

# Annex 3

## Example RA foam plants

Risks assessment summary and risk management overview for foam plants: overview.			
Process equipment (the overlap between the limits of the system are made voluntarily) general: valid for block and moulding			
sector / possible hazard	main causes	prevention	protection
unloading (limits= from tanker to pipe on top of the bulk)			
leak: liquid emitting vapors or fuel leak	pipe rupture (all causes) hose rupture (all causes) gaskets rupture (all causes)	design guidelines inspection preventive maintenance on hoses audits  Alarms audible/visual Seals replacement procedure /type	emergency response
vapors leak	same as before vent line return rupture vapors emissions following tank collapse and shell rupture leak emitting vapors (emptying of a hose, gasket valve leak, pipe leak, pipe rupture) tank opened to the air (man hole, flanges) due to multi compartment deliveries and tank identification mistake tanker with several compartments unloading with error in vent line / compressed air connections	design guidelines inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections SIF training double checks on critical tasks Alarms audible/visual	emergency response PPE
projections (liquid phase)	back flow from pump or hose/ pipe (i.e. maintenance) projection following pipe / hose rupture projections during truck disconnection rupture in the pressurized line after the pump tank put under pressure and valve opened	critical installation: permit to work critical tasks instruction design and inspections SIF training	emergency response PPE
projections by pressure / over pressurization	excess of allowable pressure in the tanker / hoses / pipes opening of a cap during unloading by pressure valve failure during hoses disconnection unloading valve closed during pumping (pump outlet) tyres / breaks air tank rupture	design guideline inspection critical tasks instructions and double checks critical installation: permit to work competency evaluation and trainings audits inspections	emergency response information
accident with moving truck (operator) HGV/Road tankers	truck reversing with low visibility truck maneuvering in an narrow space truck moving unexpectedly (wheels shocks missing, brakes failure) Blind spots Collisions	human safety barriers installation design critical tasks instructions Reversing alarms Speed restriction Site traffic management ie One way and segregation of vehicle types	zoning access restriction information Segregation from other types of vehicles
fall from height (truck or tank)	slippery tank tanker moving efforts to connect pipe leading to losing balance wind	usage of fall protection + harness coordination between operators design Off-loading Grantries	Fall arrest PPE

tank collapse	vent line return plugged (valves failure, human error, pipes obstruction) compressed air failure (polyols unloading) vent valve failure (all other chemicals in bulk)	design and inspection (safety P limiter on air connections) critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections Minimum temp of chemicals for offloading	
moving / mobile parts : pumps and gearbox	inaccurate protection partial dismantling unexpected start-up	LOTO Auto Safety lockouts design training regular inspection	
runaway	water ingress in tanks accidental mixture of chemicals (unloading error, multi compartment tanks)	wet side design and BIC critical tasks: permit to work no go instructions (multi compartment tanker) Bunded separation	emergency response
crystallization	cold chemical partially reacted chemical contamination with other chemicals	specifications design: filters in unloading line preventive maintenance TDI / MDI Min Offloading temperature 19	emergency response
liquid leak and vapors emissions	siphon during unloading (with hose rupture) cistern with bottom valve failing shell rupture (mechanical aggression, overpressure, forklifts, collisions)	design and inspections specifications preventive maintenance Area vapour monitors	emergency response
skin contact contamination	contaminated equipment and tools (missing PPE) projections emergency response (inappropriate protection)	critical installation: permit to work critical tasks instruction design and inspections Emergency showers at Off-load point and machine head	PPE
storage (from unloading pump outlet to valve on top of the day tank) (drums / IBC storage)			
catalysts projection (corrosive)	runaway in a drum drum exposed to large heat before opening drum ,/ IBC rupture (falling, perforation) handling of contaminated parts (gaskets, drum caps, buckets)	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections Defined storage locations Bunded area	PPE first aid
leak (drums, IBC's, bulk)	pipe rupture (all causes) hose rupture (all causes) gaskets rupture (all causes) valve leaking pump leaking tank overfilling rupture of the shell external aggression projections during drums / IBC emptying (manually) siphon (during drums / IBC unloading) overfilling of transfer drums	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections double checks Defined storage locations Bunded area	emergency response PPE
moving / mobile parts : pumps and gearbox	inaccurate protection partial dismantling unexpected start-up	LOTO design training	information
fire	not detailed here	not detailed here	emergency response
drum / IBC falling	sudden braking during transportation lack of balance damaged pallets / racks collision	instructions trainings competency evaluation	emergency response

Runaway	water ingress in tanks (diisocyanates) accidental mixture of chemicals (unloading error, error in transfer, insufficient labeling)	design critical tasks: permit to work inspections preventive maintenance (dryers)	emergency response RPE/PPE
Vapors emissions: acute, chronic or sub chronic effects	leaks releases from tanks (venting) surface contamination accidental releases (overpressure, rupture, fire)	room enclosure and exhaust black and white instruction design	emergency response RPE/PPE
Fall from height (tank)	inappropriate guarding design of access (not following standard)	usage of fall protection + harness coordination between operators design	PPE
Slips and falls	obstacles leaks slippery floor difficult access (including for maintenance)	design cleaning inspections	immediate corrective actions
Manual handling (accident or illness) Ergonomics / Repetitive strain	heavy loads falling loads collision between drums / loads difficulties for prehension repetitive motion postures for handling	tools for handling need for manual handling reduced to a minimum storage design training (partial barrier)	
Crystallization	contact with humid air insufficient storage temperature wet air curtains in tanks	design inspections preventive maintenance	emergency response
dimerization / trimerization	local overheating applied on an installation	critical installation: permit to work critical tasks instruction design and inspections	emergency response
skin contact contamination	contaminated equipment and tools (missing PPE) projections emergency response (inappropriate protection)	black and white instruction PPE guideline	PPE instructions
hot surfaces, on transfer pumps	incorrect flow (viscosity, int'l safety valve failure)	design and inspections specifications	
blending / chemical wastes (from polyols tanks to valves on top of the day tanks) (from waste generation point to wastes storage, including wastes storage)			
catalysts projection (corrosive)	During hose removal from a drum or during transfer / connection. Rupture on pipes / pumps (all cases) leak during removal of the blend tank	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections	PPE
leak	container (IBC) rupture (external aggression) or connection ruptures pipe rupture (all causes) hose rupture (all causes) gaskets rupture (all causes) valve leaking pump leaking tank overfilling rupture of the shell external aggression siphon (during drums / IBC unloading) overfilling of transfer drums or day tanks	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections (siphon not fully prevented)	emergency response access restrictions
drum / IBC falling	rack rupture sudden stop during transportation unstable piling during emptying of an IBC / blending) during handling (from / to the truck)	design inspections specifications training	emergency response

runaway	water entering container (rain, leak, heat exchanger rupture, day tank wall leak, dry air contamination) mixture with incompatible chemicals (catalysts, decontaminant)	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections (important: water pressure < diisocyanates pressure)	emergency response
moving / mobile parts : pumps and gearbox	inaccurate protection partial dismantling unexpected start-up Guarding	LOTO design training	
projections under pressure	hydraulic hose or pipe or tank rupture (fatigue, external aggression, internal aggression) see catalysts projections dismantling of pneumatic equipment under pressure rupture of liquid pipe under pressure	design installation guidelines (must be improved) LOTO	
vapors emissions: acute, chronic or sub chronic effects	leaks releases from tanks (venting) surface contamination accidental releases (overpressure, rupture, fire) chronic emissions of empty containers (catalysts)	black and white instruction PPE guideline LOTO trainings	RPE/PPE
vision impairment: blue haze	emissions of amines with insufficient air renewal	(insufficient prevention) air monitoring lines and curing conveyors enclosure LEV on crushers	
skin contact contamination	contaminated equipment and tools (missing PPE) projections emergency response (inappropriate protection)	black and white PPE	PPE instructions
liquid leak and vapors emissions	leak on a catalyst container (see leaks) chronic emission of drums / IBC during handling	design and inspection critical tasks instructions critical installation: permit to work competency evaluation and trainings audits inspections	PPE
burns (hot surfaces)	contact with transfer pump (CPP polyol)	design (reduced head pressure drop)	
Process errors (formulation, preparation etc.)	incorrect labeling human error piping mistake	training competency evaluation critical tasks instructions permit to work	
wet-side room (from the outlet of the pump in bulk to pouring heads / from the outlet of blending pipes to pouring heads), valid for block and moulding			
vapors emissions: acute, chronic or sub chronic effects	continuous breathing of the day tanks through the safety relief valve not directed to the outside leaks (on pumps, day tanks, threaded connections, gaskets), including amines and diisocyanates emissions pouring head leak (internal), contaminating the oil line with diisocyanates open buckets / drums (flow test and waste drums)	design; tanks vents directed to outside leak policy inspections maintenance pouring head maintenance black and white	PPE access restriction
leaks (oil, chemicals, solvents)	bottom of IBC's connections leaking drums emptying in inappropriate areas blender leaks after blending gaskets / connections / hoses leaking (all causes, from ageing to external aggression, including the chemical aggression of amines on PVC / PE / PP hoses.	design; tanks vents directed to outside leak policy inspections maintenance regular cleaning black and white	bunds

projections under pressure	<p>opening of a valve at the outlet of a working pump</p> <p>bursting hose or gasket (wrong replacement, incorrect assembly, inappropriate gasket, damaged equipment due to internal or external aggressions)</p> <p>hose motion during re filling of an IBC (after a precedent incident) (hose not fixed).</p> <p>build-up at the outlet of the pouring head</p> <p>tanks overfilling</p>	<p>design</p> <p>training and competency</p> <p>critical tasks instructions</p> <p>SIF design</p> <p>inspections and maintenance</p>	<p>emergency response</p>
projection of toxics	<p>opening of a valve at the outlet of a working pump</p> <p>bursting hose or gasket (wrong replacement, incorrect assembly, inappropriate gasket, damaged equipment due to internal or external aggressions)</p> <p>hose motion during re filling of an IBC (after a precedent incident) (hose not fixed).</p> <p>build-up at the outlet of the pouring head</p> <p>transfer of liquids (flow test to waste drums) or opening of a line under pressure</p> <p>container falling (drum, bucket, IBC)</p> <p>runaway chemical reaction</p>	<p>design</p> <p>training and competency</p> <p>critical tasks instructions</p> <p>SIF design</p> <p>inspections and maintenance</p> <p>black and white</p>	<p>emergency response</p> <p>PPE</p>
surface contamination (TDI / MDI, amines)	<p>after a precedent leak (insufficient decontamination)</p> <p>pumps and pouring heads repairs in maintenance</p> <p>contact between surfaces and contaminated gloves / shoes (switches, door handles, tools, drums, hand rails, floors)</p> <p>contaminated clothes (after a precedent incident)</p>	<p>design</p> <p>training and competency</p> <p>critical tasks instructions</p> <p>SIF design</p> <p>inspections and maintenance</p> <p>black and white</p>	<p>emergency response</p> <p>PPE</p>
runaway chemical reaction	<p>any contact between TDI / MDI and another liquid (water jacket leaking, heat exchanger leaking, wastes mix, error in decontamination, after an overfilling of a container of any type and a bund in which water remains)</p>	<p>design guideline</p> <p>audits</p> <p>critical tasks</p> <p>permit to work</p>	<p>emergency response</p>
moving / mobile parts : pumps and gearbox, heads	<p>unprotected couplings on pumps</p> <p>opening in MK heads where the internal piston is accessible</p>	<p>LOTO</p> <p>design</p> <p>training</p> <p>regular inspection</p>	
manual handling (accident)	<p>drums and IBC manipulation</p> <p>drum falling during transfer (made by rotating the drum on its bottom)</p>	<p>design (machine)</p> <p>design (storage)</p> <p>instructions and work organization (handling tools)</p> <p>ergo observation and feedback</p>	
object falling (pumps etc.) in maintenance operation	<p>missing hangers on heavy parts</p> <p>insufficient access for maintenance during heavy parts repair</p>	<p>training and experience</p>	<p>two operators for the most difficult operations</p>
falling from height (maintenance door on mezzanine)	<p>in some plants, where wet side is on a mezzanine, and a large door is used for maintenance</p>	<p>access guarding</p>	<p>harness</p>