HSE

Health and Safety Executive

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Findings From Voluntary Reporting of Loss of Containment Incidents 2004/05

HSE

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Lessons Learnt From Chemical Loss of Containment

Incidents: 2004/05

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Introduction

During 2004/05 HSE and the onshore chemical and major hazard industries collaborated in the collection of causation information and lessons learnt from loss of containment incidents reported to HSE under RIDDOR[1]. This was a voluntary scheme aimed at collecting information on the underlying causes of loss of containment events. The aim being to identify common failure mechanisms that feature in chemical incidents. As part of that initiative participants were asked to provide a lesson learnt from the incident, which they would wish to pass on to others within the sector.

Sharing such information others was a key message from the BP Grangemouth Report[2] which recommended that:

"*Major hazard industries should ensure that the knowledge available from previous incidents both within their own organisation and externally are incorporated into current safety management systems*."

There are two sets of data, one for the chemicals sector (excluding refineries) and one for the refineries sector.

Trade Associations and employee representatives should be able to use these findings as a prompt for further discussion on where process safety management systems may be weak or failing. Individual organisations should use the findings to check whether similar circumstances feature in their own operations.

The full set of results against the chemical sector and refinery dataset can be found at:

Annex 1 – Lessons Learnt

Annex 2 – Full Data Results

HSE would like to thank all those companies who provided information under the voluntary reporting of underlying causes and lessons learnt from chemical loss of containment incidents project. This project is continuing in 2005/06. The information provided is handled with strict confidence and kept in an anonymous format by HSE. All major hazard and chemical site operators are encouraged to support this scheme.

For more information please contact:

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Voluntary Reporting – The Process

Following a RIDDOR loss of containment event the company is invited to supply additional information on causation. The company self codes the incident against the causation framework and provides a description of the incident together with any information in the form of 'lessons learnt', which they would want to pass on to other operators. The results are collated in an anonymised form by the HID data analysis team and the original form is destroyed.

Main Findings for the Chemical Sector (excluding refineries)

Overview - 69 % of incidents can be categorised as either being as the result of an incorrect action by an operator (37%), or the equipment or plant failure (32%). The remaining 31% of incidents are spread across the other primary cause categories.

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[1] The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995
[2] Major Incident Investigation Report, BP Grangemouth Scotland, 29 May – 10 June 2000. COMAH Competent Authority Report, August 2003.

The underlying causes of operator error and equipment failure were:

Operator Error:

- 34% - inadequate operating procedures
- 18% - inadequate plant design
- 14% - inadequate supervision
- 12% - management of change

Equipment Failure:

- 30% - inadequate maintenance
- 28% - inadequate design

9. Across all incidents the three most common Risk Control Systems to fail, which may warrant further attention are:

- 37% - Operating Procedures
- 32% - Plant Design, and
- 26% - Hazard Analysis

Further Analysis –

The following section contains a summary of data by reporting category.

In all 73 reports were submitted and analysed.

COMAH Status

68% occurred at COMAH sites

32% occurred at non-COMAH sites

The higher level of incidents at COMAH sites may be surprising given that COMAH establishments are subject to more stringent regulatory regime. However, COMAH sites tend to be larger and more complex operations than non-COMAH sites and therefore the opportunity for loss of containment incidents is grater at these sites. Additionally due to the high level of scrutiny at COMAH establishments, operators may be more likely to report RIDDOR incidents.

Nature of Substance

45% of incidents occurred from the use of flammable substances (including extremely flammable, highly flammable, flammable and flammable liquids).

27% of incidents involved non-COMAH substances.

14% of incidents involved the release of a toxic or very toxic substance.

Only 5% of Operating Mode

Operating Mode

56% of incidents occurred during normal operating mode. This information tallies with the information coded as part of the HSL loss of containment analysis[3]. It has always been presumed that the majority of incidents occur outside of normal operations.

Site of Release

No problems highlighted with any particular parts of plant or equipment. The results were spread across all the categories, with the highest results being against:

Flexible hoses – 18%

Storage Vessels – 14%

Pipework – 12%

Costs

Not all companies were able to provide costs of incidents however, the majority did:

Damage to property & plant in the establishment - £252,545

Business Interruption - £645,280

Clean up costs - £259,109

Total Cost - £1,156,934

Dispersion/Off Site Emergency Plans

Only 11% of incidents spread offsite, with 8% of incidents involving the activation of the offsite emergency plan.

Mitigating Defences

42% of incidents involved either no mitagatory action or the mitigating measure was unknown.

For 19% of incidents the mitigation was that the process was stopped.

For 19% of incidents the loss of containment was contained within the bund or effluent system.

Primary Cause of Incident

Information on primary cause has been given under 'Overview'. The two main causes of Operator Error and Equipment Failure comprise of the following categories:

Operator Error: human error, impact/dropped object, procedural violation, inadequate isolation, incorrect installation.

Equipment Failure: corrosion, defective equipment, overpressure, stress/fatigue/vibration, and unsuitable equipment.

Risk Control Systems

The risk control systems found to have weaknesses/failures where:

1. Operating Procedures – 37%

[3] Loss of Containment Incident Analysis. HSL/2003/07. Health and Safety Laboratory, Broad Lane Sheffield.

2. Plant and Process Design – 32%

3. Hazard and Risk Assessment – 26%

Operating Procedures –

A failure of the operating procedure risk control system can occur for a number of reasons:

1. a work activity is deficient,

2. procedure is documented adequately but not followed or an error is still made by an operator/contractor,

3. procedure is not documented, or inadequately documented causing operator/contractor error.

From the brief descriptions given it was difficult to allocate an incident to any of the above scenarios, however we can presume that incidents that fall under option 2 will have been coded under 'Procedural Violation'.

The HSE Human Factors Team will soon publish information on poor written procedures leading to procedural violations or operator/contractor error.

Plant and Process Design –

There were no particular problems highlighted in any aspects of design. The incidents were due to many different design faults: non return valves not fitted, restricted views or shut off valves etc not accessible, drums/barrels falling off FLTs and shelving systems, pressure vessel bursting discs set too high, bungs/valves being able to be manually opened closed, flexi hose used instead of hard piping etc.

Hazard and Risk Assessment -

Upon further analysis there are four main areas of failure: Choosing unsuitable equipment, not knowing/obtaining information on intrinsic hazards of substances in the context of their use, over-reliance on prevention rather than linking hazard assessments to mitigation and management of change – not assessing risks attached to changing a process, not complying with a HAZOP action.

Health and Safety Management System

37% incidents were caused by a failure of the planning and implementation aspect of the Safety Management System.

16%, by organising – control and 16% by monitoring.

Main Findings for the Refineries Sector

Overview:

As the total number of incidents for the refineries sector is so small, it is difficult to identify emerging findings. Notably in comparison with the rest of the chemicals sector was the severity of the incident and the impact in terms of cost. Failure of pipework is the most common site of release for a loss of containment.

Further Analysis –

The following section contains a summary of data by reporting category.

In all 15 reports were submitted and analysed.

Category of Event – 9 out of the 15 incidents were coded as 'significant'.

Nature of substance – 15 of the substances released were flammable (8 were extremely flammable).

Plant Installation/Site of Release – no particular problems identified, although for 'site of release' pipework predominates.

Operating Mode – 53% of incidents occurred during normal operations.

Cost – Around 50% of companies provided us with cost details:

Damage to property/plant in the establishment - £1,009,500

Damage to property outside the establishment - £1, 425,000

Business Interruption - £815,000

Clean Up Costs - £501,500

Total Costs - £3,751,000

Despite damage outside the establishment amounting to around £1.5 million, no off site dispersion was notified and only one incident caused damage to the environment.

Primary Cause – Over a third of incidents (6) were caused by corrosion, the underlying causes of the corrosion were quite spread:

- Operating procedures – 2
- Maintenance Procedures – 2
- Selection/Management of Contractors – 1
- Plant Inspection – 4
- Management of Change – 1
- Plant/Process Design 3

Risk Control Systems – 5 RCS were coded evenly as being those that failed to result in LoC:

- Planned Plant Inspection – 4
- Permit to Work – 4
- Operating Procedures – 4
- Planned Maintenance Procedures – 4
- Plant and Process Design – 4

Health and Safety management Systems – a third of incidents were due to poor planning and implementation.

Mitigating Defences – in 47% of incidents the shut off valve was operated.

Emergency Action – Only 1 incident resulted in the offsite emergency plan to be actioned.

Annex 1 Lessons Learnt

The lessons have been grouped by 'Primary Cause of the Incident' headings used in the Underlying Causes Voluntary Reporting project. For each incident as well as the lesson learnt a brief description of the incident is provided together with the Risk Control Systems which were considered to be fault. Finally, the overarching part of the safety management system[4] involved has been included.

[4] Based on Successful Health and Safety Management, HS(G)65. HSE Books.

CHEMICAL SECTOR – LESSONS LEARNT

AUTO IGNITION/SPONTANEOUS COMBUSTION

LESSONS LEARNT	**Routine checks should be made on the status of safety critical detection systems. Inspection routines should cover isolated, unmanned areas.**
PRIMARY CAUSE OF INCIDENT	Auto ignition/spontaneous combustion
DESCRIPTION OF INCIDENT	During the manufacture of a batch of varnish the fire alarm sounded. Staff evacuated and alarm investigated. Small fire in boiler room caused by small leak from boiler flange dripping onto hot pipe. Fire extinguished with CO2 extinguisher, some damage found to boiler's instrumentation wiring preventing boiler start up. The area was controlled by a gas fire suppression system which was found to be in manual mode after the event, meaning the system would not have activated automatically. Now included in the permit to work system under a lock-off procedure.
RISK CONTROL SYSTEM(S)	Permit to Work Operating Procedures
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Particulate filter installed in sample hose to reduce likelihood of ingress and internal hose "coil" angle reduced.**
PRIMARY CAUSE OF INCIDENT	Auto ignition/spontaneous combustion
DESCRIPTION OF INCIDENT	During the quality control check of a medical oxygen cylinder, the 0.5mm sample hose had an ignition, resulting in a localised minor fire, the process was stopped, site evacuated (as a precaution) and fire extinguished.
RISK CONTROL SYSTEM(S)	Plant and Process Design Plant Maintenance Procedures
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Inspection is made easier if hot oil pumps are located outside and the lagging is removed from pipework around the pump.**
PRIMARY CAUSE OF INCIDENT	Auto ignition/spontaneous combustion
DESCRIPTION OF INCIDENT	Small lagging fire at Hot Oil House, extinguished with hand held extinguishers by on site fire team members.
RISK CONTROL SYSTEM(S)	Planned plant inspection
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Consider treating loads as discrete batches and not mixing with other wastes, reducing the risk of adverse reactions. Mixtures for waste blends could be allowed to stand for 48 hours to allow for slow reactions.** **Good process design allows the reacting mixture to be isolated in the line, stopping the materials getting further into the storage tank system and reducing the likelihood of a larger scale reaction.**
PRIMARY CAUSE OF INCIDENT	Auto ignition/spontaneous combustion
DESCRIPTION OF INCIDENT	Two operatives were bulking up material in the early evening. The materials had been checked and left to stand for 24 hours. No reactions were observed in the samples. Written instructions, including PPE requirements, were left and started by the evening shift. About three drums of one code were bulked followed by some materials from another customer. On the seventh drum on the list, SIH silozone loop drainings, pressure was observed coming from the filter pot. This comes before the pump but after the drum draining dipleg. Very quickly what appeared to be whitish fumes were observed from the pot then almost immediately pressure blew back along the lines and back into the drum. The operatives were unsure but thought they could see clear flames so they went for an extinguisher. As the pressure blew back clear flames seemed to be visible above the surface of the drum, briefly, but these were immediately extinguished. As a precaution the area was doused with the extinguisher and the manager called to attend. The drum was monitored for the next four hours. No re-ignition occurred. There was a small release of fumes from the pressurisation. One of the operatives fell over and bruised his arm. Some white powder was pushed out of the drum as it pressurised. This was deemed to be calcium Carbonate after investigation and was safely contained. The cause of the pressurisation was traced after further investigation by ourselves and our customer to be a reaction of a resin stream. In some cases this can decompose in this way. Following an investigation it was learnt that this part process resin has the capacity to break down and form small amounts of hydrogen. Although this was not obvious from the information supplied.
RISK CONTROL SYSTEM(S)	Operating Procedures Hazard Analysis/Risk Assessment
SAFETY MANAGEMENT SYSTEM	Organising Competence

BLOCKAGE

LESSONS LEARNT	**Planned maintenance should always consider the risk of loss of containment.**
PRIMARY CAUSE OF INCIDENT	Blockage
DESCRIPTION OF INCIDENT	A sealed pump was being repaired in the filtration dept – a quantity of alcohol spirit at 40% was spilled onto the floor. Spirit retrieved and contained in overflow tank. Spill-pigs will be positioned on floor before opening up of pumps take place in the future.
RISK CONTROL SYSTEM(S)	Operating Procedures Planned Maintenance Procedures
SAFETY MANAGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Safety critical valves on process reactor vessels should be maintained to a high standard.**
PRIMARY CAUSE OF INCIDENT	Blockage
DESCRIPTION OF INCIDENT	Plant operators were attempting to clear a blockage in the bottom of the drain valve of a reactor containing 4,000 litres of recovered heptane. An attempt was made to open and close the valve. The valve failed to close fully, resulting in the loss of the contents to a local process effluent drain.
RISK CONTROL SYSTEM(S)	Planned inspection/maintenance
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

CORROSION – EXTERNAL/INTERNAL/UNKNOWN/UNDER LAGGING

LESSONS LEARNT	**Inspection and maintenance systems should cover minor leaks, which have the potential over time to affect plant integrity.**
PRIMARY CAUSE OF INCIDENT	Corrosion (External)
DESCRIPTION OF INCIDENT	Major leak from aqueous waste tank over 75 minutes. Entire contents drained to bund. Saunder's valve, attached to the discharge pipe work had become detached as bolts securing the Saunder's valve had corroded to the point they had sheared, allowing the valve to break free. The evidence suggests that a small leak, resulting from a missing bolt, allowed acidic aqueous waste to wash over the remaining three bolts securing the Saunders valve to the pipe work. Over a period of time the bolts corroded until catastrophic failure occurred.
RISK CONTROL SYSTEM(S)	Plant Inspection
SAFETY MANAGEMENT SYSTEM	Monitoring

LESSONS LEARNT	**Ensure the expected lifetime of a material is known before tests are carried out.** **Ensure maintenance schedule for replacement of corrosive systems is adequate.** **Consider fitting a non-return valve on all inlet lines before the reaction vessel, to prevent uncontrolled discharge of vessel contents.**
PRIMARY CAUSE OF INCIDENT	Corrosion (Internal)
DESCRIPTION OF INCIDENT	Aqueos HCl (500 ml) was being pumped into a pressure vessel via a pre-heating oven through a small volume tubing (1/8 inch). During the charging process, the tubing in the oven failed, causing a release of a small amount of HCl. The premises were evacuated and the fire brigade attended to vent the building.
RISK CONTROL SYSTEM(S)	Plant and process design
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure the tops of tanks are inspected adequately.** **Consider replacing mild steel bolts with stainless steel ones.**
PRIMARY CAUSE OF INCIDENT	Corrosion (Internal)
DESCRIPTION OF INCIDENT	The site was receiving a bulk delivery of Hydrochloric Acid 36% from a road tanker into a bulk storage tank. During the delivery a fire engine arrived on site in response to a telephone call from a local petrol station. It stated that some of their customers were suffering coughing and sore throats. On investigation it was discovered that the hydrochloric acid bulk tank fume abatement pipework had become detached thus releasing vapour into the air. Further investigation revealed that some securing bolts had become corroded so allowing the vapour duct to leak. As a precaution surrounding roads were closed to the public for a short time. There were no reports of any casualties.
RISK CONTROL SYSTEM(S)	Planned plant inspection Plant process design
SMS	Monitoring

LESSONS LEARNT	**Planned inspection should be able to detect degradation of all safety critical equipment.** **Pre-start up checks should confirm integrity of plant/equipment.**
PRIMARY CAUSE OF INCIDENT	Corrosion (Internal)
DESCRIPTION OF INCIDENT	Corrosion of flange & flange bolts leading to an emission of SO3
RISK CONTROL SYSTEM(S)	Planned maintenance procedures Planned plant inspection
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

DEFECTIVE/UNSUITABLE EQUIPMENT

LESSONS LEARNT	**Consignors, hauliers and drivers need to ensure vehicles and properly matched to hazardous loads. Recipients should check the vehicle and load are compatible before allowing on-site. Emergency arrangements must take account of loss of containment during loading and off-loading.**
PRIMARY CAUSE OF INCIDENT	Unsuitable Equipment
DESCRIPTION OF INCIDENT	A tanker was parked up waiting for authority to unload waste solvent. Driver was not with vehicle. The tankers sight-glass shattered and the contents started to spill from the sight-glass as the isolation valves were not closed. Site spill containment initiated and driver called to vehicle, site staff and driver attempted to close sight-glass valves but failed and tanker's donkey engine used to vacuum up the tanker barrel to stem the leak so valves could be closed. On inspection the vehicle was not suitable for carrying hazardous materials. There were no preventative fittings for control of static and no flame arrestors or electrical protection/isolators to prevent ignition of a flammable vapour. The haulier indicated that an error had been made in specifying the tanker for that job. Consignor's responsibilities poorly understood so the unsuitable vehicle was not identified prior to loading and dispatch. The waste hauliers failed to ensure the vehicle they used was suitable for the load carried. Driver did not ensure sight-glass was closed and also did not ensure the load was suitable for the tanker.
RISK CONTROL SYSTEM (S)	Hazard analysis/Risk Assessment Handover/communication
SAFETY MANAGEMENT SYSTEM	Organising – Control

LESSONS LEARNT	**Bund shut off valves should be re-closed following routine draining. Careful HAZOP needed when plant change undertaken.**
PRIMARY CAUSE OF INCIDENT	Defective equipment
DESCRIPTION OF INCIDENT	Leak of benzene ignited at a pumping station for a dedicated storage tank serving an acetic anhydride manufacturing plant. Fire quickly brought under control, allowed to continue to burn under controlled conditions, extinguished after 4 hours. Damage limited to pumping station and adjacent area. Equipment critically underestimated due to change in mode of operation (intermittent to continuous) Pumps installed below sill level leading to occasional partial immersion in sill contents. Pressure gauges on the adjacent pumps failed in the fire and provided secondary fuel source above the foam blanket. Local shut-off valve in the tank bund was inaccessible during the fire.
RISK CONTROL SYSTEM (S)	Plant and Process Design Planned Maintenance Procedures
SAFETY MANGEMENT SYSTEM	Monitoring

LESSONS LEARNT	**Having completed a plant change it is important to check the adequacy before re-commissioning with hazardous material.**
PRIMARY CAUSE OF INCIDENT	Unsuitable Equipment
DESCRIPTION OF INCIDENT	The incident occurred when a production team leader tried to use a newly installed HF sampling point on a Condenser in the electronic grade HF plant. When the sample valves were opened the HF flow rate from the sample point was too high. There were ventilation holes in the front of the sample box. As a consequence of high flow rate and inadequate containment by the sample box HF splashed out of the sample box and onto adjacent gantry and handrails. The incident resulted in LOC of approx. 100ml 65% HF. The spillage did not contact the team leader, his PPE or anyone else.
RISK CONTROL SYSTEM (S)	Management of change including plant mods. Plant Commissioning
SAFETY MANAGEMENT SYSTEMS	Planning and Implementation

LESSONS LEARNT	**Inspection and maintenance systems should include flanges and valves to ensure small leaks are detected early.**
PRIMARY CAUSE OF INCIDENT	Defective Equipment
DESCRIPTION OF INCIDENT	Maintenance fitters were to repair a leaking flange, after deciding how best to tackle the repair, they set about removing the lagging from around the flange, this made the leak worse. The MAA leaked out (approx 1 ton) and the area was evacuated and a major incident was called
RISK CONTROL SYSTEM (S)	Permit to Work Planned Maintenance Procedures
SAFETY MANGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Double check alignment of flanges and gasket condition during routine maintenance.**
PRIMARY CAUSE OF INCIDENT	Defective Equipment
DESCRIPTION OF INCIDENT	A leak of Acetic acid occurred as the result of a gasket failure on the sump line of a large storage vessel. The leak was discovered early and corrective action taken. All material was maintained within the tank bund.
RISK CONTROL SYSTEM (S)	Planned Maintenance Procedures
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Risk assessment should have highlighted the need for more frequent inspection of safety critical equipment.**
PRIMARY CAUSE OF INCIDENT	Defective Equipment
DESCRIPTION OF INCIDENT	A fault with a high level probe in a bottling filling machine failed to shut the automatic valve, resulting in a spillage of 300 l/alc (750 bulk litres at 40%).
RISK CONTROL SYSTEM (S)	Planned Maintenance Procedures Operating Procedures
SAFETY MANGEMENT SYSTEM	Organising (Control)

LESSONS LEARNT	**Secondary inspection or alternative check procedure required when calibration of hydrostatic gauges is not a viable or practicable to carry out.**
PRIMARY CAUSE OF INCIDENT	Defective Equipment
DESCRIPTION OF INCIDENT	During a bulk raw material offloading operation into a bulk storage tank in flammables tank farm area, 2500 kilos of solvent escaped via the overflow line into the containment bund. A defective tank gauge, which was showing an incorrect tank volume reading, caused the dangerous occurrence. On investigation it was discovered that there was insufficient capacity in the storage tank to received delivery volume which consequently overflowed from the tank.
RISK CONTROL SYSTEM (S)	Operating procedures Management of change incl plant mods
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure all containers on site are in date and fit for purpose. Ensure that risk assessment for decommissioning considers hazards such as LoC due to defective containers. Ensure the roads used for transportation are adequately maintained.**
PRIMARY CAUSE OF INCIDENT	Defective Equipment
DESCRIPTION OF INCIDENT	A process operator was transporting an IBC containing 1500kg of aqueous solution by FLT. During the operation the IBC fell from the truck and ruptured on impact on the ground. The IBC was not suitable for the storage of the product due to its age and condition. The IBC was not safe to transport. The IBC fell because the truck driver ran over a pothole in the site roadway.
RISK CONTROL SYSTEM (S)	Permit to Work Hazard analysis/risk assessment
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

DEGREDATION OF MATERIAL PROPERTIES

LESSONS LEARNT	**Ensure that process reactions are complete and material stable prior to transfer and storage.**
PRIMARY CAUSE OF INCIDENT	Degradation of Material Properties
DESCRIPTION OF INCIDENT	30 litres of contaminated material was isolated into a 200-litre drum. After 30 mins the drum was sealed. After another 30 minutes, the drum ruptured and was thrown up into the air, causing local damage to the plant. Material in the drum had continued to react, causing an over pressurisation to occur when the drum was sealed. Miscommunication at a shift handover. Other issues – plant design, operating instructions and management of abnormal circumstances during routine operations.
RISK CONTROL SYSTEM (S)	Operating Procedures Plant and Process design
SAFETY MANAGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Ensure adequate quality assurance systems are in place to ensure the integrity of cylinders prior to filling at high pressure.**
PRIMARY CAUSE OF INCIDENT	Degradation of Material Properties
DESCRIPTION OF INCIDENT	Failure of a residual pressure cassette retaining nut / plug on the back of a Ceodeux residual pressure brass cylinder valve, in industrial oxygen service. The component parted company from the valve body at 2000psig during the normal cylinder filling process and was ejected across the filling area - nobody was injured as a result of this failure. Failed component and valve sent for analysis.
RISK CONTROL SYSTEM (S)	Plant Design Inspection/maintenance
SAFETY MANAGEMENT SYSTEM	Organising – Control.

LESSONS LEARNT	**Ensure full assessment of each substance and its use is carried out. Do not rely purely on information in MSDS but conduct wider research of the properties associated with the intended use.**
PRIMARY CAUSE OF INCIDENT	Degradation of Material Properties
DESCRIPTION OF INCIDENT	An explosion/fire occurred when opening a valve in the line between a quench vessel and the Phosphorus acid storage tank. The cause is due to the decomposition of Phosphorus acid in the line and exposure to air when the valve was opened. We were not aware of the chemistry related to phosphorus acid and the MSDS did not give enough detail as to the hazards associated with degradation.
RISK CONTROL SYSTEM (S)	Hazard/risk assessment Operating Procedures
SAFETY MANAGEMENT SYSTEM	Organising - Communication

LESSONS LEARNT	**If the gasket specification is suitable for the service temperature, consider undertaking chemical analysis to see if the chemicals are affecting the integrity in the system.**
PRIMARY CAUSE OF INCIDENT	Degradation of Material Properties
DESCRIPTION OF INCIDENT	Uncontrolled release of a product at 160 degc from a pipe flange, due to a gasket failure (small segment). No persons present at the time, but due to the release position at approx head height and the frequency of occupancy in the area, it was considered "high potential" to cause an injury.
RISK CONTROL SYSTEM (S)	Hazard and Risk Assessment Plant and Process Design
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

HUMAN ERROR

LESSONS LEARNT	**When changing plant layout, conduct a HAZOP review. Ensure that work instructions are reviewed after plant modifications. Where possible, avoid the use of flexible hoses by hard piping.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	Intermediate paint product spilled onto factory floor when operator tried to pump it across to another location from the process tank.
RISK CONTROL SYSTEMS (S)	Management of Change inc Plant Mods Operating Procedures
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Even for temporary activities undertake risk assessment before overriding an automated control system.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	During an inter-vessel transfer / filtration, vacuum was manually applied to the receiving vessel because the filtration was slow. The temperature is critical to ensure the material does not solidify and cause blockages, as is the duration of the filtration stage. Because the filtration / transfer was being done at 70C, the vacuum caused the solvent to vaporise and condense in the building ductwork. This was not detected by the vapour flow detection as it had been manually overridden, which resulted in the occurrence. The root cause was the manual overriding of the computerised control system to such an extent that the computer did not detect vapour flow. Had it done so it would have stopped the operation. Vapour flow cannot now be manually overridden. All manual interventions are now logged and have to be approved by a manager / team leader prior to use.
RISK CONTROL SYSTEMS (S)	Operating Procedures Management of Change inc plants mods
SAFETY MANAGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Consider fitting a non-return valve where back siphonage can occur**.
PRIMARY CAUSE OF INCIDENT	Human Error
DESCRIPTION OF INCIDENT	Spillage of Kerosine water mixture from a Slops tank occurred due to a siphoning action, discharging a product/water mix into a pit, which in turn overflowed into the surrounding ground (including a small brook). Several factors contributed to the incident, two were human error and one was poor design. If a non-return valve had been fitted into the Slops return line this would have acted as a 'Fail Safe' and prevented the incident from happening. There is a gate valve in the system that prevents any siphoning action of slops back into underground pits, but this was not isolated. Another operation linked to this incident was that of the interceptor cleaning operation. Clean water is removed from the interceptor and stored in the Slops tank bund whilst the interceptor is being cleaned. A bung is placed in the bund wall whilst this operation is being carried out, this prevents clean water going into the pits, but also prevents the pits overflowing back into the interceptor. Since the incident: procedures have been examined and re-issued; return pipe line modified to incorporate a non-return valve, a Bentonite seal has been installed to prevent any future offsite contamination.
RISK CONTROL SYSTEMS (S)	Plant and Process Design
SAFETY MANAGEMENT SYSTEM	Monitoring

LESSONS LEARNT	**Review Risk Assessment to ensure any manual valves that can be accidentally left open are removed/upgraded to prevent this type of loss occurring.**
PRIMARY CAUSE OF INCIDENT	Human Error
DESCRIPTION OF INCIDENT	A spillage of 190 litres of alcohol (40% vol) occurred in the filtration room. Alcohol had been diverted into a temporary holding vat to allow filter sheets to be changed. When this was completed the connection from the filter station to the holding vat was removed and the station put back online. The operator forgot to close the hose connection manual valve and alcohol subsequently spilled onto the floor.
RISK CONTROL SYSTEMS (S)	Plant & Process Design Supervision
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure staff are prepared for emergency situations and provide adequate training and instruction on the control of incidents.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	During the manual charging of red amorphous phosphorous from 25kg bags through an open reactor manway, the bag of phosphorous ignited in the operators. The operator dropped the bag onto the floor adjacent to the reactor. This caused another six bags to ignite in the fire. A large amount of dense white smoke was produced causing the plant to be evacuated and the off-site emergency plan initiated.
RISK CONTROL SYSTEMS (S)	Hazard analysis/Risk Assessment Operating Procedures
SAFETY MANAGEMENT SYSTEM	Organising - communication

LESSONS LEARNT	**Before new operations are carried out ensure adequate training is provided and written procedures are in place.**
PRIMARY CAUSE OF INCIDENT	Human Error
DESCRIPTION OF INCIDENT	To reduce manual handling, a new type of operation was being used, when 9 drums rolled out of the rear of a racked trailer.
RISK CONTROL SYSTEMS (S)	Operating Procedures Supervision
SAFETY MANAGEMENT SYSTEM	Organising - Competence

LESSONS LEARNT	**Consider eradicating unbanded stock and only use secured drums.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	FLT driver was driving up a slope and braked causing an unbanded drum to fall from a pallet.
RISK CONTROL SYSTEMS (S)	Plant and Process Design Operating Procedures
SAFETY MANGEMENT SYSTEM	Organising - Competence

LESSONS LEARNT	**Establish a temporary modifications procedure with a timeframe to adopt as permanent or removed. Regular reassessments of initial risk assessments are required.** **Consider involving recently appointed operators in the risk assessment process as they often ask questions, which may highlight problems.** **Consider restricting access during loading to minimum personnel, but have one other person aware of the operation during its progress.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	A tanker driver was washing the wheels of his vehicle on a tanker loading hard stand when liquid came out of the loading arm, showering him causing irritation to his eyes, shoulders, chest and ankles. When the system was installed, the process was acceptable as there was a clear line of vision to the outside of the building where the discharge is affected. The introduction of additional tanks and increased production has altered this.
RISK CONTROL SYSTEMS (S)	Plant and Process Design Operating Procedures
SAFETY MANAGEMENT SYSTEMS	Planning and Implementation

LESSONS LEARNT	**Ensure management of change to processes is handled effectively and new processes are communicated to all employees.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	Pallets of drums were being unloaded from a roller bed trailer, the pallets being lifted out snagged on the following pallets, causing 6 drums to fall from vehicle. Contents of 3 drums were lost. Operations had been recently changed to remove the manual handling risks involved.
RISK CONTROL SYSTEMS (S)	Operating Procedures Hazard analysis/Risk assessment
SAFETY MANAGEMENT SYSTEM	Audit and Review

LESSONS LEARNT	**Don't make assumptions about the status of equipment and where facilities exist to check the integrity of isolations, these must be used immediately prior to breaking containment.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	During the mechanical isolation of an Acetic Acid final product storage tank in readiness for internal inspection a release of between 0.9 and 1.5tes of Acetic Acid occurred.
RISK CONTROL SYSTEMS (S)	Planned maintenance procedures Supervision
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure operators are fully trained in the process and are aware of their actions downstream of the process they are involved in.** **Implement engineering controls, such as high level alarms.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	A vat was accidentally overfilled, when adding water to dilute a mixture.
RISK CONTROL SYSTEMS (S)	Operating Procedures Handover/communication
SAFETY MANAGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Re-asses the method statement before making any amendments.** **Ensure monitoring of the area is done frequently (in this instance it was only checked twice in 7 hours)** **Always use BA protection in such circumstances.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	Three members of a sub division of the company, were working packing down solid avermectin / rhodium catalyst contaminated with Acetonitrile. The operation involved repacking in a fume extracted area wearing respiratory protection, Drums of around 40 kilos were to be packed to 25 kilos. The solid was meant to be lightly wetted but when the operation commenced was found to be more heavily contaminated. In addition the customer was worried about contamination of the equipment and asked the team to reduce the levels of fume extraction. This was contrary to the method statement agreed. The personnel agreed to try the repack and commenced the operation wearing respiratory filters only. During the operation levels of acetonitrile built up in the tented area and swamped the filters. The persons felt reasonably well while working but when they left the tented area felt tired. Two of the personnel felt unwell in the night and were sick. They were still unwell in the morning and had to be taken into hospital. They had breathing difficulties and were nauseous and disorientated. They were taken in by the chemical incident team to Hospital. They were given Oxygen therapy and antibiotics and a battery of tests carried out over the next few days. All tests came back negative except for one of the blood test, which showed the presence of cyanide, a breakdown product of acetonitrile. The personnel were kept in for five and seven days respectively. They recovered from all of their symptoms fully and show no long terms effects. The cause was traced to a) Non use of BA equipment which would have protected the persons in the tented area. b) non use of the fume extraction provided. c) Amendment of the agreed method statement without fully reassessing the results.
RISK CONTROL SYSTEMS (S)	Plant change (including temporary modifications)
SAFETY MANAGEMENT SYSTEMS	Monitoring

LESSONS LEARNT	**Ensure that there is a clear and unambiguous commissioning procedure for new plant and equipment particularly regarding the formal handover to site staff. Ensure that the local Management of Change procedure deals specifically with changes where the design criteria are not fully met during projects. Ensure that business demands do not place undue pressure on project staff to proceed with formal handover of new plant before the design intent is met unless a safe system of work (albeit temporary) is in place.**
PRIMARY CAUSE OF INCIDENT	Human Error
DESCRIPTION OF INCIDENT	High temperature oil based heating system from a redundant reaction vessel had been re-installed on a new reaction vessel. The system was being used as a heat transfer medium to manufacture product in a new reactor when a gasket on a flange in the oil heater service room ruptured leading to a release of 50-100 litres of hot heating oil. The flange ruptured because a shutoff valve ahead of the oil heating unit was left in the closed position preventing circulation of the hot oil under pressure, causing the oil to increase in temperature to a point when the gasket material ruptured and hot oil was released into the enclosed unoccupied service room. This hazard had been identified during the project HAZOP and two appropriate control measures had been identified to control the risk. Had one or both control measure been in place the incident would not have happened? An attempt to fit one of the control measures (a valve interlock which would isolate the oil heating system when the valve was in the closed position) was made on the Friday immediately preceding the Monday on which incident happened. This had proved unsuccessful and it is believed that the valve was left in the closed position at some time during this work. There were outstanding orders for the high temperature product, which could only be made on this reactor system, and a production batch had been scheduled for the Monday on which the incident occurred.
RISK CONTROL SYSTEMS (S)	Management of change including temp mods Plant commissioning
SAFETY MANAGEMENT SYSTEM	Organising Control

LESSONS LEARNT	**Consider carrying out a complete Hazop of the affected process.** **The amount of spirit released to the drain could have been minimised with better training of the operator and supervisor who dealt with the event.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	A leak was reported on a sight glass at the base of the re-rectifier. The column was closed down for repair the next day. The spirit in the column dropped to the base but was above the level of the sight glass. The glass shattered later in the day and there was a release of spirit estimated to be between 1 to 2 tonnes. There are a significant number of risk assessments carried out for the distillation process and equipment. Even with a significant number of years experience between operators and management we failed to see the risk of the sight glass shattering and no planned preventive maintenance was put in place.
RISK CONTROL SYSTEMS (S)	Planned Plant Inspection Hazard/Risk Assessment
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure full risk assessment is carried out before any temporary modifications are made.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	As a temporary measure, due to a vital piece of equipment having broken down and waiting repair, we had to resort to using a flexible hosepipe to pump Ammonia Solution 25% from an IBC into a mixing vessel. During the operation the hosepipe dislodged itself from the mixing vessel causing a small amount of material to splash out. Fortunately the operator was able to shut the valve quickly, but not before an operator working nearby received a minor splash to his forehead, which he washed of immediately with cold running water.
RISK CONTROL SYSTEMS (S)	Hazard analysis/Risk assessment
SAFETY MANAGEMENT SYSTEM	Organising - competence

LESSONS LEARNT	**Ensure signage is very clear.** **Consider implementing a unique key flange guard system.**
PRIMARY CAUSE OF INCIDENT	Human error
DESCRIPTION OF INCIDENT	Routine maintenance work was being carried out on a paint-mixing vessel. The engineer had isolated the vessel on the top floor and proceeded to the lower floor to remove the base flange from the vessel. There are multiple vessels in the same location and all vessels are identified. The engineer removed the base flange from the incorrect vessel which contained 5000lt of paint at the time. This resulted in a spill which was contained within the factory.
RISK CONTROL SYSTEMS (S)	Planned maintenance procedures Supervision
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

IMPACT/DROPPED OBJECT

LESSONS LEARNT	**Consider re-routing hazardous pipelines so they do not cross roadways etc.**
PRIMARY CAUSE OF INCIDENT	Impact/Dropped Object
DESCRIPTION OF INCIDENT	Delivery vehicle reversing down site roadway collided with a pipebridge and severed a compressed air pipeline by breaking cast iron saunders valve cutting off supply to a plant requiring the air for pneumatic systems. This created disruption to operations on loss of supply. Pipebridges were signed, speed limit of 10mph enforced, traffic routes designated and explained, vehicle heights checked, vehicle types are specified with suppliers and when considered necessary escorted.
RISK CONTROL SYSTEM (S)	Management of Change inc Plant Mods Operating Procedures
SAFETY MANEGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Only use pallets of adequate specification for banding drums. This prevents movement of polypropylene banding on polyethylene drums.**
PRIMARY CAUSE OF INCIDENT	Impact/Dropped Object
DESCRIPTION OF INCIDENT	A vehicle carrying mixed packaged chemicals was turning right where he had to brake sharply to avoid a collision. On arrival at the customer's site it was noticed that potassium hydroxide 48/50% was leaking from the vehicle. The spillage was prevented from entering the drains with spill absorbent followed by dilution. The fire brigade were in attendance and Environment agency was informed. Approximately 79kg of product was lost. On investigation it was found that the pallet carrying 4 200l drums was substandard and had snapped on the leading edge board
RISK CONTROL SYSTEM (S)	Operating procedures
SAFETY MANGEMENT SYSTEM	Audit and Review

LESSONS LEARNT	**Ensure racking and storage systems are effectively designed to cope with movement/storage of drums.** **Make periodic checks of integrity of storage system.**
PRIMARY CAUSE OF INCIDENT	Impact/Dropped Object
DESCRIPTION OF INCIDENT	Drum fell off pallet whilst stowing in warehouse, loss of 200 ltrs inside warehouse.
RISK CONTROL SYSTEM (S)	Operating Procedures Plant and Process design
SAFETY MANGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Always secure drums adequately before transportation.**
PRIMARY CAUSE OF INCIDENT	Impact/Dropped Object
DESCRIPTION OF INCIDENT	Drum fell off a 6-barrel pallet inside warehouse. The FLT driver was driving up the slope from the warehouse to the loading bay with 6 drums when he braked causing an un-banded drum to fall off the pallet.
RISK CONTROL SYSTEM (S)	Plant and process design Operating procedures
SAFETY MANAGEMENT SYSTEM	Organising - competence

INADEQUATE ISOLATION

LESSONS LEARNT	**Ensure all plant/equipment specified in the permit to work are securely isolated before work commences.**
PRIMARY CAUSE OF INCIDENT	Inadequate Isolation
DESCRIPTION OF INCIDENT	A spillage of approx 300kgs of hot polymer at 85 Deg C spilled into an area where 3 contractors had been working minutes before. The spillage was a polymer and so chemically inert and was contained within the plant area and so did not cause environmental problems. The event happened because a valve which should have been secured was opened. Severe scalds would have resulted if the contractors had been in the line of fire of the polymer. In this instance a technician who had not be told about the work which was going on saw the opportunity to fill a tanker with polymer and found a valve handle to open the valve which should have been locked off to prevent him opening it.
RISK CONTROL SYSTEM (S)	Permit to Work Handover/Communication
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

INCORRECT INSTALLATION

LESSONS LEARNT	**Ensure contractors are competent and adequately supervised.** **Ensure testing takes place following maintenance.**
PRIMARY CAUSE OF INCIDENT	Incorrect Installation
DESCRIPTION OF INCIDENT	During the start up a leak of Di-acetone Sorbose and toluene occurred. The operators in the area closed the valve on the transfer line after approximately 30 seconds, as a leak from a heat exchanger was immediate. Approximately 250 litres of material was spilled. Internal ER team called and shortly afterwards external fore brigade called. Foam blanket applied to spillage. Minor splash injuries to operators in attendance at start up.
RISK CONTROL SYSTEM (S)	Plant commissioning Selection and Management of Contractors
SAFETY MANAGEMENT SYSTEM	Policy

MANUFACTURING DEFECT

LESSONS LEARNT	**Consider a review of the control mechanisms.** **Introduce mitigating measures to contain any potential for further release.**
PRIMARY CAUSE OF INCIDENT	Manufacturing Defect
DESCRIPTION OF INCIDENT	One of the three liquid nitrogen reciprocating pumps suffered mechanical failure of stud assembly which subsequently damaged a flexible hose resulting in a release of LN. Immediate action taken to carry our improvements to prevent a recurrence whilst longer term solution and full investigation carried out to identify revised design criteria and improved levels of control.
RISK CONTROL SYSTEM (S)	Plant and process design
SAFETY MANAGEMENT SYSTEMS	Monitoring

LESSONS LEARNT	**Ensure the integrity of small bore connections on pressure systems prior to breaking into the system for instrument testing**
PRIMARY CAUSE OF INCIDENT	Manufacturing Defect
DESCRIPTION OF INCIDENT	A boiler was undergoing an accumulation and safety valve relief test, being witnessed by a third party insurance inspector. The relief tapping failed between the relief valve and the steam drum. There was an uncontrolled release of 56barg steam. No injuries.
RISK CONTROL SYSTEM (S)	Plant and process design Inspection and maintenance
SAFETY MANAGEMENT SYSTEMS	Organising - communication

OVERFLOW

LESSONS LEARNT	**Adequately identify all hazards and risks even for what appears to be the simplest of activities**.
PRIMARY CAUSE OF INCIDENT	Overflow
DESCRIPTION OF INCIDENT	A vessel of resin was being emptied using hot condensate as a flushing medium. The resin was being emptied into a large bag via a special application hose. An engineer was holding the bag when the hose came out and he received some hot condensate splashed on his neck. He was immediately put under the safety shower. Although there was only a slight blistering to the skin there was the potential for serious burns.
RISK CONTROL SYSTEMS (S)	Hazard analysis/Risk Assessment Operating Procedures
SAFETY MANAGEMENT SYSTEM	Organising - Control

OVERPRESSURE

LESSONS LEARNT	**Scope of a pressure system must include all associated pipework and connections that are liable to become pressurised in the operation of a pressure system. Under normal operating modes as well as abnormal.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	A glass bottle containing 15 litres of 40% sodium hydroxide became pressurised and exploded spraying its contents and glass pieces within an (empty) process room. Bottle was connected to a pressure system which had a blocked vent filter leading to a build up of pressure. Glass bottle failed below the operating pressure of the pressure vessel bursting disc. Dual failure of the temperature control probe and independent temperature interlock probe occurred.
RISK CONTROL SYSTEM (S)	Plant and Process design / Management of change inc plant mods
SAFETY MANAGEMENT SYSTEM	Planning and Implementing

LESSONS LEARNT	**Consider installing a pressure transmitter and high pressure interlock to valve under tundish.** **Failure to recognise that vent system may be unable to adequately relieve pressure generated by abnormally high temperature and hence the risk of ejecting material via the dip pipe.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	An atmospheric operated Washer Catch Tank ejected liquors via a dip pipe connected to an open ended sample point tundish. A system over-pressure occurred due to over-temperature boiling of an inter-connected Washer vessel. Failure of Washer Temperature control loop and independent high temperature switch and valve had resulted in over temperature. Ejected liquors were contained in plant floor secondary containment sump.
RISK CONTROL SYSTEM (S)	Plant and Process Design Hazard Analysis/Risk Assessment
SAFETY MANGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Consider using a checklist approach for handover processes to ensure all aspects are covered.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	A 210 litre polydrum containing waste materials from cleaning out of equipment became pressurised and ruptured. It is believed that the reaction that occurred between Methanol and Acetic Anhydride was catalysed by a tiny amount of Sulphuric Acid that may have been present in the drum. A thorough risk assessment had been carried out and a detailed cleaning protocol had been drawn up and adhered to. The resulting mixture in the drum proved to be incompatible due to possible trace amounts of Sulphuric Acid.
RISK CONTROL SYSTEM (S)	Management of change inc plant mods Handover/communication
SAFETY MANAGEMENT SYSTEM	Organising - Communication

LESSONS LEARNT	**This incident highlights the importance of effective review and close-out of HAZOP actions.** **Consider replacing flexible line with hard piping.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	**During the transfer of the Pyrosulphate salt of Dimethyl Sulphate and Sulphur Trioxide, from the "pyro" reactor to the next stage reactor, a PTFE lined braided stainless steel transfer hose developed a leak. Approximately, 400kg of pyrosulphate was released to the plant sump. The material reacts rapidly with water and a cloud of Sulphuric acid mist was generated.** The flexible transfer hose was ~ 300mm long and formed part of the transfer line. It was there to provide flexibility because the reactor is on load cells. Analysis of the process software identified that high temperature in the receiving vessel tripped the transfer which led to the transfer line became hydraulically locked. The line is both electrically and steam traced to prevent the material solidifying but no pressure relief route existed in the line. The HAZOP study had identified that failure of the transfer line was a possible deviation, leading to an uncontrolled release. However, the action specified, to replace the flexible line with hard-piping, was not carried out.
RISK CONTROL SYSTEM (S)	Plant and Process Design Hazard analysis/Risk Assessment
SAFETY MANGEMENT SYSTEM	Planning and implementation

LESSONS LEARNT	**Ensure instrumentation/alarms are tested to an agreed schedule. Consider fitting an extra transmitter to allow differential pressure to be monitored across the filter, to act as a backup in the event of a failure of one of the transmitters.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	The lid on a filter downstream of a reactor export pump blew off during the export of material from the reactor to the tank farm. No one was in the area and the material in the reactor was non hazardous. It is normal practice for the operator to be monitoring the export in the Control room and access to the reactor is restricted, although it is possible for someone to be in the area. There is one pressure sensor on the line between the pump and the filter that failed. This transmitter reports to the plant computer control system which would give a quicker response considering the system is fully wetted and acting as a hydraulic system.
RISK CONTROL SYSTEM (S)	Plant and Process design Operating Procedures
SAFETY MANAGEMENT SYSTEMS	Planning and implementation

LESSONS LEARNT	**Plant should be designed to make such operations obsolete or controlled. In cases where this is not achievable adequate procedures and protection (PPE) should be implemented.**
PRIMARY CAUSE OF INCIDENT	Overpressure
DESCRIPTION OF INCIDENT	Operator was drumming off corrosive VP residues at approx 100 degrees. Drum was filled and bung temporarily replaced to allow safe movement of drum to storage area. Bung then removed to prevent pressurisation of drum. On removing bung some product shot out and caught operator slightly on the side of the neck.
RISK CONTROL SYSTEM (S)	Plant and process design Operating procedures
SAFETY MANAGEMENT SYSTEMS	Planning and Implementation

PROCEDURAL VIOLATION

LESSONS LEARNT	**Positive visual checks should be made for pipe blanks on braches and unused connection points at commissioning. Similar checks should be included in routine plant inspections.**
PRIMARY CAUSE OF INCIDENT	Procedural Violation
DESCRIPTION OF INCIDENT	406kg of cellulose acetate/acetone dope was released from an open branch on the discharge side of the storage tank pump. Due to vicious nature of the dope, the spillage remained local to the source and was shovelled into drums for disposal.
RISK CONTROL SYSTEM (S)	Management of Change inc plant mods Plant Commissioning
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Check compatibility of materials when transferring into partly full containers.**
PRIMARY CAUSE OF INCIDENT	Procedural violation
DESCRIPTION OF INCIDENT	Operator decanting one IBC of sodium chlorite into another to make on full IBC instead of two part IBCs. Both labelled as sodium chlorite, however one was incorrectly labelled and an uncontrolled reaction occurred. Operator mistakenly placed a vented cap on the IBC and the subsequent build up of pressure caused the IBC to rupture. Improved training for emergency situations has been put in place with practice scenarios run on a regular basis. There is also to be improved control of labelling of products and waste.
RISK CONTROL SYSTEM (S)	Operating Procedures. Supervision
SAFETY MANAGEMENT SYSTEM	Organising - Control

LESSONS LEARNT	**Consider developing a performance indicator to measure the Return To Operations (RTO) Process for adequacy. It was the failure of RTO that started this incident.** **The company investigative process, identified the underlying issues that would have prevented the incident.**
PRIMARY CAUSE OF INCIDENT	Procedural violation
DESCRIPTION OF INCIDENT	During transfer of 5 tonnes of methyl tert butyl ether containing 2.5% hydrogen cyanide (HCN), the HCN alarm was activated and 17 ppm of HCN detected. Investigation showed that the vessel hatch had not been fully secured allowing a small release of HCN to take place. At some stage the manway had been opened and shut without any evidence of a controlling system (Safe Working Practice or Authorised Operating Procedure) in place, denotes that there was no control for a task that required one. It was the failure of the Return to Operations process that caused this incident.
RISK CONTROL SYSTEM (S)	Permit to Work Handover/Communication
SAFETY MANGEMENT SYSTEM	Organising - Communication

LESSONS LEARNT	**Ensure operating procedures and instructions are not only understood but also being carried out.**
PRIMARY CAUSE OF INCIDENT	Procedural Violation
DESCRIPTION OF INCIDENT	During a transfer of Sodium Hydroxide solution at 22% from an IBC to a pressure bin, the hose connecting the two separated resulting in a loss of product which leaked onto a neighbouring site. The neighbour's site was contacted and spill kits provided to neutralise and absorb the spill. All drains were covered and no loss to drain occurred. Total amount of product lost was 560Kg.
RISK CONTROL SYSTEM (S)	Operating Procedures Supervision

LESSONS LEARNT	**The procedure in place required the driver to carry out a routine check to ensure the back valve is closed prior to commencing loading. In 99 times out of 100 this will be the case because the vehicles are dedicated to the carriage of Methanol and the driver will have closed his valve after discharging. On this occasion, the trailer had been picked up from a vehicle wash out station and the back valve had been left open to assist draining and drying in transit to the terminal. It may be unrealistic to expect total reliability of a procedure to confirm the expected known state.** **To avoid a recurrence, Methanol is being brought to bottom loading through a batch meter with interlocked pump earth system, vapour dispersal and overspill protection. Although expensive, this solution deals with addresses various issues including falls from height, dangers due to not earthing the vehicle, overspill protection, COSHH and spills from an open back valve.**
PRIMARY CAUSE OF INCIDENT	Procedural Violation
DESCRIPTION OF INCIDENT	Road tanker top loading bulk Methanol. Tanker back valve not closed before loading commenced and product spilt onto roadway. Tanker driver standing on loading gantry top level holding open dead mans handle of top loading arm. An employee noticed the spill, instructed the driver to stop loading and closed the vehicle back valve. The spilt product was retained in a spill collection system.
RISK CONTROL SYSTEM (S)	Operating Procedures Plant and Process design
SAFETY MANAGEMENT SYSTEM	Organising Control

RUNAWAY/CHEMICAL REACTION

LESSONS LEARNT	**Subsequent HSE investigation identified the need for hardwired interlocks on the Rubber Dissolver vessel that were independent to the DCS controls.** **SIL assessments are now linked to the HAZOP Risk Assessment process.** **When performing retrospective HAZOPs it is important to validate that control measures are in place and work correctly.** **Strive for inherent safety as it may have been possible with the original design to avoid energy accumulation from the agitator.eg. lower power, lagging not present on vessel**
PRIMARY CAUSE OF INCIDENT	Runaway/chemical reaction
DESCRIPTION OF INCIDENT	A batch of rubber and styrene solution was left stirring for 48 hours (normal time would be c.5 hours) and this caused accumulation of energy from the agitator on the vessel. The temperature gradually increased until the exothermic onset temperature (94 degC) had been achieved. Stirring continued and eventually an exothermic polymerisation reaction occurred converting styrene to polystyrene.
RISK CONTROL SYSTEMS (S)	Hazard analysis/risk assessment Operating procedures
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Always obtain exothermic data in these situations. It is better for the process manager or the chemist to carry out the hazard assessment themselves to promote a greater ownership of the findings. Revisit assessments in light of any changes such as scale up.**
PRIMARY CAUSE OF INCIDENT	Runaway/chemical reaction
DESCRIPTION OF INCIDENT	Reaction runaway due to exotherm. Relief system operated but a joint on the glassware on the reactor inside the plant was displaced causing the release of reaction liquors inside the plant. The material was predominantly acetic acid and caused the plant to be evacuated due to the pungent smell and high concentration of vapour in the atmosphere. Exotherm data was not obtained in the initial assessment an estimated score was entered in the assessment based on laboratory observation. The process was scaled up after the assessment and not re-assessed. The person operating the process was not the person who carried out the assessment.
RISK CONTROL SYSTEMS (S)	Hazard analysis/Risk assessment Plant and process design
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure adequate maintenance and cleaning occurs to eliminate residues.**
PRIMARY CAUSE OF INCIDENT	Runaway/Chemical Reaction
DESCRIPTION OF INCIDENT	A percussive emission occurred in a bay of a treatment plant.
RISK CONTROL SYSTEMS (S)	Hazard analysis/Risk assessment Planned maintenance procedures
SAFETY MANAGEMENT SYSTEM	Monitoring

STRESS/FATIGUE/VIBRATION

LESSONS LEARNT	Consider imposed loading on small-bore piping, especially where vibration may or flow may induce additional movement.
PRIMARY CAUSE OF INCIDENT	Stress/fatigue/vibration
DESCRIPTION OF INCIDENT	A weld on a drain line feeding water to a boiler failed. The line was ASA 600 OD 25mm carrying water at 45 barg and 105 deg C. The drain line was fitted via a weldolet onto the main line. The escaping water set off some level alarms, which shut the boiler down and attracted the attention of the plant supervisor who called out the boiler operator. The drain branch is concluded to have failed by fatigue cracking as a result of the heavy drain valve on the small bore branch. Any movement in the pipe causes stresses in the branch, trying to move the heavy valve. On replacement a much shorter drain line was used to reduce strain/movement on the weld and a fillet was welded between the main water line and the 25mm drain line to strengthen the arrangement. This repair has eliminated this branch and therefore the potential for further failure.
RISK CONTROL SYSTEM (S)	Planned Plant Inspection
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Ensure hoses are supported away from sharp edges.**
PRIMARY CAUSE OF INCIDENT	Stress/fatigue/vibration
DESCRIPTION OF INCIDENT	Hoses and air pump was being used for transfer of flammable hydrocarbon. Hoses frayed due to agitation against rough surface and allowed a hydrocarbon release to the bund. Hydrocarbon captured by interceptors. Volume lost 5-10000 litres.
RISK CONTROL SYSTEM (S)	Planned Plant Inspection Operating Procedures
SAFETY MANGEMENT SYSTEM	Planning and implementation

LESSONS LEARNT	**To make inspection easier prior to use, consider replacing reinforced silicone hoses with braided steel hose.**
PRIMARY CAUSE OF INCIDENT	Stress/fatigue/vibration
DESCRIPTION OF INCIDENT	After moving to new premises a fermenter was being re-commissioned. It had been inspected by an insurance inspector. On reaching working pressure, a flexible steam hose (approx 10mm diameter) ruptured releasing steam for about 3 minutes before the supply was cut. It is believed the steam hose had been stressed in the move to the new premises. The plant was supplied with reinforced silicone hoses, which technically meet the required temperature and specification. However mechanical damage can be very difficult to detect by inspection. Cold pressure testing is impracticable.
RISK CONTROL SYSTEM (S)	Planned plant inspection Planned maintenance procedures
SAFETY MANAGEMENT SYSTEM	NOT GIVEN

REFINERY SECTOR – LESSONS LEARNT

CORROSION

LESSONS LEARNT	**Dead legs on corrosive service need to be managed by:** **1. Modification– Engineer a solution to remove and eliminate the dead leg.** **2. Procedure Control – Implement procedures to minimise corrosion on dead legs which cannot be designed out, eg routine flushing.** **3. Monitoring Corrosion – The inspection team should monitor the dead leg for any potential deterioration.**
PRIMARY CAUSE OF INCIDENT	Corrosion – internal (under deposit corrosion)
DESCRIPTION OF INCIDENT	A leak occurred on a dead leg. The dead leg is in the wet undersalted crude process system.
RISK CONTROL SYSTEM (S)	Planned plant inspection Operating Procedures
SAFETY MANAGEMENT SYSTEM	Organising – co operation

LESSONS LEARNT	**Failure of floor and wall paint coating system led to localised areas of corrosion and penetration of floor plates. Review frequency of tank internal inspection for coated/painted tanks.**
PRIMARY CAUSE OF INCIDENT	Corrosion-Internal
DESCRIPTION OF INCIDENT	Leak of motor spirit from storage tank due to corrosion of floor plates.
RISK CONTROL SYSTEM (S)	Plant and Process Design
SAFETY MANAGEMENT SYSTEM	Monitoring

LESSONS LEARNT	**Ensure risk based inspection incorporates known areas of weakness.**
PRIMARY CAUSE OF INCIDENT	Corrosion – Internal
DESCRIPTION OF INCIDENT	Leak of platformate (motor spirit blending component) due to holes caused by corrosion of the floor plates. Failure of the internal floor paint covering led to isolated areas of corrosion, leading to penetration of the floor plates and release of stored product. In addition underfloor corrosion due to presence of water under the floor plates also led to a penetrating area of corrosion.
RISK CONTROL SYSTEM (S)	Planned plant inspection Plant and process design
SAFETY MANAGEMENT SYSTEM	Policy

LESSONS LEARNT	**Consider impact on adjacent plant from any modification which alters the ambient conditions.**
PRIMARY CAUSE OF INCIDENT	Corrosion – Internal
DESCRIPTION OF INCIDENT	Release of 6 tonnes of a mixture of diesel-type streams and vapour (containing hydrogen, ethane, propane and butane). A leak occurred in the hydrofiner, in the cold separator line between the exchanger and stripper tower. The inspection history of the line was good, however recent changes in process conditions resulted in a previously unrecognised degradation mechanism, causing accelerated internal corrosion, leading to line failure. The temperature of the line that failed was slightly increased after a heat exchanger was replaced (the exchanger was more efficient than had been planned for). This led to conditions supporting an aggressive corrosion mechanism, which had not been previously recognised in this type of service and was therefore not covered by the equipment strategy. Two earlier leaks on the line were boxed. Work to establish extent and cause of metal loss was being carried out when the line failed (teared due to extra load of boxes). Although one box included engineering support, the design (20 years ago) of the original support to which it was attached was less than adequate.
RISK CONTROL SYSTEM (S)	Planned plant inspection Management of change including plant modifications
SAFETY MANAGEMENT SYSTEMS	PLANNING & IMPLEMENTATION

LESSONS LEARNT	**Ensure pipes are laid on proper bedding and fully corrosion protected. Ensure this is included in inspection regime.**
PRIMARY CAUSE OF INCIDENT	Corrosion - External
DESCRIPTION OF INCIDENT	A discolouration was noted in the grass above a pipeline – found to be a small hole in a crude oil transfer line. Heavy rain led to a small amount entering a stretch of water.
RISK CONTROL SYSTEM (S)	Selection & Management of Corrosion Planned Maintenance Procedures
SAFETY MANEGEMENT SYSTEM	Audit & Review

LESSONS LEARNT	**Review the implications of differing sizes of rail tank cars on control set points such as anti-spill cut off levels.**
PRIMARY CAUSE OF INCIDENT	Electrical/electronic/programmable
DESCRIPTION OF INCIDENT	During the loading of rail tank cars with motor spirit, a system shutdown was activated by a detected high level in one of the rail tank cars. When this happens all the loading lances in service at the time are set to partially retract within the car. The system allowed one to retract completely from the car leading to a spillage of the product being loaded at the time.
RISK CONTROL SYSTEM (S)	Plant and process design Planned plant inspection
SAFETY MANAGEMENT SYSTEM	MONITORING

HUMAN ERROR

LESSONS LEARNT	**Double check product and destination before any critical product transfer.**
PRIMARY CAUSE OF INCIDENT	Human Error
DESCRIPTION OF INCIDENT	An activity to drop caustic from a Merox unit vessel was in progress. Olefin from the vessel was also inadvertently transferred to the Spent Caustic Tank. This vented to atmosphere where it ignited on an adjacent diesel generator. The hydrocarbon source was quickly identified and isolated and the fire was extinguished within approximately ten minutes. There was extensive damage to the diesel generator enclosure but only minor fire damage.
RISK CONTROL SYSTEM (S)	Operating Procedures Plant and Process Design
SAFETY MANAGEMENT SYSTEM	Organising

STATIC/SPARK

LESSONS LEARNT	**The presence of flammable materials absorbed in a sandy type of material does not give sufficient vapour presence to trigger off conventional flammable gas detector but can ignite if contacted by sparks from grinding or welding operations.** **Consider ……**
PRIMARY CAUSE OF INCIDENT	Static/Spark
DESCRIPTION OF INCIDENT	Motor spirit line had been nitrogen purged and blinded prior to being cold cut for the replacement of a section of line. A spillage of residues to grade occurred which had been water flushed and gully sucked. Whilst preparing the end of the pipe for welding a small fire occurred which was immediately extinguished and work stopped. Further water flushing of the area was undertaken with fire blankets and sand being used in the area. Gas testing for flammable vapours showed negative results and work recommenced. On restarting hot work a further fire occurred under the pipework.
RISK CONTROL SYSTEM (S)	Permit to work
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

INADEQUATE ISOLATION

LESSONS LEARNT	**Ensure Blinding list is adequate to allow for the removal of pipework to enable the exchanger to be removed for replacement/refurbishment. Ensure permit to work is adequate and covers all aspect of the process to be carried out. (The permit to work did not specifically allow this pipework to be removed but the fitter assumed it was a necessity)**
PRIMARY CAUSE OF INCIDENT	Inadequate Isolation
DESCRIPTION OF INCIDENT	Release of gases from refinery slop system header occurred due to inadequate isolation of a section of line that was removed to enable a heat exchanger to be dismantled. At the time of removal the line had become plugged with heavy oil residues and no release occurred. The plug melted when the steam tracing was reinstated later in the shutdown and the release occurred.
RISK CONTROL SYSTEM (S)	Planned maintenance procedures Permit to work
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

LESSONS LEARNT	**Always check fuel gas flow is to specification before starting up.**
PRIMARY CAUSE OF INCIDENT	Inadequate Isolation
DESCRIPTION OF INCIDENT	A reformer unit was being prepared for start up. Hydrogen was circulating and preparations were underway to light furnaces from cold. During attempts to light the furnace an explosion occurred. The explosion was the result of the presence of an excess of fuel gas in the furnace at the time of introducing the ignition source.
RISK CONTROL SYSTEM (S)	Management of change Operating procedures
SAFETY MANGEMENT SYSTEM	Planning and Implementing

PROCEDURAL VIOLATION

LESSONS LEARNT	**Ensure that staff involved in new work are fully conversant with work procedures.**
PRIMARY CAUSE OF INCIDENT	Procedural violation
DESCRIPTION OF INCIDENT	Release of 55 tonnes of light tops into a pipe track from an open drain valve on a product rundown pipe during the recommissioning of the pipe after a plant turnaround. Note that during the turnaround a section of the pipe had been replaced. The PTW procedures and normal planned maintenance procedures were not followed. 'Can do' attitude by person co-ordinating the work. Person co-ordinating the commissioning on the day was carrying out their normal role as a production shift manager and not 100% involved in the task.
RISK CONTROL SYSTEM (S)	Permit to work
SAFETY MANAGEMENT SYSTEM	Organising - control

LESSONS LEARNT	**Ensure adequate knowledge of persons preparing permits to work, especially when there is a change from original planned work.**
PRIMARY CAUSE OF INCIDENT	Procedural violation
DESCRIPTION OF INCIDENT	Release of flammable/toxic refinery flare gas occurred when fitters disconnected a flange to change a valve with inadequate isolation. Breathing apparatus had not been specified as necessary RPE for the fitters – under the prevailing conditions it should have been. A change in the sequencing of shutdown activities led to a problem of isolation of a valve due for removal. In the original sequence of events the valve would have been isolated elsewhere and breathing apparatus would not have been required. In the event isolation was inadequate at the time of commencing the job and this should have been checked at the time. In line with normal practice, permits to work for shutdown activities are prepared in advance based on the agreed schedule. The implications of rescheduling this task were not realised.
RISK CONTROL SYSTEM (S)	Permit to work Handover/communication
SAFETY MANAGEMENT SYSTEM	Planning and Implementation

STRESS/FATIGUE/VIBRATION

LESSONS LEARNT	**Be alert to unexpected change in process conditions, which could lead to corrosion especially where water is present.**
PRIMARY CAUSE OF INCIDENT	Stress/fatigue/vibration
DESCRIPTION OF INCIDENT	A ½ inch line from a reflux pump discharge line to the discharge pressure gauge fractured, resulting in the loss of approximately 1850 kg of reflux product (predominately butane). Although vibration was the cause of the failure, the vibration was caused by acid corrosion in the system. HCI is normally present, and in this instance it reacted with residual water to form acid, which caused significant damage to the pump impeller, which was the source of the high vibration.
RISK CONTROL SYSTEM (S)	Operating Procedures Planned Maintenance Procedures
SAFETY MANAGEMENT SYSTEM	Organising - competence

Annex 2 – Full Results Against the Loss of Containment Dataset

CHEMICALS SECTOR (EXCLUDING REFINERIES)

Manufacturing Activity – Chemicals Sector	
Basic Pharmaceutical Prods	6
Dyes and Pigments	0
Fertilisers and Nitrogen Compounds	0
Industrial Gases	5
None Selected	15
Other Chemicals	28
Other Inorganic Basic Chemicals	4
Other Organic Basic Chemicals	8
Paints/Varnishes/Links	3
Pesticides & Agrochem Products	0
Pharmaceutical Preps	2
Plastics in Primary Form	1
Printing Ink	0
Synthetic Rubber Primary Form	0
Caused Environmental Damage	0

Operating Mode – Chemicals Sector	
Cleaning/Washing	4
Commissioning	2
Construction	0
Decommissioning	1
Delivery	4
Maintenance planned	2
Maintenance Reactive	5
Normal Operation	41
Plant/Process Modification	1
Shutdown/Shutting Down	0
Start-up/Reinstatement	7
Testing/Sampling	1
Unknown	1
Warehouse/Storage	4

Site Release – Chemicals Sector	
Bursting Disc	0
Coupling	2
Extraction System	2
Flexible Hose Body	7
Flexible Hose Connection	1
Flexible Hose Open End	5
Instrument Connection	0
Manlid Open	3
Other Equipment Body	5
Other Equipment Flange	4
Other Equipment Seal	1
Pipe Body	2
Pipe Flange	3
Pipe Open End	3
Pipe Weld	1
Process Vessel Body	1
Process Vessel Flange	0
Process Vessel Open	1
Process Vessel Vent	1
Vessel Other	4
Pump Body	1
Pump/Compressor Flange	0
Pump/Compressor Seal	1
Road Tanker	2
Scrubber	0
Storage Vessel Body	8
Storage Vessel Flange	0
Storage Vessel Open	1
Storage Vessel Vent	2
Unknown	5
Valve Body	2
Valve Flange	3
Valve Open End	2

COMAH Status – Chemicals Sector	
Top Tier	30
Lower Tier	20
Non-COMAH	23

Incident Type – Chemicals Sector	
Major Accident Reportable to the EC	0
Major Accident to the Environment	0
Process Related Dangerous Occurrences	64
Other Incident	8

Category of Event - Chemicals Sector	
Major	2
Significant	16
Minor	52
None Selected	3

Nature of Substance – Chemicals Sector	
Explosive	0
Oxidizing	4
Extremely Flammable	2
Highly Flammable	13
Flammable	17
Very Toxic	4
Toxic	6
Highly Flammable Liquid	1
Non Comah	20
Any Class R14	0
Any Class R29	0
D for the E R50	1
D for the E R51, R53	3
Unknown	3

Injuries – Chemicals Sector	
Fatal Injuries	0
Major Injuries	0
Injuries not Requiring Hospital Treatment	0
Over 3 Day Injuries	0
Occupational Disease	0

Environment – Chemicals Sector	
Caused Environmental Damage	8

Cost – Chemicals Sector	
Damage to Property & Plant in the Establishment	252,545
Damage to Property Outside the Establishment	0
Business Interruption	645,280
Clean Up Costs	259,109
Total Costs	1,156,934

Ignition – Chemicals Sector	
Flash Fire	5
Jet Fire	0
Pool Fire	1
Explosion	1
Other	4
Total Number of Ignitions	11

Dispersion – Chemicals Sector	
On-Site	58
Off-Site	8
Unknown	5

Primary Cause of The Incident – Chemicals Sector	
Auto Ignition/Spontaneous Combustion	5
Blockage	3
Corrosion – External	1
Corrosion – Internal	3
Corrosion – Unknown	0
Corrosion Under Lagging	0
Defective Equipment	8
Degradation of Material Properties	3
Drive Away	0
Dust Explosion	0
Electrical/Electronic/Programmable	1
Human Error	17
Impact/Dropped Object	4
Inadequate Isolation	1
Incorrect Installation	1
Lightning	0
Manufacturing Defect	2
Overflow	1
Overpressure	6
Procedural Violation	4
Runaway/Chemical Reaction	3
Static/Spark	0
Stress/Fatigue/Vibration	3
Unknown	5
Unsuitable Equipment	2

Risk Control System – Chemicals Sector	
Planned Plant Inspection	8
Permit to Work	7
Operating Procedures	27
Planned Maintenance Procedures	14
Management of Change Inc Plant Mods	9
Selection and Management of Contracts	2
Plant Commissioning	4
Plant and Process Design	23
Securing Assessing Competence	1
Handover/Communication	5
Supervision	6
Hazard Analysis/Risk Assessment	19
Not Applicable	0
Unknown	2

Health and Safety Management System – Chemicals Sector	
Policy	1
Organising – Control	12
Organising – Co – Operation	1
Organising – Communication	5
Organising Competence	4
Planning and Implementation	27
Monitoring	12
Audit and Review	2

Mitigating Defences – Chemicals Sector	
Automatic Shut Off Valve Operated	0
Contained Within Bund	8
Contained Within Effluent System	6
Fire Extinguished	1
Fire or Gas Detectors Alerted Operators	2
Flame Arrester	0
Manual Shut Off Valve Operated	7
None/Unknown	31
Pressure Relief System	1
Process Stopped	14
Water Sprays/Sprinklers	1

Emergency Action – Chemicals Sector	
On-Site	46
Off-Site	6

Full Results Against the Loss of Containment Dataset

REFINERIES SECTOR

Manufacturing Activity – Refinery Sector	
Refinery Products	11
None Selected	4

Plant Installations – Refinery Sector	
Alkylation Plant	0
Catalytic Cracker	0
Crude Distillation/Vacuum	2
Distribution/Product Receipt: Jetty	0
Distribution/Product Receipt: Rail Tanker	1
Distribution/Product Receipt: Road Tanker	0
Dimersol	0
Hydrodesulphurisation	1
Merox Units	1
Amine Unit	0
Sulphur Plant	0
Hydrocracking	0
Reforming	1
Isomeration	2
Other	4
Other Bulk Storage	3
PLPL/LPG Bulk Storage	0
Utilities	0

Operating Mode – Refinery Sector	
Cleaning/Washing/Flushing	0
Commissioning	1
Construction/Hot Work	0
Construction/Other	0
Decommissioning	0
Delivery	1
Maintenance/Hot Work	1
Maintenance/Other	0
Normal Operation	8
Plant/Process Modification	0
Shutdown/Shutting down	2
Start-up/reinstatement	2
Testing/Sampling	0
Unknown	0
Warehouse/Storage	0

Site of Release – Refinery Sector	
Bellows	1
Bursting Disc	0
Centrifuge	0
Compression Flange	0
Compression Seal	0
Extraction System	0
Flexible Hose Body	0
Flexible Hose Connection	0
Flexible Hose Open End	0
Instrument Connection	2
Other Equipment Body	0
Other Equipment Flange	1
Other Equipment Seal	0
Pipe Body	3
Pipe Flange	1
Pipe Open End	3
Pipe Weld	0
Process Vessel Body	0
Process Vessel Flange	0
Process Vessel Open End	0
Pump	0
Pump Flange	0
Pump seal/piping	0
Relief Device Bursting Disc	0
Relief Device – Valve	0
Scrubber/Vent/Flare	0
Small Bore Connection	0
Small Bore Piping	0
Instrument Tapping	0
Storage Vessel Body	2
Storage Vessel Flange	0
Storage Vessel Open End	1
Compressor Receipt	0
Compressor Turbine	0
Turbine	0
Unknown	0
Valve Body	0
Valve Flange	0
Valve Open End	1
Valve Stem	0

Incident Type – Refinery Sector	
Major Accident Reportable to the EC	0
Major Accident to the Environment	0
Process Related Dangerous Occurrences	14
Other Incident	1

Category of Event – Refinery Sector	
Major	0
Significant	9
Minor	5
None Selected	1

Nature of Substance – Refinery Sector	
Explosive	1
Oxidizing	0
Extremely Flammable	8
Highly Flammable	1
Flammable	5
Very Toxic	0
Toxic	1
Highly Flammable Liquid	1
Non Comah	0
Any Class R14	0
Any Class R29	0
D for the E R50	0
D for the E R51, R53	1
Unknown	0

Injuries – Refinery Sector	
Fatal Injuries	0
Major Injuries	0
Injuries not Requiring Hospital Treatment	0
Over 3 Day Injuries	0
Occupational Disease	0

Environment – Refinery Sector	
Caused Environmental Damage	1

Cost – Refinery Sector	
Damage to Property & Plant in the Establishment	1,009,500
Damage to Property Outside the Establishment	1,425,000
Business Interruption	815,000
Clean Up Costs	501,500
Total Costs	3,751,000

Ignition – Refinery Sector	
None	2
Flash Fire	1
Jet Fire	1
Pool Fire	3
Explosion	0
Other	16
Total Number of Ignitions	

Dispersion – Refinery Sector	
On-Site	15
Off-Site	0
Unknown	0

Emergency Action – Refinery Sector	
On-Site	8
Off-Site	1

Primary Cause of The Incident - Refinery Sector	
Auto Ignition/Spontaneous Combustion	0
Blockage	0
Corrosion – External	1
Corrosion – Internal	4
Corrosion – Unknown	0
Corrosion Under Lagging	0
Defective Equipment	0
Degradation of Material Properties	0
Drive Away	0
Dust Explosion	0
Electrical/Electronic/Programmable	1
Erosion	0
Human Error	2
Impact/Dropped Object	0
Inadequate Control System	0
Inadequate Isolation	2
Incorrect Installation	0
Inadequate Procedures	0
Lightning	0
Manufacturing Defect	0
Overflow	0
Overpressure	0
Procedural Violation	2
Runaway/Chemical Reaction	0
Static/Spark	1
Stress/fatigue/vibration	2
Unknown	0
Unsuitable Equipment	0

Risk Control System – Refinery Sector	
Planned Plant Inspection	4
Permit to Work	4
Operating Procedures	4
Planned Maintenance Procedures	4
Management of Change Inc Plant Mods	2
Selection and Management of Contracts	1
Plant Commissioning	0
Plant and Process Design	4
Securing Assessing Competence	1
Handover/Communication	1
Supervision	0
Hazard Analysis/Risk Assessment	2
Alarm Handling	0
Emergency Response	0
Not Applicable	0
Unknown	0

Health and Safety Management System – Refinery Sector	
Policy	1
Organising – Control	2
Organising – Co – Operation	1
Organising – Communication	0
Organising Competence	2
Planning and Implementation	5
Monitoring	2
Audit and Review	2

Mitigating Defences – Refinery Sector	
Shut Off Valve Operated	7
Contained Within Effluent System	2
Fire Extinguished	2
Fire or Gas Detectors Alerted Operators	0
Flame Arrester	0
Lost to Bund	1
None/Unknown	2
Pressure Relief System	0
Process Stopped	0
Water Sprays/Sprinklers	1