventilation shall be provided to remove residual solvent vapors when filters are to be opened.

4.3.4.7 **Wastewater Evaporation**

4.3.4.7.1 Process wastewater shall pass through an evaporator – to assure removal of any solvent –temperature probe protected- before entering the separation sump.

4.3.4.8 **Heat Exchangers, Condensers, and Flash Drums**

4.3.4.8.1 The water side of condensers and heat exchangers shall be kept at a greater pressure than the solvent or vapor side.

4.3.5 Flammable gas/vapor detection

4.3.5.1 **Flammable Vapor Detection**

4.3.5.1.1 Approved and calibrated combustible gas indicators shall be permanently installed and maintained in good working order and are used to start ventilation and/or shutting off equipment.

4.3.5.1.2 Provisions shall be made for monitoring the atmosphere in areas where flammable vapors can present a hazard. Monitoring shall be permitted to be accomplished by installing an approved combustible gas detection system with audible and visual alarms. Where such a detection system is used, it shall be tested and maintained in good working order in accordance with the manufacturer's instructions.

4.3.6 Spill containment/protection

4.3.6.1 **Drainage and Spill Control.**

4.3.6.1.1 Provisions shall be made to guard against the introduction of solvent into the sewer systems.

4.3.6.1.2 A separation sump shall be provided to effect separation of water from oil, solvent, or miscella, taking into account the maximum hydraulic charge.

4.3.6.1.3 The separation sump shall be located within the 7.5m from the extraction process and/or within the vapor barrier.

4.3.6.1.4 The separation sump shall be concrete or of equivalent noncombustible construction.

4.3.6.1.5 The separation sump shall consist of one or more retention sections and a final water discharge section and shall meet the following requirements:

(1) The retention section(s) shall be sized to retain all oil, solvent, and miscella that can be released by a single break in a vessel or piping system, plus an additional 50 percent of that amount.

(2) The final water discharge section shall be designed with a liquid seal or other means to prevent the flow of vapor or liquid solvent to the sewer.

4.3.6.1.6 Means shall be provided to prevent the outflow of oil, solvent, or miscella from the separation sump to the sewer system under emergency conditions or if the liquid seal fails. In the event of any flow of fire protection water, provisions shall be made to contain the flow of oil, solvent, and miscella in a safe location.

4.3.6.1.7 A pump shall be provided to recover oil, solvent, or miscella collected in the separation sump.

4.3.6.1.8 Fire protection shall be provided above the separation sump.

4.3.7 Avoiding ignition sources

4.3.7.1 **General**

To ensure that ignition through equipment is avoided, there are two options :

4.3.7.1.1 Equipment made available for the first time before June, 30, 2003 should be assessed using the standard EN 13463-1. The equipment should be assessed for normal operating conditions when installed in

an area classified as zone 2, and for normal operating conditions and expected malfunctions when installed in an area classified as zone 1. Equipment installed in an area classified as zone 0 should be assessed for: normal operating conditions, expected malfunctions and rare malfunctions.

4.3.7.1.2 All equipment made available for the first time after June 30, 2003 should meet the appropriate minimum requirements as listed in Directive 94/9/EC. This means a Declaration of Conformity with the minimum requirements of the Directive 94/9/EC should be present for each piece of equipment.

4.3.7.2 **Hot surfaces : Exceptions**

4.3.7.2.1 Space heating, if required, shall be provided by indirect means. Temperatures on heated surfaces shall not exceed 120°C (250°F).

4.3.7.2.2 If steam tracing or jacketing is provided, temperatures on both internal and external heated surfaces shall not exceed 120°C (250°F).

Process temperatures shall be permitted to exceed 120°C (250°F), provided the temperature is reduced to 120°C (250°F) during shutdown periods.

4.3.7.3 **Flames and hot gases**

4.3.7.3.1 Flares or burners from process vents shall be prohibited within areas classified as zone 0, 1 and 2, but shall be permitted to be installed outside these areas. Such flares or burners shall be equipped with approved devices to prevent flashbacks in the vent piping.

4.3.7.3.2 To prevent potential explosions caused by fire in the building a sprinkler/deluge/foam system should be considered.

4.3.7.4 **Mechanically generated sparks**

4.3.7.4.1 In mechanical equipment that has moving parts and where friction, impact or abrasion can occur, the combination of light metal and steel should be avoided. The contents of light metal for category 1 equipment (for use in zone 0,1 ,2 and 20, 21 , 22) should be not more than 10% in total by mass of aluminum, magnesium, titanium and zirconium or not more than 7.5% in total by mass of magnesium, titanium and zirconium.

For category 2 equipment (for use in zone 1, 2 and 21, 22) not more than 7.5% by mass of magnesium.

For category 3 equipment (for use in zone 2 and 22) there are no special requirements for light metal use.

The use of non-sparking tools and equipment is compulsory when the installation is operating or when hexane vapors can be present.

4.3.7.4.2 Power transmission belts shall not be used in any area that is classified as a zone 0, 1 and 2.

4.3.7.5 **Electrical apparatus** (see Annex 3)

4.3.7.5.1 Electrical equipment used in hazardous places shall meet the requirements for at least category 2 equipment in accordance with Directive 94/9/EC or equivalent when made available for the first time before June 30, 2003. Equipment made available for the first time after June 30, 2003 must be selected on the basis of the zoning as per Directive 1999/92/EC Annex I and comply with Directive 94/9/EC. In accordance with the explosion protection document the work equipment, including warning devices, must be designed, operated and maintained with due regard to safety.

4.3.7.6 **Stray electrical currents, cathodic corrosion protection**

In line with risk assessment conducted.

4.3.7.7 **Static electricity**

4.3.7.7.1 All storage tanks, solvent transfer equipment, tank cars or tank trucks, and unloading structures shall be bonded effectively. Transfer of liquids should be done through dip pipes.

4.3.7.7.2 Transfer or storage tanks, unloading structures, tank cars, and tank trucks shall be electrically interconnected with supply piping or containers during the transfer of liquids.

4.3.7.7.3 Static protection shall be installed in accordance with accepted good practice and tested periodically by a competent person.

4.3.7.7.4 All tanks, vessels, motors, pipes, conduit, grating, and building frames within the process shall be electrically bonded together.

4.3.7.7.5 Building frames and metal structures shall be grounded and tested periodically to determine electrical continuity.

4.3.7.7.6 All hose, except hose used in water service, shall be electrically bonded to the supply line and to the tank or vessel where discharge takes place.

4.3.7.7.7 Grounding wires or bonding connections shall be provided between any dispensing vessel and any receiving vessel used for the transfer of solvent or mixtures of solvent and oil where bonding is not achieved through fixed connections. This shall include all sampling cocks.

4.3.7.7.8 If steam purging, cleaning, or sparging is used, all pipes or nozzles through which steam is discharged shall be bonded to the equipment being purged, cleaned, or sparged, or the objects shall be connected to ground.

4.3.7.7.9 All clothing consists of materials which don't give rise to electrostatic discharges that can ignite explosive atmospheres.

4.3.7.7.10 **Liquids & Vapors - Electrostatic Ignition Sources**

Vapors and gases have low MIEs and additional safeguards / control measures are required to eliminate low energy electrostatic discharges capable of igniting vapors and gases. Particular care must be taken to control electrostatic risks associated with:

- processing and handling of low conductivity liquids (hexane), particularly where two phase mixtures may be present.
- personnel; controlled by the use of antistatic footwear and flooring providing a resistance to earth < 108Ω.
- the use of non-conductive (e.g. plastic) components.

4.3.7.8. **Lightning**

4.3.7.8.1 Where required, an approved lightning protection system, installed in accordance with the Standard for the Installation of Lightning Protection Systems, shall be provided for the extraction process.

4.3.7.9 **Electromagnetic fields in the frequency range from 9 kHz to 300 GHz**

In line with risk assessment conducted

4.3.7.10 **Electromagnetic radiation in the frequency range from 300 GHz to 3million GHz**

In line with risk assessment conducted

4.3.7.11 **Ionizing radiation**

In line with risk assessment conducted

4.3.7.12 **Ultrasonic**

In line with risk assessment conducted

4.3.7.13 **Adiabatic compression, shock waves, gas flows**

In line with risk assessment conducted

4.3.7.14 **Chemical reactions**

4.3.7.14.1 Extractors, desolventizers and spent flake conveyors shall be of a design that minimizes the possibility of ignition of product deposits.

4.4. Management of change

4.4.1 Before making any changes to solvent containing equipment, an assessment has to be made and all identified control measures have to be implemented (inclusive of training, instructing relevant staff and adapting written procedures and instructions).

4.4.2 A pre start-up inspection is conducted before the change is made effective.

4.4.3 The whole change process is documented.

4.5. Emergency preparedness

4.5.1 All employees shall be trained in the necessary actions to be taken in time of emergency, including emergency shutdown procedures.

4.5.2 Personnel shall be trained as to the location of exits.

4.5.3 All personnel shall be trained in the use and limitations of each type of fire-fighting equipment on the premises, including control valves for the water spray systems.

4.5.4 A fire brigade, if established, shall be composed of selected personnel on each shift and shall be trained as a unit with each person assigned definite responsibilities in case of an emergency.

4.5.5 Periodic drills shall be held to ensure that employees can carry out the procedures in 4.5.1 through 4.5.4.

4.5.6 Emergency safety devices or systems provided in the plant shall be periodically tested in accordance with established procedures and a record made thereof.

5. Zone classification of extraction unit guidance and appropriate equipment categories : proposal

The proposed zoning in this chapter is based on implementing all measure as described in this FEDIOL guide.

Companies or locations that have elected NFPA as additional requirement will assure that ATEX zones are extended to meet also NFPA requirements (electrical installations only).

Zone classification outside equipment	Zone	Zone dimensions	Electrical equipment category[1]	Mechanical equipment category	Remarks
Area description					
Inside extraction process building	2		II 2G	II 3G	Unless otherwise specified below
Sampling points –hexane, miscella, white flakes	1	2 m around sampling point down to the solid floor	II 2G	II 2G	
Open trench/sewer/duct in extraction bunded area	1	Inside whole trench/duct etc	II 2G	II 2G	
Final fan exhaust – (flame arrester to be provided)	1 or 0		II 2G Or II 1G	II 2G Or II 1G	To be agreed with absorption equipment suppliers and depending on operating conditions
Hexane truck unloading-hoses and connections in tanker bay	2		II 2G	II 3G	
Hexane truck unloading - Truck hatch access	1	2 m around	II 2G	II 2G	
Separation sump	1		II 2G	II 2G	
Hexane storage pit underground tanks	1		II 2G	II 2G	Enclosed volumes always zone 0
Flame arrester hexane tanks	1	3 m around emission point down to next Floor level	II 2G	II 2G	

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[1] A separate electrical category classification has been selected in order to harmonize this document of good practice with NFPA 36 requirements for electrical systems

(continued)

Zone classification outside equipment	Zone	Zone dimensions	Electrical equipment category[1]	Mechanical equipment category	Remarks
Area description					
Exhaust vents, building fan and purge fan	1 2	Within 5 m around exhaust point In area between 5 and 10 m around exhaust point			
Emergency vents for vessels and tanks	2	Inside the duct and at least within 10 m around the exhaust point-down to ground level. At ground level zone 2 is extended to a radius of 15 m and 2.5 m high.	II 2G	II 3G	When gas detection is provided within duct

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[1] A separate electrical category classification has been selected in order to harmonize this document of good practice with NFPA 36 requirements for electrical systems

(continued)

Zone classification inside equipment	Zone	Zone dimensions	Electrical equipment category[2]	Mechanical equipment category	Remarks
Area description					
Intake hopper (only for dry hopper extractor)	1		II 2G	II 2G	
Continuous air aspiration on feed conveyor, fan and cyclone (see 4.3.4.4.1)	2	Till 3 m around release point	II 2G	II 3G	
Airbreak Vent opening (see 4.3.1.4.4.2)	1	Extended diameter of 7.5m around gate down to ground floor. At ground level zone 1 is extended to a radius of 15m and 2.5m high.	II 2G	II 2G	
Plug screw and isolation valve	1		II 2G	II 2G	
Feed conveyor between airbreak vent opening and plug screw	1		II 2G	II 2G	
Hexane storage tanks	0		II 1G	II 1G	
Extraction equipment as Extractor /white flake/screw conveyors / mechanical filters	1		II 2G	II 2G	The extractor must be vented through the white flake conveyor (at the top) at start up. The

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[2] A separate electrical category classification has been selected in order to harmonize this document of good practice with NFPA 36 requirements for electrical systems

(continued)

Zone classification inside equipment	Zone	Zone dimensions	Electrical equipment category[2]	Mechanical equipment category	Remarks
Area description					
					zoning may be altered in agreement with the suppliers and the instruction manual.
Distillation/ SWS / Miscella tank/liquid piping	1		II 2G	II 2G	
Absorber	0		II 1G	II 1G	
Final fan	0 Or 1		II 1G Or II 2G	II 1G Or II 2G	Zone to be defined in accordance with operating conditions-fan to be selected accordingly.
DT –Shumaker type	2		II 2G	II 3G	In accordance with the suppliers and the instruction manual.
Pumps	-		-	-	In accordance with the suppliers and the instruction manual.
Purge fan and ducts	1		II 2G	II 2G	When properly monitored –or sufficient by-pass air is provided.
Building fan and ducts	1		II 2G	II 2G	

[2]A separate electrical category classification has been selected in order to harmonize this document of good practice with NFPA 36 requirements for electrical systems

Annex 1. Leak tightness and number of leaks

In this guide the term leak tight and the value of 1 gram /second was introduced in chapter 4.3.4.
This annex tries to substantiate these values and ensure that it will not be possible for an explosive atmosphere to develop and or exist.
For this calculations are made of natural and mechanical ventilation requirements to remain at or below a 10% LEL level with a 1 gram/second leak.

Findings

In the guide we differentiate two situations, namely in the open (4.3.1.2.1) or in an enclosed building with ventilation to change the air volume at least six times per hour (4.3.1.2.2)
To establish safe levels (< 10%LEL) within a enclosed building ventilation is required. To calculate the ventilation requirement to remain below 10 % LEL the following formulas have been used, as found in literature reference 1.
In this reference a distinction is made between a single source and multiple sources not operating at the same time in which case 25% LEL is used provided all sources operate simultaneously. In this document the 10% LEL is used and a single source.

$$VC = a \times \frac{100}{LEL} \times \frac{100}{k} \qquad (1)$$

in which:

- VC = ventilation capacity in m^3/hr air
- a = is the leak flow in m^3/hr
- LEL = lower explosion level in % volume percentage
- k = the safety margin used on the LEL

To calculate a, when the flow is given in gram/ second the following formula is used:

$$a = a_m \times \frac{1}{M} \times 25 \times 3.6 \qquad (2)$$

in which:

- a_m = is the leak flow, in gram/second
- M = Moleculair mass in gram/mol
- 25 = is the molvolume at surrounding temperature, in m3/kmol
- 3.6 = conversion factor.

Calculating the flow in m^3/hr using formula (2)

$$a = 1 \times \frac{1}{86.2} \times 25 \times 3.6 = 1.05 \text{ m}^3\text{/hr of hexane.}$$

For an enclosed building

Ventilation capacity for an enclosed building using formula (1) LEL is 1.2 %.

$$VC = 1.05 \times \frac{100}{1.2} \times \frac{100}{10} = 875 \text{ m}^3/\text{hr}$$

Based on the 6 air changes (4.3.1.2.2) this would mean that there can be one leak per 150 m3/hr air in the building.

For an open building

Minimum air speeds in an open building are anywhere near 0.5- 2 m/s. Using the outcome of 875 m3/hr, per leak this would mean .24 m^3/sec. Using the wind speed of .5 m/sec this would require an open area of .5 m2.

Literature

1. NPR 7910-1: 2001 Classification of hazardous areas with respect to explosion hazard- Part 1: Gas explosion hazard, based on NEN-EN-IEC 60079-10, NEN, Nederlands Normalisatie Instituut, Delft
2. International Chemical safety Cards, n-HEXANE ICSC : 0279 1993

Annex 2. Comparing NFPA with "ATEX" Directives

Summary of comparing NFPA with ATEX

	NFPA 497 and 499	**ATEX (1999/92/EC)**
Application	Focus on ignition from failure of electrical equipment	Electrical and mechanical equipment could provide ignition source not only through failure.
Zoning	Class1 Division 1 and 2 have no comparison in ATEX	
	Zone 0-2 comparable to ATEX	Zone 0-2 comparable to NFPA
	Class II, division 1 comparable to zone 20	Zone 20 comparable to Class II, division 1
		Zone 21 no comparison in NFPA
	Class II, division 2 comparable to zone 22	Zone 22 comparable to Class II, division 2

Equipment classification for suited use in zone /classified areas NFPA 70 also refers to zone 0,1,2, and 20, 21, 22 as these are IEC :

Zone	**NFPA 70 (applies to electrical only)**	**1999/92/EC refers to 94/9/EC (applies to electrical and mechanical)**
0	Class I division 1	Group II, category 1G
1	Class I division 1	Group II, category 1G or Group II, category 2G
2	Class I division 1 or Class I Division 2	Group II, category 1G or Group II, category 2G or Group II, category 3G
20	Class II Division 1	Group II, category 1D
21	Class II Division 1	Group II, category 1D or Group II, category 2D
22	Class II Division 1 or Class II division 2	Group II, category 1D or Group II, category 2D or Group II, category 3D

NFPA Zoning versus ATEX

NFPA 497		1999/92/EC	
Class I, Division 1	is a location (1) in which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions, or (2) in which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage, or (3) in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition. [70:500.5(B)(1)]		
Class I, Division 2	is a location (1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems or in case of abnormal operation of equipment, or (2) in which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilating equipment, or (3) that is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [70:500.5(B)(2)]		

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NFPA 497		1999/92/EC	
Class I, Zone 0	is a location (1) ignitable concentrations of flammable gases or vapors are present continuously, or (2) ignitable concentrations of flammable gases or vapors are present for long periods of time. [70:505.5(B)(1)]	Zone 0	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is present continuously or for long periods or frequently
Class I, Zone 1	is a location (1) in which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or (2) in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or (4) that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [70:505.5(B)(2)]	Zone 1	A place in which an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally

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(continued)

NFPA 497		1999/92/EC	
Class I, Zone 2	is a location (1) in which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation and, if they do occur, will exist only for a short period; or (2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used but in which the liquids, gases, or vapors normally are confined within closed containers of closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as a result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or (3) in which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation but which may become hazardous as a result of failure or abnormal operation of the ventilation equipment; or (4) that is adjacent to a Class I, Zone 1 location, from which ignitable concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. [70:505.5(B)(3)]	Zone 2	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

NFPA 499		1999/92/EC	
Class II, Division 1	is a location (1) in which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures, or (2) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes, or (3) in which combustible dusts of an electrically conductive nature may be present in hazardous quantities. [70:500.5(C)(1)]	Zone 20	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently
		Zone 21	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.
Class II, Division 2	is a location (1) where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and (2) where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitable by abnormal operation or failure of electrical equipment. [70:500.5(C)(2)]	Zone 22	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Annex 3. Guidance on electrical equipment on ATEX 100 Equipment Directive 94/9 EC

The equipment is based on the location of its intended use and the categorized according to the level of "ignition protection" provided.

Group	Level of Ignition source		
	Very high	High	N/A
II	Cat 1	Cat 2	Cat 3

The level of protection required for each of the Group II cat is summarized below :

Level of protection	Category Group II	Performance of protection
Very High	1	Two independent means of protection or safe even when two faults occur independently of each other
High	2	Suitable for normal operation and frequently occurring disturbances or equipment where faults are normally taken into account
Normal	3	Suitable for normal operations

There is a clear link between Group II cat and hazardous areas (zones) as defined in ATEX. This relationship is shown in the table below:
Each category requires sub-division depending on its intended duty.
G = gas, vapor or mist

Gases, Vapors
Zone 0 - category 1 G
Zone 1 – category 1 G or 2 G
Zone 2 – category 1 G, 2 G or 3 G

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(continued)

It should be noted that where an equipment user's ATEX risk assessment determination of safety based on explosion protection (venting or suppression) reduces risk to an acceptable level, a lower category of equipment can be used.

Temperature classification

Hot surfaces represent potential ignition sources and the maximum surface temperature of equipment should be considered. A common approach is to use the T class.

When selecting apparatus according to temperature classification, the maximum surface temperature or the T class of the apparatus should be specified to avoid ignition sources of the potential flammable atmosphere.

T class is normally assigned basis the temperature rise tests assuming ambient temperature not exceeding 40 °C.

In other cases revert to the supplier in particular hen equipment is installed inside the insulation.

Temperature classes

T class	Maximum surface temperature °C
T 1	450
T 2	300
T 3	200
T 4	135
T 5	100
T 6	85

Guidance in a draft European Code of Practice:

"Electrostatics - Code of Practice for the avoidance of hazards due to static electricity", which has been published by British Standards as a published document ref:-PD CLC/TR 50404:2003.

Gases / Vapors

Based on published material test data (PD IEC 60079-20:2000); **new equipment for hazardous area** should be selected based on the guidance below.

MATERIAL	T CLASS	APPARATUS GROUP
Hexane	T3	IIA
Miscella	Assume as Hexane	Assume as Hexane

(continued)

Additional requirements may be required regarding T Class if the ambient temperature exceeds 40°C.

ZONE	GROUP & CATEGORY
0	1G
1	1G or 2G
2	1G, 2G, or 3G

Any existing electrical equipment within the defined hazardous areas should be surveyed to ensure it meets the standards outlined below.

ZONE 0	TYPE OF PROTECTION
0	Ex i(a) Ex s
1	any of the above or Ex d Ex i(b) Ex p Ex e Ex s Ex m Ex o Ex q
2	any of the above or Ex n

T Class and apparatus group should be as recommended for new equipment.

Existing non-electrical equipment within the defined hazardous areas must be of good design and construction, properly installed and well maintained following a formal preventive maintenance program.

Annex 4. Check-List for the application of the operating procedures of this guide

1) Extractor start-up
   - Check documented procedures,
   - No mechanical equipment or moving parts shall be started until safe conditions (above UFL) have been reached
   - Pumps shall be kept under liquids,
   - Air from the equipment shall be removed while heating the vapor phase inside the equipment above 38°C,
   - If the above is not possible, the documented alternative steps (such as O_2 monitoring) assuring safe transition shall be followed

2) Extractor shut-down
   - Check documented procedures,
   - All mechanical equipment or moving parts shall be shut down once the temperature inside the solvent containing equipment with moving parts is dropping below 38°C (or equivalent safe level defined).

3) Preliminary steps to purging
   - All mechanical or moving equipment shall be locked out (only fans required for safe purging may remain in operation),
   - All connections to equipment installed in buildings adjacent to the extraction process shall be fully isolated,
   - Tanks, vessels, piping, and traps shall be emptied of all materials. All such material shall be removed to a safe location,
   - Emptying will consist usually of 3 steps under closed conditions to avoid any spills or leak to the extraction floor or skimpit :
     i. Draining main amount of liquids through fixed drain lines to safe storage
     ii. Draining of residuals amounts through flexible hoses to safe storage
     iii. Manual draining of minor residues by safety canisters and poured in safe storage tanks using adequate earthing protection and safe clothing
   - All piping and other connections to solvent/miscella storage facilities shall be disconnected, plugged, or blanked off,
   - Storage tanks located in a fenced area will be vented though local flame arresters ./.

- Extraction unit management shall verify that all flammable liquids have effectively been removed.

4) Steam purging
- The equipment shall be adequately vented to prevent damage from excessive pressure or vacuum,
- Steam supply lines (properly spread over the equipment to assure all places are well purged) shall be bonded to the equipment,
- The rate of supply of steam shall exceed the rate of condensation so that the equipment is heated close to the boiling point of water,
- The equipment shall be steamed long enough to vaporize the residues from all portions of hexane (equipment surface temperature will provide good guidance for the period of steaming).

5) Purging with air
- The temperature shall have been reduced below 38 °C (or any other validated level) to permit vapor removal to be accomplished by purging with air,
- Proper grounding shall be assured,
- Continued purging shall be permitted to maintain a safe atmosphere in the ducts (e.g. < 25 % LEL),
- Where fixed ventilating equipment is not provided, air movers shall be permitted to be attached so that air is drawn in and discharged through the air mover, or air can be introduced through the air mover and discharged through another opening,
- Discharge shall be to a safe location,
- Air movers shall be approved for the locations in which they are used,
- Precautions shall be taken to ensure that the air mover is bonded to the equipment to minimize the hazard of ignition by static electricity,
- In poor weather conditions (lightning) purging will be postponed,
- Any traffic inside and outside (within the 'restricted area') the vapor wall shall be fully suspended.

6) Hot works
- When hot works are to be performed in the process equipment, the procedure of steam purging shall be immediately followed by purging with air,
- Hot works shall be authorized by the Site Extraction Management in writing to be performed only after full steam and air purging. ./.

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7) Purging with inert gas
- Purging with inert gas shall be immediately followed by ventilating with air.

8) Good housekeeping standards
- Flammable liquids not contained in the process equipment shall be stored (only in small quantities) in approved safety cans,
- Waste materials shall be deposited in approved waste cans and removed from the premises not less than once a day,
- Dust originating from material in process shall be kept to a minimum,
- The space within the 15m and 30m safe areas shall be kept free of dry grass, weeds, trash and all combustible materials,
- Any spills of oil, solvent, or deposits of solvent-bearing material shall be cleaned up immediately and removed to a safe place,
- Operating procedures shall be established to minimize the occurrence of the discharge or removal of solvent-bearing material.

9) Maintaining the critical equipment
- All equipment identified as critical shall be included in a preventive maintenance program. The program indicates frequency, description and criteria for the maintenance to be conducted.

10) Power tools
- Maintenance operations involving the use of power tools that can produce sources of ignition shall be prohibited.
  Exceptions:
  Hot Work. Any repairs or alterations to preparation and meal finishing equipment that require welding, cutting, or other hot work shall be permitted, provided that either of the following applies :
  a) The extraction equipment has been shut down and cooled to prevent the release of vapor,
  b) The equipment being repaired has been isolated from any conveyor or duct through which a fire might be conveyed to or otherwise brought into contact with solvent vapors.

11) Electrical equipment
- Repairs on live electrical wiring or equipment shall be prohibited. If it is necessary to replace or repair electrical wiring or equipment, the power shall be disconnected completely, and the switch shall be locked in an open

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position. Exception is made for EXi equipment when in accordance with suppliers' recommendations and installation.

12) Repairs or alterations to equipment or buildings

- The opening of equipment that contains or is likely to contain solvent shall be authorized in writing by the individual in responsible charge of the plant before the work is started,
- Repairs or alterations to equipment or buildings that can produce ignition sources shall be performed only when the plant has been shut down and completely purged and has been declared safe by Extraction unit management. Safe conditions must be documented,
- Upon completion of repairs or alterations, the plant shall be checked by the extraction unit management to ensure that operations can be resumed safely.

13) Test for presence of flammable vapors

- To ensure a safe condition, even on units out of service, tests for the presence of flammable vapors shall be made with a combustible gas indicator under each of the following conditions :
  a) Before commencing alterations or repairs, including welding, cutting, or heating operations,
  b) Immediately after starting any welding, cutting, or heating operations,
  c) Frequently during the course of such work,
- All such work shall be stopped immediately when the presence of flammable vapor is indicated. The source of the vapor release shall be located & removed and the tests required - as specified above - shall be repeated before the work is recommenced,
- Approved and calibrated combustible gas indicators shall be permanently installed and maintained in good working order and are used to start ventilation and/or shutting off equipment,
- Provisions shall be made for monitoring the atmosphere in areas where flammable vapors can present a hazard. Monitoring shall be permitted to be accomplished by installing an approved combustible gas detection system with audible and visual alarms. Where such a detection system is used, it shall be tested and maintained in good working order in accordance with the manufacturer's instructions.

14) Pressure testing

- After installation and before covering or painting, all piping systems (including suction lines) might require pressure testing as per 1997/23/EC or recognized standards.

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15) Hot surfaces
- Space heating, if required, shall be provided by indirect means. Temperatures on heated surfaces shall not exceed 120°C,
- If steam tracing or jacketing is provided, temperatures on both internal and external heated surfaces shall not exceed 120°C,
- Process temperatures shall be permitted to exceed 120°C, provided the temperature is reduced to 120°C during shutdown periods.

16) Liquids & Vapors: Electrostatic ignition sources
- Vapors and gases have low MIEs and additional safeguards/control measures are required to eliminate low energy electrostatic discharges capable of igniting vapors and gases. Particular care must be taken to control electrostatic risks associated with :
  a) Processing and handling of low conductivity liquids (hexane), particularly where two phase mixtures may be present ,
  b) Personnel controlled by the use of antistatic footwear and flooring providing a resistance to earth < 108Ω
  c) Use of non-conductive (e.g. plastic) components.

17) Management of change
- Before making any changes to solvent containing equipment, an assessment has to be made and all identified control measures have to be implemented (inclusive of training, instructing relevant staff and adapting written procedures and instructions),
- A pre start-up inspection is conducted before the change is made effective,
- The whole change process shall be documented.