Making Process Safety personal

David Royle, Site Process Engineer, Basell Polyolefins UK Ltd.(LyondellBasell), Carrington Site, Urmston., Manchester, M31 4AJ

The LyondellBasell site at Carrington uses several techniques to achieve the same focus on process safety as on occupational safety. The main aims are to make process safety as personal as possible and use all possibilities to emphasise barrier management.

A high level of Process Safety near misses is reported. Hypothetical scenarios have been developed based on combining a number of these actual near misses into hypothetical events which could be catastrophic if they occurred. The aim is to foster a sense of unease by showing the possibility of such events if several barriers fail and thus the importance of each individual barrier.

Quarterly Process Safety newsletters are issued to all personnel providing reminders of previous incidents within industry as a whole and within the company. Articles are also included as refreshers of the hazards of different fluids and updates of process safety improvement projects.

On significant anniversaries of major incidents, reminders are sent to everyone on site with an overview of the incident including the underlying causes of the barriers which failed.

Process Safety Tool Box talks are carried out on all the above subjects, with sharing of topics across company sites for discussions with operating and maintenance technicians.

Under the general Process Safety theme of 'Lives and Livelihoods', a newsletter was produced based solely on process safety hazards in the home including LPG storage & handling, prevention of gas leaks, flammable hazards of clothes driers, smoke and carbon monoxide detection and emergency planning.

Keywords: Process Safety, Personal, Barriers, Theoretical Scenarios, Newsletters, Tool Box Talks.

Introduction

Historically, companies have concentrated their safety management culture more on Occupational Safety than on Process Safety.

LyondellBasell corporate HSE philosophy is 'Goal Zero' where the aim is to prevent incidents and injuries.

LyondellBasell has increased the level of focus on Process Safety at a corporate level and the Basell Polyolefins UK Ltd. site at Carrington (part of the LyondellBasell group) uses several techniques to achieve the same focus on process safety as on occupational safety. The main aims are to make process safety as personal as possible and use opportunities whenever possible to emphasise barrier management, under the general Process Safety theme of 'Lives and Livelihoods'.

Development of Scenarios from Near Misses

A high level of Process Safety near misses is reported, with the site reporting the highest number of process safety near misses per person within the whole company.

Hypothetical situations have been developed based on combining a number of these actual near misses from a range of equipment across site at different times leading to hypothetical scenarios which could be catastrophic if they occurred on the same equipment at the same time. The aim is to foster a sense of unease by showing, from real near misses, the possibility of such events if several barriers fail at the same time and thus the importance of each individual barrier.

Two such hypothetical situations leading to similar consequences to site COMAH Key Scenarios are as follows:-

(a) BLEVE of Reactor Vessel (see Figure 1)
- C3= Pump Cavitates
- Pump Doesn't Trip
- Leak from Incorrect Gasket
- ROSOV Seizes
- Jet fire created
- Auto Deluge Valve Fails
- Fire pump fails
- Evacuation Alarm Confusion
- Fireproofing missing
- REACTOR BLEVE

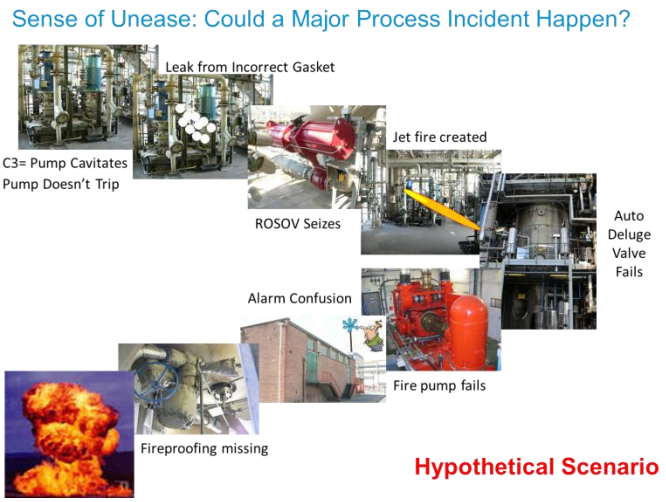


Figure1: Hypothetical Reactor BLEVE Scenario

(a) LPG Storage Sphere Overfill Leading to Explosion in Temporary Building (see Figure 2)
- Sphere undergoing Maintenance
- Corrosion Found delaying re-commissioning
- Ship waiting to off-load at Jetty
- Interlock Broken
- Flow Trip Fails
- Level Trip Awaiting Spares
- Actuator Seizes
- RV to Flare undergoing Test
- RV to Atmosphere Lifts
- Gas drifts towards temporary building
- Confusion from contractors about the correct emergency response
- EXPLOSION WITHIN PORTACABIN

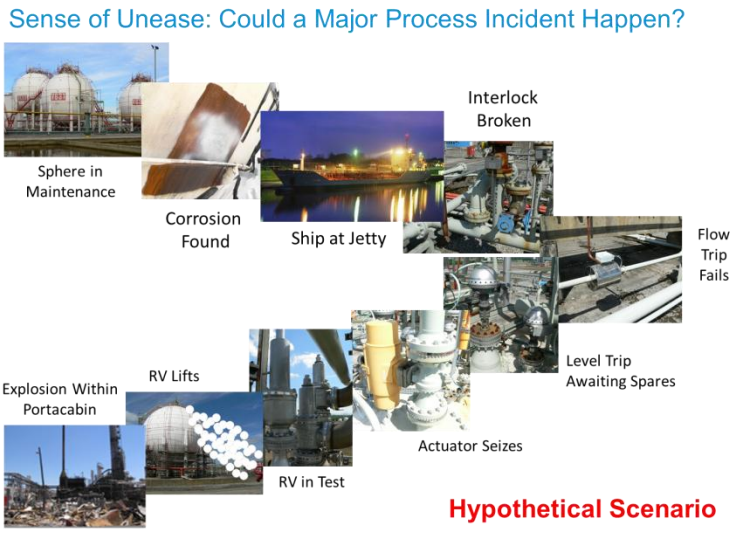


Figure2: Hypothetical LPG Sphere Overfill Scenario

Process Safety Newsletters

Quarterly Process Safety newsletters are issued to all personnel (including term contractors) to communicate important Process Safety information such as reminders of previous incidents within industry as a whole and within the company. Articles are also included as refreshers of the hazards of different fluids and updates of process safety assessments and improvement projects. Tool box talks are held with each operating shift team (and where applicable the maintenance team) to discuss the content face-to-face and allow detailed questions about the issues involved. On many occasions this leads to useful discussion and information being received which may not be known by engineers,

Articles about the causes and relevance for Carrington site have been written about the following Major Industrial Incidents:-
- Imperial Sugar, Georgia
- San Juan, Mexico City
- Icmesa, Seveso
- Shell, Moerdijk
- AZF, Toulouse
- Philips, Pasedena
- BP, Texas City
- Esso, Longford
- Formosa, Texas
- Union Carbide, Bhopal
- Nypro, Flixborough,
- Occidental, Piper Alpha
- BP, Grangemouth
- Hertfordshire Oil Storage, Buncefield

Articles have been written about the following Process Safety Initiatives:-
- Minor Incidents at Site and their root causes
- Incidents at Sister plants
- Incidents at plants within the same Technology
- Filter switching incidents
- Incidents generating Chlorine clouds from incorrect water treatment chemical offloading
- Annual Summary of most important Site near misses
- Plant re-Hazoping
- Human Factors Risk Assessments
- Occupied Buildings Assessments
- SIL Assessment update
- Alarm Management update
- Hazardous Properties of Materials on Site (Peroxide temperature sensitivity, Nitrogen Asphyxiation, Ethylene Decomposition)
- Low Temperature Embrittlement
- Corrosion Under Insulation
- Safety Critical Tasks
- Safety Critical Equipment
- Process Safety improvement projects implemented
- Contractor initiatives
- COMAH report updates
- Risks from Adjacent sites
- Review of Level 5 COMAH exercises with authorities

Examples of these newsletters are shown below:-

PROCESS SAFETY NEWSLETTER
Carrington Site
No. 1: July 2011

GENERAL

Welcome to the first issue of the Carrington Process Safety News, a quarterly newsletter that covers process safety initiatives and in particular giving reminders about previous incidents and their causes at Carrington, within the company and in the wider industry.

5 YEARS AGO: BUNCEFIELD

The Buncefield explosion and fire was the largest fire in the UK since the 2nd World War. Although the incident took place at a fuel storage depot, there are some learning points which are relevant for the chemical industry. The issues raised by the Buncefield incident were:-
- Known reliability issues with the storage tank level indicator/alarm
- Independent high level trip inadvertently defeated by lack of knowledge about the type of instrument needing to be locked in place
- Insufficient screens available to plant operators
- Inadequate maintenance of bunds
- Inadequate firewater runoff capacity

If you recognise that protection systems are not working, report these as soon as possible to have them rectified and if necessary take extra measures in the meantime to control the risk.

THIS YEAR: FATALITY AT WALKERS CRISPS FACTORY FROM CHLORINE GAS

Did you know that chlorine gas can be produced when sodium hypochlorite is mixed with acids?

This occurred at a Walkers crisps factory when someone connected a hose to the wrong offloading point. The worker was overcome by the fumes and died later in hospital. At Carrington, this possibility occurs at the cooling towers where offloading sulphuric acid or phosphoric acid into the hypo tank (or vice versa) could lead to chlorine gas being given off.

Although the connections aren't the same, there is always the possibility that other fittings could be used to make the job easier.
Always ensure that the supplier is sure which tank a delivery of chemicals needs to be offloaded into.

BILFINGER PROCESS SAFETY CARD

- A recent review of the topics raised via the Bilfinger Process Safety Cards submitted over the past 12 months at different sites around the country where they work clearly identifies the main areas where possible plant failures are occurring on sites.

These three areas include: Process Leaks, Missing Supports & Damage to Insulation

- All three can cause significant damage to plant.
- The Industry is focusing on the prevention of major incidents on sites and a key element of this is ensuring the integrity of the plant and the reporting of failures.
- Corrosion Under Insulation (CUI) can be plaguing to the chemical industry as the extent of the damage is often unseen
- Corrosion can attack the insulation and underlying equipment such as pipe work
- The drying/wetting cycles in CUI associated problems are a strong accelerator of corrosion damage since they provoke the formation of an increasingly aggressive chemistry that can lead to the worst corrosion problems possible, e.g. stress corrosion cracking, and premature catastrophic equipment failures
- Please ensure you report any corrosion seen on site – it may just prevent a major incident

Thanks to Claire Evans, the Bilfinger Safety Advisor for this article.

SAFETY CRITICAL EQUIPMENT

Are you aware of which equipment is Safety Critical on the plant? Essentially, any equipment which helps to prevent or reduce the severity of a major incident is deemed as safety critical.

It is really important that this equipment is kept in full working order to minimise the possibility of a major incident occurring to as low as possible.

Examples of Safety Critical Equipment (SCE) on site are:-
- Certain trip systems
- Depressurising valves
- Fire & Gas detection systems
- Fireproofing
- Mechanical Interlock Systems
- Fire fighting systems (e.g. deluges or fire pumps)
- Relief Valves and Bursting Disks
- Instruments which are part of Safety Critical Alarms
- RO's and control valves which limit the size of relief cases
- Certain Non-Return Valves
- Evacuation systems

Are you aware that CCTV cameras on the plant are SCE? Several were not working recently such that emergency procedures could not be fully followed in an incident.
Look out for issues with any of these systems when you are working on the plant and report any problems to your supervisor so that they can be repaired as soon as possible.

UTILITY SUPPLY CONNECTIONS

A project was implemented in 2013 to improve the utility points around site to have dedicated connections for each utility type.
Recently there have been several issues found with nitrogen connections at Movements/Jetty:-
- NRV missing from one of the supplies
- Carbon steel flange found connected to a MacDonald coupling where the system is designed to be stainless steel
- Incorrect hoses stored at N2 supply points
- Jetty N2 hose not rated for the correct design pressure

It is important to keep the integrity of these utility systems as designed. Modification of any such systems in this way should only be done via the MOC system.

PROCESS SAFETY NEWSLETTER

Carrington Site No. 5: Sept 2012

GENERAL

Welcome to the fifth issue of the Carrington Process Safety News.
If you have any questions or ideas for articles in future newsletters, please contact Dave Royle (x3235).

1989: PHILLIPS PASADENA

An explosion and fire occurred at the Phillips Pasadena HDPE plant on 23rd October 1989, killing 23 people and injuring another 314 and causing $1.4 Billion in damage and consequential losses.

The accident occurred when blockages in reactor settling legs were being cleared during a shut-down. The leak occurred when a blockage cleared due to only a single valve isolation and the single valve having its air lines connected the opposite way round to that intended. The explosion occurred 2 minutes after the leak.

Learning points from the incident are:-

- The company standard for double valve isolation was not followed.
- Air lines should have been disconnected to instrumented valves if used for isolation.
- The plant had no fixed gas detection system.
- It is probable that some people in parts of the plant could not hear the evacuation alarm.
- Separation distances between plants and escape routes were criticised.

CORROSION UNDER INSULATION

Corrosion of varying types costs Industry millions of pounds pa in repair and lost production costs. One of the most common causes is "Corrosion Under Insulation" or CUI. This is a result of moisture entering the insulation setting up a "corrosion cell", simular to a car battery, where the "anode" gradually corrodes away. In our case this is usually carbon steel piping or equipment.
There are several barriers to CUI:

- Good design avoiding moisture traps and penetrations in the insulation e.g. pipe hangers.
- Protective coatings such as paint or galvanising.
- Well installed properly sealed insulation or closed cell insulation.
- Material of construction e.g. Stainless Steel rather than Carbon Steel.

CUI is particularly aggressive between +50C and +120C. Temperature fluctuations e.g. start-ups and shut-downs, "Thawing zones" on low temperature plant and areas where there is condensation and re-evaporation also exacerbates the effects! So what can we do to help prevent this?

- Carry out Risk based Inspection (RBI) studies to identify high risk areas.
- Regular inspections of piping and equipment including insulation removal.
- Ensuring that painting and insulation is properly applied and maintained.

So what can you do to help prevent this?

- **If you see missing or damaged insulation; report it or raise a notification in SAP.**

Thanks go to Alec Morrow for this article.

>25 YEARS ETHYLENE FIRE IN MORRIS, ILLINOIS

On September 12th 1989, a fatal incident occurred at the LyondellBasell Morris site in the USA. Two people lost their lives and seven people were severely injured.

The incident was on the Ethylene Cracker after the de-ethaniser, one day after a start-up. The overheads of the de-ethaniser were still being flared with the backpressure being controlled.

A gas leak from the flange of a heat exchanger was minimised by reducing the pressure in the overheads line by closing the column overhead control valve. This caused greater condenser load and then a high level in the overheads reflux drum. Due to the overheads control valve passing, some liquid flashed through it to the downstream exchangers which were at an abnormally low pressure, causing a temperature of approx. -75C.

Following bypassing of the leaking exchanger, the control valve was re-opened. The sudden increase in pressure, combined with the already cold temperature caused another carbon steel exchanger to fail catastrophically, leading to a major fire.

This is an example of brittle failure caused by auto-refrigeration of equipment which had not been specified for such low temperatures in upset conditions.

Most parts of PP and Movements are constructed from low temperature materials. However it is possible for C3= or C2= to condense in other systems e.g. HP Bag Filter or Ethylene pipeline. As discussed in the recent ethylene hazards training, prevention of liquefaction of hydrocarbons in normal CS systems is key to preventing such incidents. If liquid forms, flashing the liquid into other plant systems and re-pressurisation should be avoided.

PROCESS SAFETY PROJECT UPDATE

A project has been approved to further reduce risk on certain systems on the plant as follows. These items were raised in the site audit which was carried out by corporate teams:-

- Fireproof the steelwork on the propylene drier unit
- Provide Smith Flow Locks on RV/BD Isolation Valves
- Provide Double Block & Bleed Isolations on Critical Items

The fireproofing on the propylene drier unit has been completed such that the structure would retain its integrity for at least 2 hours in the event of a fire, reducing the likelihood of loss of containment and the potential domino effect to other systems.

The design of the new RV isolation locks has been completed and the locks fitted to the valves on the PP plant. A panel is on-order for the PP control room wall such that the status of all locking systems can be easily seen at any one time.

The design of the double block and bleed systems has been completed. Some systems will be provided with integral DBB (butterfly) valves within a single casting which can be a direct replacement for existing single valves (same face-to-face dimension). This will release other (expensive) 300#/600# stainless steel valves for providing double block and bleeds in other locations at a lower cost.

The systems being provided with DBB's as part of this project are:-

C3= recycle pumps
Propylene Driers,
Reactor liquid C3= feed filter,
Pre-pol C3= Filter
Liquid C3= purge filter
Column feed filter.

The systems will be installed in a step-by-step basis as and when plant shut-downs allow and some involving welding may need to be installed in the next major shut-down.

PROCESS SAFETY NEWSLETTER

Carrington Site No.6 : December 2012

GENERAL

Welcome to the sixth issue of the Carrington Process Safety News.
If you have any questions or ideas for articles in future newsletters, please contact Dave Royle (x3235).

FLIXBOROUGH 30+ YEARS AGO

A fire and explosion occurred at the Nypro plant at Flixborough on 1st June 1974, killing 28 people and injuring another 36 (on-site) and 53 (off-site). The injury toll would have been much higher had the incident not happened at the weekend.

The accident occurred when a leak of cyclohexane occurred from a 'temporary' line with a dog-leg which was installed to bypass one of the reactors due to one of the reactors having a leak. The new line was not subject to a formal MOC and failed during operation.

Following this accident, more stringent Management of Change (MOC) procedures were introduced across the industry so that changes, including temporary ones, are fully assessed.

There have been 7 temporary MOCs completed at Carrington during the last 12 months as follows:-

- Temporary H2 bay operation.
- MOS Level Trip on Recycle Compressor KO Pot.
- Removal of high level probe in the decomposer vessel.
- Overhead condenser alarm changes.
- Gas heaters for the packing line.
- Overriding C3= sphere outlet valves.
- Recycle accumulator level control modifications.

BALL VALVE FAILURE, BRAZIL, 1995

A serious fire occurred at the LIPP plant near Rio de Janeiro, Brazil in December 1995, in the polishing unit. The fire was caused by a leak of liquid propylene from a ball valve when the ball was ejected from the 4" valve (Worcester Type 52) whilst a spool piece was being removed for plant modifications. Three people were killed and 5 people were injured. Following investigation, the cause was found to be due to a sheared grub screws which held an insert in place which in turn held the ball in place. Checks were made at Carrington immediately following the incident and several valves of the same type were replaced. A safety notification was issued in 2012 for all LyondellBasell plants to remove such valves from service.

This highlights the potential risks with single valve isolations, especially in high pressure liquid propylene duty.

An assessment is currently being carried out regarding isolation requirements for routine isolations such as for replacing filters and removing pumps.

LIQUID PROPYLENE IN HP BAG FILTER

On 8th January 2010, liquid propylene was found in the HP bag filter on the Carrington PP plant. This occurred due to a loss of steam to the plant during very cold weather. This caused the impulse line of the low pressure trip on the steam to the Pipeline Drier to freeze and therefore not shut-off the propylene flush to the Pipeline Drier. The liquid propylene was not vaporised as normal due to no steam being available.

Excellent response by the operators to slowly introduce warm vapour to vaporise the liquid prevented a much more serious potential event occurring as the HP Bag Filter is not made of low temperature steel.

Since the incident, the impulse line has been relocated to a non-exposed location and replaced with one of a pre-insulated design.

PEROXIDE TEMPERATURE SENSITIVITY

The Carrington LIPP plant uses Trigonox-101 peroxide as a cracking agent. This peroxide freezes at approximately +8C. This in itself is not hazardous if the peroxide is left to thaw naturally. However, in several plants in the world, peroxides have been provided with heat to thaw them more quickly when needed for production in cold weather conditions.

This way of thawing peroxides can be very dangerous. If a peroxide heats up locally, once it reaches the Self-Accelerating Decomposition Temperature (SADT), the decomposition reaction cannot be arrested and a large release of gas will occur which could lead to failure of equipment or a fire/explosion can be caused.

Peroxides should never be provided directly with external heat and should only be allowed to thaw naturally.

NITROGEN HAZARDS

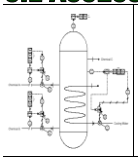
Fatalities are still caused each year in industry due to Nitrogen asphyxiation. Fatalities and near misses have also happened within our own predecessor companies, with a potentially fatal near miss in 2012.

A reduction in the O2 content of air from 21% to 18% already becomes hazardous. At 10% O2 concentration, death is almost certain. Symptoms of asphyxia include headache or vertigo, but inert gases are very dangerous as people do not notice these symptoms as asphyxia and a victim could die very quickly. **Did you know that only one or two breaths of pure nitrogen can cause death?**

The following link shows an animation video regarding the dangers of nitrogen:-

http://www.csb.gov/videoroom/detail.aspx?vid=11&F=0&CID=1&pg=1&F_All=y

SIL ASSESSMENT UPDATE



All trip systems on site have undergone a type of risk assessment called Safety Integrity Level (SIL) assessment to determine how important they are for HSE and economic reasons. This determines the design and testing requirements for each system. Most trip systems have been found to be more than adequately designed and testing frequencies can be reduced. The small number found to be inadequate in the initial assessment have been subjected to more detailed asessments.

Of these, some are having additional protection layers installed as follows:-

- V2301 High Level (Safety Critical Task for response to a High Level Alarm)
- V2602 overfill to Fuel Header (Low temperature switch on the fuel header)
- Peeb kill tracing failure (Safety Critical Task for response to a Tracing Alarm)
- Peeb kill valve failure (Safety Critical Task for response to a Failure Alarm)

PROCESS SAFETY NEWSLETTER

Carrington Site No.8 : September 2013

GENERAL

Welcome to the eighth issue of the Carrington Process Safety News.
If you have any questions or ideas for articles in future newsletters, please contact Dave Royle (x3235).

IMPERIAL SUGAR 5 YEARS AGO

A devastating dust explosion occurred at the Imperial Sugar plant in Georgia, USA on 7th December 2008, killing 14 people and injuring 38 others. This fatal accident was caused by a secondary explosion of dust which had built-up around the plant. The initial explosion occurred in a conveyor which had been fitted with covers as a modification.

The US Chemical safety Board determined that, on average, 10 serious dust explosions occurred in the USA each year.

We are all probably aware that PP and PE dust can cause dust explosions. Did you know that it is normally a secondary dust explosion which causes the main damage from dust dislodged from piping, support beams, cables trays etc. and the explosion can be catastrophic? In fact when the Wilton plant was demolished, it is thought that a dust explosion occurred when the plant fell down due to accumulated dust.

During the current PP major maintenance shut-down, the plant may be free from propylene and other gaseous/liquid hydrocarbons, but dust may still be present and be emitted when systems are being emptied. This could be just as hazardous.

Do we look out for dust accumulations in our day-to-day jobs and when doing safety walks? Recently, we have seen some dust build-up on cable trays in PP and around star valve seals on LDPE storage.

SAFETY CRITICAL TASKS

The site has been reviewing which jobs are higher hazard from a Process Safety point of view where a person is part of one of the major barriers to a potential serious incident.

The Operational list is as follows:- Reactor Batch Start-Up, Offloading Alkyls, Offloading Cooling Tower Chemicals, Start-Up and Shut-Down of Propylene Pumps, Switching Propylene Filters, Re-commissioning Equipment after Spading, Emptying Pre-pol Blowdown Vessel, Refilling PCP, Re-filling Pre-pol Reactor, Peroxide Dosing System, Re-commissioning Ethylene at ELDS or Pipeline, High Level in K2301 Suction KO Pot, Failure of Peeb Kill Injection Valve, Failure of Peeb Kill Heat Tracing.

The Maintenance list is as follows:- Replacement of Reactor Seal, Servicing of Propylene Sphere RV's, Replacement of Propylene Pump Seals, Testing Reactor Seal Trip System.

Several Human Factors Assessments have taken place to look at ways of reducing risk further and the others will be assessed in the next year.

Do you know which jobs you could carry out which are Safety Critical Tasks? The detailed step-by-step procedure must always be followed when one of these jobs is done.

PROCESS SAFETY IN THE HOME

We all know about process safety in the plant, but have you thought about Process Safety in the home? Here are some examples:

Toxic Gases: In our plants around the world, we have the possibility for the release of toxic gases (e.g. Ammonia and Chlorine potential at Carrington). In the home, there is the potential for Carbon Monoxide or Chlorine. There is on average 1 person is killed at home every week in the UK and 4000 go to A&E every year with the effects of CO poisoning. A friend of mine and his family almost died some years ago due to a faulty flue. Mixing the wrong cleaning agents with each other (hypochlorite and acid based products as in the plant) can produce chlorine. **Do you have a Carbon Monoxide alarm to protect your family? Are your heating appliances regularly tested and serviced?**

Flammable Gases: In our plants, we are ever vigilant about the potential for Loss of Containment of gases such as Propylene and Ethylene. In the house, most of us have natural gas supplies. Although the pressure is much lower, the ultimate consequences can be catastrophic. In a typical house, there only needs to be about 5 kg of natural gas to have a flammable mixture through the whole house. There have been several gas explosions in houses in the UK in recent years with many people being killed. **Do you know, especially if you have moved house recently, if all your gas appliances have been fitted correctly? Are they regularly tested and serviced?**

LPG: Do you have LPG for heating your house or cylinders for a BBQ or garden heaters? It goes without saying that there is quite some potential for things to go wrong. When we were looking to move house last year, we viewed one house where the family was worried about storing 2 LPG cylinders in the garage below the children's bedroom, so they stored them in the dining room instead! **Do you look after LPG cylinders and, if you have one, storage tanks like you would do at work? Are they safely stored and away from children?**

Fires in Vents and Flues: There is potential for solids to build-up in vents from driers and fires etc. In the Pernis LIPP plant ~ 20 years ago, a serious fire which started in an extract system almost burned down the whole extruder building. This could happen in your house. **How often do you check these vents for build-up of flammable material which could set fire to your house?**

Fire Detection: In the plant we all know that early detection of a process safety incident can be the difference between a small effect and something which can get out-of-hand and be devastating. We have good fire detection and smoke detection in many different places in our plants. Did you know that on average more than 400 people still die each year in house fires in the UK? Most of these deaths could be prevented if smoke detectors were fitted in houses. However, like our instrumentation in the plants, it's not just about having detectors, but we must ensure that they are located in the right place and always working. **How often do you test your smoke alarms at home to check that they are working?**

Emergency Plans: In the plants, we have detailed emergency plans, train our staff and test the plans frequently, just in case the worst should ever happen. This could be vital at home. If a smoke alarm goes off in the night, does your family, especially children, know what to do (and also what not to do)? **How would you raise the alarm, how would you rescue the children, how would you escape?**

Equipment Monitoring: At work, there are certain items of equipment which are Critical to Safety. Maybe we don't think that we have these in the house. We've mentioned above about gas appliances and driers, but there are other items of equipment which can cause fires such as washing machines and dishwashers. We read that the dishwasher in the house we have just bought was one which had a fault which could cause a fire. Luckily the previous owners had responded to the safety notice and had the faulty component replaced, but less than 50% of households had done this. Failures of these household appliances can happen at any time. **Do you run the washer or dishwasher at night when electricity may be cheaper, or do you leave appliances running when you are out of the house?**

As in the plant, we probably think about Personal Safety when we are doing jobs at home because of our training at work (isolating electricity, wearing safety glasses and dust masks, using the right tools etc. etc.), but how many of us really think about the Process Safety type incidents which could happen and be catastrophic for you and your family if one happened?

Are you aiming for Goal Zero for you and your family?

PROCESS SAFETY NEWSLETTER

Carrington Site No.13 : December 2015

GENERAL

Welcome to the thirteenth issue of the Carrington Process Safety News.
If you have any questions or ideas for articles in future newsletters, please contact Dave Royle (x3235).

~15 YEARS AGO TOULOUSE EXPLOSION

On the 21st September 2001, a large explosion occurred in Toulouse, France, killing 29 people mostly within the site and injuring more than 2500 people. The explosion was equivalent to about 30 tonnes of TNT and was caused by inadvertent storage of another compound in an ammonium nitrate warehouse which caused a reaction to occur. A 7m deep crater of 40m diameter was left and, amongst other things, a nearby motorway was damaged. The power of the explosion was equivalent to 3.4 on the Richter scale and could be heard 50 miles away.

The investigation found one of the issues was encroachment of other developments around the ammonium nitrate plant which had been at the site for more than 100 years. This led to a change in planning and development near major hazard installations in France. It is ironic that the factory was relocated to that site due to explosions in the 1700's and 1800's so as to be further from the centre of the expanding city of Toulouse.

The domino effects of the incident could have been much worse as the site stored large quantities of ammonia and also chlorine and phosgene, but separation distances employed in the design of these facilities meant that no loss of containment occurred. However, run-off from the site caused pollution of the river Garonne.

GEELONG DECOMPOSER INCIDENT

On Tuesday September 13th 1994 a fatal accident occurred at the LIPP plant in Geelong on the Alkyl Decomposer system.

The accident was caused by an excessive reaction between residual water and concentrated (~60%) DEAC in the outlet line of the decomposer when two operators were trying to clear a blockage in the outlet line of the decomposer vessel. This caused a failure of the base valve due to overheating, with the contents of the vessel being lost to atmosphere, resulting in a fire which killed one of the operators.

The decomposer would normally have contained decomposed material (water, salts, solvent and oligomers) but, due to a sequence of events, contained mainly DEAC. DEAC had been transferred inadvertently from the storage vessel to the alkyls collection vessel during an intended solvent flush of a filter due to problems with one of the isolation valves and due to DEAC storage pressure being higher pressure than solvent.

Several changes were made on the Carrington system immediately after the incident and, more recently, the system was fundamentally changed to be provided with batch sequencing and safeguarding to limit the amount of alkyls to be decomposed.

However, this incident is a good reminder as to the hazard potential of alkyls reacting with water within the plant systems.

SILO DEGASSING PROJECT

The peroxide used in the extruder to crack the PP to a higher MI produces decomposition products such as acetone and butanol which remain in the pellets leaving the extruder. In addition, thermal cracking in the extruder generates methane and ethane. These hydrocarbons slowly diffuse from the PP pellets in the downstream silos with the lighter gases diffusing easily and heavier ones remaining in the pellets. The intermediate volatility components are the most hazardous as they diffuse at a reasonable rate in the run-down bunkers and, if they build up sufficiently, can cause a flammable atmosphere in the silos.

Several fires and explosions have occurred in PP run-down bunkers throughout the world, including in the LIPP plant in Pernis ~20 years ago.

A project has been approved at Carrington to inject degassing air to the homogenisation / off-spec silos and the extruder pellet surge hopper in case peroxide has been injected to the extruder at more than 350ppm. The project detailed design is being completed, equipment has been ordered and construction work is well under way.

The air will be provided by 3 of the ex-Carilon blowers with 2 required at any one time to provide the required air flow. The blowers will be increased in speed to provide sufficient air flow and new relief valves and filters will be provided.

The main air flow will be injected to the cone of the silos, with a smaller flow (so as not to impeded pellet discharge) purging the silo outlet lines. Logic will be provided to ensure that air is dosed at the correct flowrate during and for some time after the completion of products requiring 350ppm peroxide injection.

It is expected that the project will be commissioned in the first quarter of 2016.

PLANT RE-HAZOP UPDATE

Since the beginning of 2014, a team has been re-Hazoping the PP plant. This is the first time that such a study has been done since the plant was first built. The previous practice was to do Hazops or other safety reviews on modifications via MOCs. However the company standards now require a re-Hazop to be done every 10 years and an intermediate review after 5 years to assess hazards that may have crept in due to the combination of several different changes over a period of time. A 5 year hazard review has been part of the COMAH review for major hazards on a unit-by-unit basis, but this does not cover sufficient detail of individual equipment.

A 3-year plan was put together based on hazard consequences:-
2014 : Propylene and Ethylene systems
2015 : Process Chemicals
2016 : Utility systems

The team consists of process engineers, mechanical engineers & technicians, instrument engineers & technicians and the PP Improvement leader or a Shift team leader.

The Hazop aims to identify hazards and their consequences, the current safeguards/barriers in place and reviews the resulting risk. If the risk can practically be further reduced or further information is required for the assessment, an action is assigned. In order to capture as much information as possible, we are also reviewing the original plat Hazop, previous MOC Hazops and intend to do a review with the Geelong LIPP Hazop.

The propylene and ethylene systems were completed in 2014. In 2015, we have completed a Hazop of the TEA, C-donor, Peroxide, Hot Oil and Catalyst systems.

There have been no higher risk findings to date, but actions have been identified where we believe risk can be reduced in certain areas. If you want to know more, further details of the review are available from Cigdem Kemal or Loreto Micheli.

Remembering the Past

On significant anniversaries of major incidents, reminders are sent to everyone on site with an overview of the incident including the underlying causes of the barriers which failed.

Examples of such reminders are as follows:-
- San Juan, Mexico City
- Icmesa, Seveso
- Philips, Pasedena
- BP, Texas City
- Esso, Longford
- Formosa, Texas
- Union Carbide, Bhopal
- Nypro, Flixborough,
- Occidental, Piper Alpha

- Hertfordshire Oil Storage, Buncefield
- Vessel explosion at Predecessor company site.
- Filter leak leading to Explosion and Fire at Predecessor company site.

A reminder was also issued to site on each anniversary (now the 6th) of the most recent Level 2 leakage of flammable material on the Carrington site, to remind everyone of this previous event and prevent complacency due to no significant incidents having occurred at site for quite some time.

Process Safety Tool Box Talks

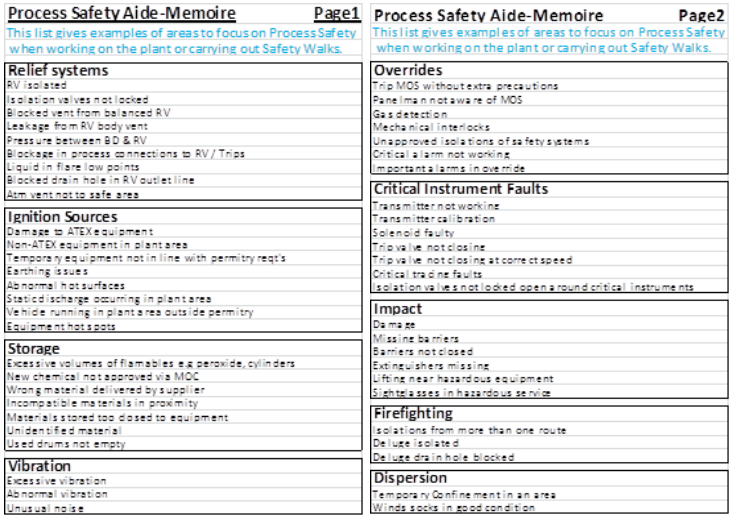
Process Safety Tool Box talks are carried out on all the above subjects, with sharing of topics across company sites for discussions with operating and maintenance technicians. Tool Box Talks are also held with each operating team following the publication of each Process Safety Newsletter.

Examples subjects include
- What's in the tanker?
- Flare systems
- Instrumental Safeguarding
- Mechanical Safeguarding
- Corrosion Under Insulation
- Human Factors
- Dust Explosions
- Earthing and Bonding to prevent Ignition Hazards

Process Safety Plant Auditing

Plant Safety auditing has been in place at site for decades. In recent years, the site has increased the focus on Process Safety in plant auditing as follows:-

- All Safety Critical Tasks have a 'Walk-Through-Talk-Through' audit annually by management. This covers a detailed discussion through all the safety critical aspects of the critical task in the control room or workshop to check the technicians understanding of the procedure and why it is critical to process safety, checking the procedure itself is accurate, clear and up-to-date and reviewing the steps which would be taken. The procedure is then followed through at the workplace (usually within the plant or workshop) to ensure that it is fit-for-purpose and that all steps are carried out as per the procedure in reality.
- Process Safety is included in all plant safety walks and an Aide-Memoire for Process Safety topics has recently been published for staff participating in the safety walks. Both safety walks and management inspections have aide-memoires based on process safety to sample different topics and proactively go 'looking for problems' before issues potentially become more severe.



Process Safety Aide-Memoire Page1

This list gives examples of areas to focus on Process Safety when working on the plant or carrying out Safety Walks.

Relief systems
- RV isolated
- Isolation valves not locked
- Blocked vent from balanced RV
- Leakage from RV body vent
- Pressure between BD & RV
- Blockage in process connections to RV / Trips
- Liquid in flare low points
- Blocked drain hole in RV outlet line
- Atm vent not to safe area

Ignition Sources
- Damage to ATEX equipment
- Non-ATEX equipment in plant area
- Temporary equipment not in line with permitry reqt's
- Earthing issues
- Abnormal hot surfaces
- Static discharge occurring in plant area
- Vehicle running in plant area outside permitry
- Equipment hot spots

Storage
- Excessive volumes of flamables e.g. peroxide, cylinders
- New chemical not approved via MOC
- Wrong material delivered by supplier
- Incompatible materials in proximity
- Materials stored too closed to equipment
- Unidentified material
- Used drums not empty

Vibration
- Excessive vibration
- Abnormal vibration
- Unusual noise

Process Safety Aide-Memoire Page2

This list gives examples of areas to focus on Process Safety when working on the plant or carrying out Safety Walks.

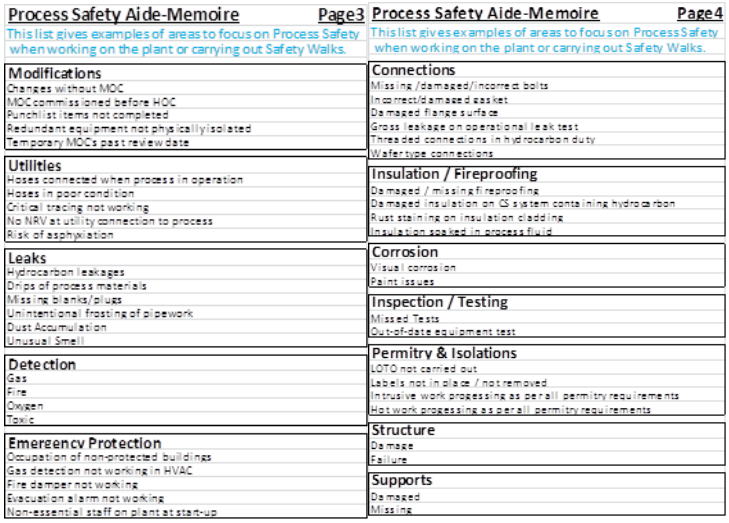
Overrides
- Trip MOS without extra precautions
- Panelman not aware of MOS
- Gas detection
- Mechanical interlocks
- Unapproved isolations of safety systems
- Critical alarm not working
- Important alarms in override

Critical Instrument Faults
- Transmitter not working
- Transmitter calibration
- Solenoid faulty
- Trip valve not closing
- Trip valve not closing at correct speed
- Critical trading faults
- Isolation valves not locked open around critical instruments

Impact
- Damage
- Missing barriers
- Barriers not closed
- Extinguishers missing
- Lifting near hazardous equipment
- Sightglasses in hazardous service

Firefighting
- Isolations from more than one route
- Deluge isolated
- Deluge drain hole blocked

Dispersion
- Temporary Confinement in an area
- Winds socks in good condition



Process Safety Aide-Memoire Page3

This list gives examples of areas to focus on Process Safety when working on the plant or carrying out Safety Walks.

Modifications
- Changes without MOC
- MOC commissioned before HOC
- Punchlist items not completed
- Redundant equipment not physically isolated
- Temporary MOCs past review date

Utilities
- Hoses connected when process in operation
- Hoses in poor condition
- Critical tracing not working
- No NRV at utility connection to process
- Risk of asphyxiation

Leaks
- Hydrocarbon leakages
- Drips of process materials
- Missing blanks/plugs
- Unintentional frosting of pipework
- Dust Accumulation
- Unusual Smell

Detection
- Gas
- Fire
- Oxygen
- Toxic

Emergency Protection
- Occupation of non-protected buildings
- Gas detection not working in HVAC
- Fire damper not working
- Evacuation alarm not working
- Non-essential staff on plant at start-up

Process Safety Aide-Memoire Page4

This list gives examples of areas to focus on Process Safety when working on the plant or carrying out Safety Walks.

Connections
- Missing /damaged/incorrect bolts
- Incorrect/damaged gasket
- Damaged flange surface
- Gross leakage on operational leak test
- Threaded connections in hydrocarbon duty
- Wafer type connections

Insulation / Fireproofing
- Damaged / missing fireproofing
- Damaged insulation on CS system containing hydrocarbon
- Rust staining on insulation cladding
- Insulation soaked in process fluid

Corrosion
- Visual corrosion
- Paint issues

Inspection / Testing
- Missed Tests
- Out-of-date equipment test

Permitry & Isolations
- LOTO not carried out
- Labels not in place / not removed
- Intrusive work processing as per all permitry requirements
- Hot work processing as per all permitry requirements

Structure
- Damage
- Failure

Supports
- Damaged
- Missing

Process Safety in the Home

One newsletter was produced based solely on process safety hazards in the home with the following text:-
'We all know about process safety in the plant, but have you thought about Process Safety in the home? Here are some examples:
Toxic Gases: In our plants around the world, we have the possibility for the release of toxic gases (e.g. Ammonia and Chlorine potential at Carrington). In the home, there is the potential for Carbon Monoxide or Chlorine. There is on average 1 person is killed at home every week in the UK and 4000 go to A&E every year with the effects of CO poisoning. A friend of mine and his family almost died some years ago due to a faulty flue. Mixing the wrong cleaning agents with each other (hypochlorite and acid based products as in the plant) can produce chlorine. Do you have a Carbon Monoxide alarm to protect your family? Are your heating appliances regularly tested and serviced?

Flammable Gases: In our plants, we are ever vigilant about the potential for Loss of Containment of gases such as Propylene and Ethylene. In the house, most of us have natural gas supplies. Although the pressure is much lower, the ultimate consequences can be catastrophic. In a typical house, there only needs to be about 5 kg of natural gas to have a flammable mixture through the whole house. There have been several gas explosions in houses in the UK in recent years with many people being killed. Do you know, especially if you have moved house recently, if all your gas appliances have been fitted correctly? Are they regularly tested and serviced?

LPG: Do you have LPG for heating your house or cylinders for a BBQ or garden heaters? It goes without saying that there is quite some potential for things to go wrong. When we were looking to move house last year, we viewed one house where the family was worried about storing 2 LPG cylinders in the garage below the children's bedroom, so they stored them in the dining room instead! Do you look after LPG cylinders and, if you have one, storage tanks like you would do at work? Are they safely stored and away from children?

Fires in Vents and Flues: There is potential for solids to build-up in vents from driers and fires etc. In the Pernis LIPP plant ~ 20 years ago, a serious fire which started in an extract system almost burned down the whole extruder building. This could happen in your house. How often do you check these vents for build-up of flammable material which could set fire to your house?

Fire Detection: In the plant we all know that early detection of a process safety incident can be the difference between a small effect and something which can get out-of-hand and be devastating. We have gas detection, fire detection and smoke detection in many different places in our plants. Did you know that on average more than 400 people still die each year in house fires in the UK? Most of these deaths could be prevented if smoke detectors were fitted in houses. However, like our instrumentation in the plants, it's not just about having detectors, but we must ensure that they are located in the right place and always working. How often do you test your smoke alarms at home to check that they are working?

Emergency Plans: In the plants, we have detailed emergency plans, train our staff and test the plans frequently, just in case the worst should ever happen. This could be vital at home. If a smoke alarm goes off in the night, does your family, especially children, know what to do (and also what not to do)? How would you raise the alarm, how would you rescue the children, how would you escape?

Equipment Monitoring: At work, there are certain items of equipment which are Critical to Safety. Maybe we don't think that we have these in the house. We've mentioned above about gas appliances and driers, but there are other items of equipment which can cause fires such as washing machines and dishwashers. We read that the dishwasher in the house we have just bought was one which had a fault which could cause a fire. Luckily the previous owners had responded to the safety notice and had the faulty component replaced, but less than 50% of households had done this. Failures of these household appliances can happen at any time. Do you run the washer or dishwasher at night when electricity may be cheaper, or do you leave appliances running when you are out of the house?

As in the plant, we probably think about Personal Safety when we are doing jobs at home because of our training at work (isolating electricity, wearing safety glasses and dust masks, using the right tools etc. etc.), but how many of us really think about the Process Safety type incidents which could happen and be catastrophic for you and your family if one happened?

Are you aiming for Goal Zero for you and your family?'

PROCESS SAFETY IN THE HOME

We all know about process safety in the plant, but have you thought about Process Safety in the home? Here are some examples:

Toxic Gases: In our plants around the world, we have the possibility for the release of toxic gases (e.g. Ammonia and Chlorine potential at Carrington). In the home, there is the potential for Carbon Monoxide or Chlorine. There is on average 1 person is killed at home every week in the UK and 4000 go to A&E every year with the effects of CO poisoning. A friend of mine and his family almost died some years ago due to a faulty flue. Mixing the wrong cleaning agents with each other (hypochlorite and acid based products as in the plant) can produce chlorine. **Do you have a Carbon Monoxide alarm to protect your family? Are your heating appliances regularly tested and serviced?**

Flammable Gases: In our plants, we are ever vigilant about the potential for Loss of Containment of gases such as Propylene and Ethylene. In the house, most of us have natural gas supplies. Although the pressure is much lower, the ultimate consequences can be catastrophic. In a typical house, there only needs to be about 5 kg of natural gas to have a flammable mixture through the whole house. There have been several gas explosions in houses in the UK in recent years with many people being killed. **Do you know, especially if you have moved house recently, if all your gas appliances have been fitted correctly? Are they regularly tested and serviced?**

LPG: Do you have LPG for heating your house or cylinders for a BBQ or garden heaters? It goes without saying that there is quite some potential for things to go wrong. When we were looking to move house last year, we viewed one house where the family was worried about storing 2 LPG cylinders in the garage below the children's bedroom, so they stored them in the dining room instead! **Do you look after LPG cylinders and, if you have one, storage tanks like you would do at work? Are they safely stored and away from children?**

Fires in Vents and Flues: There is potential for solids to build-up in vents from driers and fires etc. In the Pernis LIPP plant ~ 20 years ago, a serious fire which started in an extract system almost burned down the whole extruder building. This could happen in your house. **How often do you check these vents for build-up of flammable material which could set fire to your house?**

Fire Detection: In the plant we all know that early detection of a process safety incident can be the difference between a small effect and something which can get out-of-hand and be devastating. We have gas detection, fire detection and smoke detection in many different places in our plants. Did you know that on average more than 400 people still die each year in house fires in the UK? Most of these deaths could be prevented if smoke detectors were fitted in houses. However, like our instrumentation in the plants, it's not just about having detectors, but we must ensure that they are located in the right place and always working. **How often do you test your smoke alarms at home to check that they are working?**

Emergency Plans: In the plants, we have detailed emergency plans, train our staff and test the plans frequently, just in case the worst should ever happen. This could be vital at home. If a smoke alarm goes off in the night, does your family, especially children, know what to do (and also what not to do)? **How would you raise the alarm, how would you rescue the children, how would you escape?**

Equipment Monitoring: At work, there are certain items of equipment which are Critical to Safety. Maybe we don't think that we have these in the house. We've mentioned above about gas appliances and driers, but there are other items of equipment which can cause fires such as washing machines and dishwashers. We read that the dishwasher in the house we have just bought was one which had a fault which could cause a fire. Luckily the previous owners had responded to the safety notice and had the faulty component replaced, but less than 50% of households had done this. Failures of these household appliances can happen at any time. **Do you run the washer or dishwasher at night when electricity may be cheaper, or do you leave appliances running when you are out of the house?**

As in the plant, we probably think about Personal Safety when we are doing jobs at home because of our training at work (isolating electricity, wearing safety glasses and dust masks, using the right tools etc. etc.), but how many of us really think about the Process Safety type incidents which could happen and be catastrophic for you and your family if one happened?

Are you aiming for Goal Zero for you and your family?