**1144829 September 1998**

**Source :** ICHEME
**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

Part of a benzene plant was shutdown, as part of the annual shutdown programme. As part of the preparations for maintenance the main process sections were drained, purged and steamed in accordance with the set procedures. Work then began on the stripper column reboiler circuit, including two heat exchangers. The actions required for the preparation of one of the exchangers had been highlighted, and so it was assumed these actions had been completed. Under a Permit to Work the foreman and 4 of his team commenced on unbolting the exchanger end plate and the main channel end flange. The work was not completed and was carried forward to the next shift. During the work it was noticed that the exchanger surface was still hot. This was assumed to be due to steaming operations in the shell side of the exchanger. The following day under a re-signed Permit to Work, the team continued with unbolting and the exchanger end plate seal was released. Hot condensate spilled out of the bottom section of the exchanger end channel. When the flow ceased the final bolts were removed from the end plate flange and the end plate cover was rigged ready for lifting down to ground level. Approximately 10 minutes after the end plate was removed, a fitter working adjacent to the area was hit by a large flow of hot condensate, which flowed from the exchanger, impinged on a tube baffle plate and then sprayed over the fitter. He crawled away and colleagues put him under a safety shower until the ambulance arrived. The fitter received scalds to his back and neck. Investigations showed that there had been ineffective isolation of the exchanger system from the live LP plant steam supply. There was also passing valves on the condensate system which contributed to the presence of hot condensate. The highlighted had not in fact been completed and there had been inadequate physical checking of the isolation work prior to handover for maintenance. The Permit to Work system had not highlighted potential hazards, and due to work overload was not being operated effectively.
[permit to work system inadequate, burns, isolation inadequate]

**Lessons**

The following recommendations were made:
1. Key isolation valves should be checked for passing.
2. All work packs were re-checked for proper system isolation before shutdown work recommenced.
3. The organisation and supervision for the shutdown were reviewed and clear requirements for detailed recording and handover of progress between shift teams were set.
4. A schedule was to be set up for a management review of the progress of the new coordination routine and for general safety auditing of the shutdown activities on the plant.
5. The lessons learnt from the incident were to be circulated to other plants undergoing shutdown, to identify Best Practice for the future.
6. Generic recommendations from other condensate related incidents were to be reinforced.

**1199122 March 1998**

**Source :** ICHEME
**Location :** , SINGAPORE
**Injured :** 0 **Dead :** 0

**Abstract**

An explosion occurred in a let down tank during installation work of a disperser and platform. Apparently, contractors were carrying out welding work to secure the position of the let down tank. After the intended welds an explosion occurred inside the tank, blowing off the manway cover and blowing a hole in the roof. There were no injuries.
An investigation found that:
1. The let down tank had been cleaned but not gas freed.
2. No welding work was anticipated by the supervising engineer and a hot works permit was not requested by the contractor.
[cleaning procedure incorrect, permit to work system inadequate, contractor error]

**Lessons**

[None Reported]

**123791998**

**Source :** CHEMICAL HAZARDS IN INDUSTRY, MARCH 2000,; RESPONSIBLE CARE REPORTS, DEC 1999, (17), 5.
**Location :** , USA

**Injured :** 0 **Dead :** 1

**Abstract**

A process plant operator was killed after falling 10m through the fragile roof of the tank area of a site's distillation plant.
The incident occurred when the operator walked onto the roof from an extension recently added to a scaffold on the inside of the plant. The extension to the scaffold, through a nearby window, had been added as possible means of access to both the roof and vent pipe.
Erection of the scaffold and its extension were not included in the permit to work system.
The operator was showing an engineer the arrangement for measuring fumes from the vent pipe, which opens to atmosphere 40 cm outside the plant wall.
It is not known why the operator approached the vent via the roof, rather that from the scaffold inside the distillation plant as intended.
[fatality, scaffolding, permit to work system inadequate, fatality]

**Lessons**

[None Reported]

**1158212 September 1997**

**Source :** ICHEME
**Location :** , UK
**Injured :** 0 **Dead :** 0

**Abstract**

Similar incidents occurred within four weeks of each other on related flare stacks on a petrochemical plant. The second occurred after the actions recommended after the first event, a small explosion, had been implemented.
In the first incident an explosion occurred as spectacle pieces were being removed on the flare header by contractors. The investigation blamed inadequately trained personnel, inadequate mechanical supervision, inadequate process expertise in flare operation and failure to observe correct authorisation procedures. Some modifications were made to written procedures to detail required safety precautions. The accessibility of the working area was also criticised. This was attributed to piecemeal development over many years.
In the second incident, an estimated 0.1 tonnes of vapour, believed to be mostly nitrogen, was released. This occurred after a 24 inch spool had been removed to fit a blank. After removing the spool, it was discovered that the blank would not fit. It was 40 minutes before a suitable blank was located and fitted. During this period the flare header was isolated from each of three live process headers by single valves. All three valves were passing.
The enquiry found that the level of manufacturing team supervision was not as required by written procedures. The temporary operating instruction issued to cover the job was not being followed, and the blank had not been checked to confirm that it would fit.
Following the second incident, it was recommended that complex flare work of this nature should be directly supervised by a Works Shift Manager or Works Shift Controller. A thorough review of procedures was also instituted.
[maintenance, design or procedure error, operation inadequate, training inadequate, gas / vapour release, management system inadequate]

**Lessons**

Both incidents had the following features in common:
1. Non-compliance with procedures.
2. Inadequate supervision.
3. Inadequate engineering pre-planning.
4. Insufficient access / egress.

**1114911 September 1997**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

An ammonia tank was taken out of service in the July for its scheduled 3-year inspection and hydraulic pressure test. At that time, the opportunity was taken to replace valves A and B (part of a block and bleed system) on the steaming-out line to the tank. On August 13, during the first discharge of ammonia from a truck, an operator discovered valve B was leaking. He identified this valve as type suitable for steam but unsuitable for ammonia service. As a precautionary measure the tank was taken out of service with the ammonia depressured through a water drum to absorb the gas. At 09:00 hrs. on September 11, three contractors (including the supervisor) arrived to get their work permit signed and issued. The work to replace valves A and B involved the dismantling of the small diameter pipe that was fixed to the ammonia tank at flange 2. The Operator (Issuing Authority for the work permit) wrote on the permit form that the tank still contained ammonia vapours. He also informed the contractors that it would be necessary for them to wear breathing apparatus for all the work associated with the piping/valves to the tank. He did not, however, write this requirement on the permit form. At 14:00 hours, two of the three contractors (excluding the supervisor who was busy on another job) returned to disconnect flange 1. The contractor working on the flange wore breathing apparatus while the other stood by the breathing air gas bottle. While working on flange 2, the contractor's supervisor returned, put on breathing apparatus and assisted his colleague in removal of the pipe. The contractor's supervisor then decided to remove the leaded joint and clean it by scraping. At that moment he decided to remove his breathing apparatus (presumably to see more clearly) because he considered the atmosphere to be safe. As he bent down near the flange opening he was exposed to ammonia vapour. He was driven to the first aid station by one of his colleagues and transferred to hospital.
[unloading, gas / vapour release, safety procedures inadequate, permit to work system inadequate, asphyxiation]

**Lessons**

The issue of a work permit which, after all, is only a piece of paper does not by itself make a maintenance job safe. This is dependent upon the care and attention given by the Issuing Authority in the removal of known hazards and making certain that those performing the work are made fully knowledgeable of any remaining potential hazards and precautionary measures to be followed.

During any maintenance/repair work, replaced equipment or parts thereof must have exactly the same specification unless the modification is authorized under the Management of Change procedure.

Those who issue permits-to-work must be formally trained and certified as a competent Issuing Authority for a specific process area/unit.

Contractor's supervisors who act as a Performing Authority by accepting permits and the conditions for the work must be trained in this responsibility.

**8965 August 1997**

**Source :** THE SAFETY AND HEALTH PRACTITIONER, APRIL, 1997.
**Location :** Iowa, USA

**Injured :** 0 **Dead :** 0

**Abstract**

Contractors carrying out spot welding on the steel doors of an explosive magazine ignited the fireworks within. Approximately 17 tones of fireworks were consumed in the fire. Fortunately no one was injured but in addition to the destruction of the stock, the magazine suffered considerable damage. A permit to work system was not operated containing advise on precautions.
The company was fined £1000.
[explosion, fire - consequence, damage to equipment, permit to work system inadequate]

**Lessons**

[None Reported]

**1115515 July 1997**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

A second plug inserted into a "U" tube reactor blew out while the shell side of the Alkylation Unit's "Exchanger/Reactor" was pressurised with nitrogen at 50 psi to detect leaking tubes. The plug blew out as the craftsmen were about to drive it in, spraying a mist of liquid on to the face shield of one of the craftsmen.
The reactor had been prepared in accordance with the procedure to test for leaking tubes. The reactor had been blocked in, depressurised and drained. The shell side had been caustic washed to neutralize any alkylation acid and the reactor was blinded off from the acid settler. When the front cover plate was removed, some residual liquid was found in the bottom of the channel head and fire water was used to flush the channel head and tube sheet area. Dry nitrogen at 50 psig was then used to pressure up the shell side of the exchanger in order to find the leaking tubes. As this is a "U" tube bundle, the bottom leaking tube is usually found to dribble liquid out with the nitrogen. When a plug is driven in this end, then the top end of the leaking tube has to be found by detecting the escape of nitrogen. The top plug was put in place with the nitrogen pressure still applied on the shell side and tapped into place. The craftsmen were then preparing to drive the plug in completely when it blew out, spraying a mist of liquid on to the face shield of one of the craftsmen.
There is no written maintenance procedure specifically for repairing a leaking "U" tube in the reactors at Alkylation Unit. There is a Job Aid for repairing a leaking exchanger tube and the most significant difference between the Job Aid and the typical practice at the Alkylation 2 is that the Job Aid calls for water to be used to fill up the shell side of the exchanger and then this is pressured up (if necessary) to detect tube leaks. The investigation team discussed this at length and agreed that the use of nitrogen for the Alkylation Unit's reactor/exchanger is acceptable and can be done safely. The Job Aid, however, does specifically call for the shell side to be depressurised and drained before tube plugs are installed. Plugging a reactor tube while there is still nitrogen pressure on the exchanger shell was not typical practice. Nitrogen is normally blocked in and allowed to depressure first. The craftsman alleges that he was directed to attempt to plug the leaking tube while nitrogen pressure was still on the shell. The technique of inserting and driving home a plug does not require the craftsmen to enter the channel head area, as he uses an extension piece to reach into the tube sheet and insert the plug. This means a confined entry permit is not required.
However, to detect which tube is leaking requires the inspectors to use a portable instrument which detects the sound of a leak. To use this instrument they must climb into the channel head, following the issue of an entry permit by the safety inspector. The safety inspector had been called for a confined space entry permit, and was present when the plug blew out. He had refused to issue the confined spaced entry permit, advising the operator that the nitrogen had to be blocked out and the shell depressurised.
A safety inspector will not issue a confined space entry permit until the nitrogen is disconnected from the reactor shell. However, the corrosion inspector must have the nitrogen connected and under pressure for the instrument to "hear" the leak. Accordingly, the typical practice is for the nitrogen to be disconnected from the shell, have the shell depressurized and obtain a confined space entry permit. After this, pressurise the shell and enter the channel head area to use the instrument to detect the leak. The investigating team agreed that this was an unacceptable practice, because as soon as nitrogen is used to repressurize the shell the conditions of the confined space entry permit are invalid.
[reactors and reaction equipment, maintenance, tube, heat exchanger, reactor tube, design or procedure error, blowout, permit to work system inadequate, entry into confined space]

**Lessons**

The following recommendations were made:
1. Failure to have a detailed procedure with a task analysis and periodic observations for unusual jobs will lead to attempts to short cut normal practices.
2. Gas under pressure has a great deal of potential energy waiting to be released. Plugs under pressure whether in heat exchanger tubes or furnace tubes present a potential hazards.
3. A robust permit to work system is essential to prevent accidents.

**3082 16 April 1997**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

An incident at a coatings plant. A fitter was working on pipework to remove a blockage from a high speed disperser on the middle floor of a production building. The fitter told the supervisor and an operator not to use the machine. However, whilst he was on a break, a second operator on the top floor started to charge the disperser and 190 litres of xylene flowed out through open pipework.
The site was evacuated whilst the spill was cleared.
[evacuation, operator error, permit to work system inadequate, maintenance]

**Lessons**

Isolation procedures and Work Authorisation notes to be developed

**1123831 January 1997**

**Source :** FIRE PREVENTION 325, OCTOBER 1999.
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

An explosion occurred within the production line of an aerosol plant causing a fire and injuring three workers. A call to the fire brigade was done immediately after the explosion occurred.
The brigade managed to contain the fire to the packing area, which contained large quantities of cardboard and plastic.
The Health & Safety Executive carried out an investigation and ascertained that after being filled with butane gas, the cans were placed in a warm water bath of approximately 55 degrees C for a few minutes to raise the pressure in the cans from 3 bar to 7-8 bar. At this pressure if there was a weakness in a can then it would show and the gas would vet to fresh air.
To eliminate the problem of the water overheating a device raised the cans out of the water at a pre-set temperature. There was a second with a thermostat that monitored the water's temperature.
It is thought that on this occasion the first device was set too high a temperature and due to a modification earlier in the day, the thermostats had been bypassed. These circumstances resulted in excessive pressure in the aerosol cans and a number of them split, releasing a gas cloud that appears to have travelled outside the immediate vented area to a source of ignition.
[fire - consequence, modification procedures inadequate, high pressure, rupture, leak, normal operations, aerosol propellant]

**Lessons**

[None Reported]

**1107005 October 1996**

**Source :** ICHEME
**Location :** ,
**Injured :** 0 **Dead :** 0

**Abstract**

An FCC Unit was shut down for 9 days following failure of the wet gas compressor turbine. Total loss was estimated at $4.65 million (£2,776,119) (1996). The loss was caused by water contaminating the lubricating oil of the turbine driver. Water had entered the lube oil system through a defective steam ejector system that is an auxiliary part of the wet gas compressor's steam turbine driver. The FCC wet gas compressor was installed in 1971 and had two, long operating periods (12 years and 11 years) without an incident. On September 27, 1996, a short-term lube oil bearing temperature increase of 15 degrees F on the inboard end of the turbine was followed with a 70 degrees F fall in lube oil temperature. This was possibly the first indication of some loss of bearing material, which resulted in an increase in the bearing clearances allowing more oil to flow into the bearings. This increased flow resulted in the reduction of the lube oil temperature below normal level. On September 28, a decline in the turbine exhaust vacuum was discovered. This was rectified by adjusting the sealing steam and the condenser ejector system. The decline in vacuum was probably due to the increase in bearing clearance the previous day causing some minor degradation of the turbine labyrinth seals. The turbine exhaust steam vacuum was steady throughout the remainder of the week, until Friday, October 4. Again the sealing steam had to be adjusted to maintain proper vacuum. Operations continued normally until the morning of October 5. At 05:50 hrs. a vibration alarm came on in the control room. Operator response to the turbine-compressor train found excessive vibration on the turbine. The sealing steam pressures were abnormal and the turbine exhaust vacuum had declined. Adjustments failed to correct the vibration problem or the turbine exhaust pressure. Increased vibration and "sparks" from the packing box area of the turbine resulted in the decision to shut down.
The FCC steam turbine driven wet gas compressor was shut down owing to extremely high vibration, sparking from the inboard and outboard packing box and a total loss of turbine performance. Inspections carried out afterward on the turbine and compressor found the following:
1. The radial bearings were excessively worn, all babbit was found removed and the rotor had operated on the bronze backing of the tilt pad bearings.
2. The shaft labyrinth seals were heavily damaged.
3. There was damage to the rotor blades at the 5th stage (severe) and on the 7th and 8th stages.
4. There was evidence of heavy rust in bearing housings and the oil lubricated coupling was fouled with rust and "blocked up."
5. The compressor itself was undamaged, but there was rust in the bearing housings and minor damage to thrust bearings.
Evidence of water contaminated lube oil throughout the system caused sludge and corrosion material build up in the bearings. The water came from a defective steam ejector system. Eight out of the 12 tubes of the gland condenser had failed; and since the condenser drain was plugged, it allowed the cooling water to flow back into the turbine seals and into the lube oil system.
The refinery took a number of corrective actions that included:
1. Repair of and modification to the ejector system.
2. Development of a proper lube oil monitoring system for all rotating equipment on site.
3. A review of other machine condition monitoring systems for bearings.
4. Development of a comprehensive training program including refresher training to ensure compressor - turbine auxiliary systems are fully understood.
5. Ensuring clear communications between operations and maintenance on the priority that should be given to monitoring and maintenance of critical equipment.
The immediate cause of the failure was the presence of water in the lubricating oil system which destroyed the ability of the lube oil to support the rotating equipment. The basic cause of the contamination was the leaking tubes on the associated with the auxiliary system ejector system combined with the plugged drain. In addition, the failure to identify and/or acknowledge a number of warning signals prior to the incident was also significant. The latter was attributed to training particularly the need for refresher training on the wet gas compressor's auxiliary systems.
[cracking, turbine, mechanical equipment failure, training inadequate, plant shutdown]

**Lessons**

1. Rotating equipment lubricating oil examination to detect contaminants to be a routine operation.
2. Use condition monitoring equipment to determine critical bearing performance, but be sensitive to other early warning signals.
3. Auxiliary systems are outside operations mainstream expected performance and so are easily overlooked. Refresher training is essential for these systems.

**1153414 July 1996**

**Source :** ICHEME

**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

A pipeline connecting 3rd and 4th stage suction drums on a cracked gas compressor on an ethylene plant was being modified as part of a series of wider plant modifications, using contractors. After new pipework had been prepared and positioned a welder struck an arc to complete welding, when there was a detonation. The source of the fuel for the explosion was gasoline from residual pockets of hydrocarbons which had evaporated fron the cracked gas system and migrated into the line under modification. The total mass of fuel estimated to have been in the line was 48 grams. the welder was only slightly injured, and others working in the vicinity were unharmed.

Investigation showed that there had been failure to observe fully the permit to work and hot work systems in the factory; and that there had also been a failure to ensure that the part of the plant on which welding was to take place had been effectively isolated and purged.

[permit to work system inadequate, injury]

**Lessons**

The following lessons were learnt:

1. This incident classically illustrates the risks associated with hot work on plant and vessels in which flammable substances might be found,and emphasises the need for rigourous observance of adequate operational precautions.
2. Although there were clear operational failures in this case,investigation of the incident led to analysis and modification of the company peremit to work systems, with the objective of increasing the protection afforded by them.

**1158405 July 1996**

**Source :** ICHEME
**Location :** , UK
**Injured :** 0 **Dead :** 0

**Abstract**

While radiography of furnaces was taking place on a petrochemical plant a workshop technician discovered that he and a colleague had been working in the exclusion area inadvertently. He alerted his colleague and both then left the area. Personnel did not suffer exposure because of where they were in the exclusion area and the size of the source in use. The exclusion area had deliberately been made large to encompass all the required test sites in a single zone. The sweep for personnel that had been carried out failed to locate the technicians in question.
The zone had been set up in the knowledge of HSE requirements to minimise the size of such areas. This was blamed on the large amount of planned radiography work during a shutdown.
The enquiry recommended:-
1. A review of procedures associated with issuing radiography work permits.
2. Additional training in radiography work procedures for the shutdown teams.
It also recommended considering:-
1. The use of higher level sources to reduce the exposure period.
2. Improved communication between the personnel responsible for radiological protection and those controlling the issue of permits.
[radioactive, testing, design or procedure error, near miss, training inadequate]

**Lessons**

The investigation concluded that the exclusion zone selected had been too large to control effectively. This was attributed to pressure of work. It also identified weaknesses in allocation of responsibility for sweeping the area and controlling the perimeter.

**8404 1996**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Infringement of work permit system. During a shut-down of the high pressure hydrogenation unit to change-out catalyst, checking of and maintenance on valves in the high pressure loops was to be carried out as well. When work on the first valve had just begun, the operating authority, who happened to be passing by, stopped the work. Pressurised airline masks had been specified for removal of the valve bonnets, but the contractor supervisor had not communicated this to his crew. In addition the contractor supervisor had not posted a work permit at the work site, which was required by the permit-to-work system.

[permit to work system inadequate, near miss]

**Lessons**

Specifications for use of airline breathing masks when breaking lines must be complied with in order to provide protection to the individuals doing the work.

**8382 03 July 1995**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Sulphur pit explosion at a refinery. A flashback from the incinerator ignited an accumulation of acid gas in the sulphur pit. The cause of this accident was a previous modification to the sulphur pit design when the unit amine sump vent was connected into the sulphur pit vapour space. This allowed hydrogen sulphide to accumulate in the sulphur pit vapour space. The amine sump had originally been fitted with an atmospheric vent.
[near miss, design inadequate, refining, contamination, modification procedures inadequate]

**Lessons**

Allowing for understandable technical reasons, the contamination of the sulphur pit with drainings from the amine sump was undesirable, especially with the limited control over quantities being drained.

**8403 15 June 1995**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

Injury at steam condensate sump. While assisting with the modification of some pipework in the steam generation area, a process technician lost his balance, and his right foot and lower leg were submerged into a steam condensate sump. There were no guards or barriers around the sump. In addition there was generally poor housekeeping in the area, including temporary scaffolding and numerous hoses in the vicinity and a lack of suitable warning signs. The site regulations relating to sumps and pits were not followed. There was also a lack of awareness by personnel working in the area of the severe hazard presented by the open sump. A more rigorous safety assessment of the area prior to the issue of permits should have identified the hazard.
[inadequate guarding, safety procedures inadequate, permit to work system inadequate]

**Lessons**

Holes left by the removal of equipment, however temporary, must not be tolerated. Either securely cover the opening or provide guards/warning signs.
Work permit issue requires actual work site evaluation to consider the potential hazards that may be generated by the work to be done.
Supervisors need to monitor work being done to spot potential hazards.

**2331 13 March 1995**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, 2ND QUARTER, 1995.
**Location :** Blue Island, Illinois, USA

**Injured :** 3 **Dead :** -

**Abstract**

A fire occurred at a refinery which was caused by leak of gasoline additive ignited by faulty heater. Soot from the fire settled over a nearby school causing smoke inhalation injuries to students.
The accident occurred during repair work on a valve for a hydrocracking unit used in producing gasoline. Operators not trained in maintenance procedures were performing the work and did not properly lock out the equipment. Pressure in the line blew off the valve bonnet, shooting flammable liquid and vapour 70 feet into a welding shop, were it exploded into a fire that flashed back to the hydrocracking unit. The employees who were killed had been eating lunch in the welding shop. The three operators in the hydrocracking unit shuffered severe burns. Fatality.
[fire - consequence, training inadequate, vapour cloud explosion, injury]

**Lessons**

[None Reported]

**8395 02 January 1995**

**Source :** ICHEME
**Location :** ,
**Injured :** 1 **Dead :** 0

**Abstract**

Separator explosion at a refinery. During bar screen raking (the first treatment step) to clean out any large debris which might have been filtered, an explosion occurred within the
enclosed bar screen vapour space. There was injury and damage to equipment. It was found that modifications made had created an explosive hazard, and a new inherent process hazard was not completely understood or managed.
[cleaning, fire - consequence, refining, modification procedures inadequate, injury]

**Lessons**

Process hazard analysis teams should be reminded to consider all modes of operation during a review. The rake operating procedure should have been considered when discussing the potential for oxygen entering the bar screen vapour space.
Some of the technical information supplied by the carbon canister vendor was found to have been misleading, and following the recommended procedures did not necessarily eliminate the inherent hazards. This affected the quality of the hazard analysis.

**8354 January 1995**

**Source :** ICHEME
**Location :** ,
**Injured :** 0 **Dead :** 0

**Abstract**

Steam supply near miss. During a draining operation, a pipefitter encountered high pressure in a line thought to have been isolated. In fact the line had not been isolated when work was begun. In addition the work crew had failed to obtain a work permit, and valves in work area were not labelled.
Facility's engineer, who authorised the job, had instructed lock-out/tagout crew to isolate the wrong valves. A work permit would have provided pipefitter with better information about the valves, hot lines, and unusual problems.
[permit to work system inadequate, labelling incorrect]

**Lessons**

Isolation of systems must be verified before starting work on them. For single valve isolation, a full review of flow diagrams, site line-up, and permit requirements should ensure that the correct valves are identified to secure the work area.

**124231995**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A fire occurred in a high vacuum unit. The fire was caused by the melting of the body gasket of a stainless steel non-return valve in high temperature service, followed by the release of hydrocarbons above autoignition temperature.
Fortunately no one was injured in the fire and damage to equipment was limted.
An investigation into the incident revealed that the gasket of the non-return valve, provided by a stockist, was made of teflon rather than spiral-wound as specified in the requisition. Subsequent inspection showed that, in spite of a written compliance confirmation from the supplier, all non-return valves and gate valves installed during maintenance had been supplied with the wrong gaskets.
[fire - consequence, modification procedures inadequate, gas / vapour release, incorrect equipment installed]

**Lessons**

[None Reported]

**1091917 March 1994**

**Source :** ICHEME

**Location :** ,

**Injured :** 4 **Dead :** 0

**Abstract**

Three contractor employees and one company employee were exposed to a mixture of isobutane and hydrofluoric acid (HF). The amount of HF released was estimated to be less than the equivalent of one pound.
The release, in a small vapour cloud was as the result of breaking containment on a three quarter inch line being replaced during the turnaround.
Although during the emergency there was found to be a failure of the safety showers, quick and effective response by the refinery emergency response team prevented the incident from escalating into a major event. All four casualties were hospitalised, but they were released the next day.
Two were treated for HF burns, and two received precautionary treatment for HF inhalation. Subsequent investigation determined that plugging of the line had inhibited effective line purging, leading to the release after breaking line containment. Once the work permit had been issued, vague instructions, as well as questionable practices, compounded the magnitude of the incident.
[gas / vapour release, permit to work system inadequate, safety procedures inadequate, ]

**Lessons**

The following recommendations were made:
It is essential that systems which have been purged to allow them to be worked on by maintenance be verified as clear before containment is broken.
Techniques used by workers to cut into/open, equipment/lines should be done is such a way as to limit any spillage/leakage as far as possible in addition to the verification by operations personnel.
Safety showers must be regularly checked as being operating correctly. These must not be isolated while any possible need for their use exists on the plant; e.g., usually throughout the turnaround.
HF Alkylation Plants must ensure that they have an adequate emergency response to deal with accidental exposure of personnel to HF, both for burns and respiratory problems. Liaison with outside medical services/hospitals is essential to en-sure that correct treatment is rapidly available, with the necessary aftercare.

**1038803 March 1994**

**Source :** OCCUPATIONAL SAFETY OBSERVER, JUNE 1994.

**Location :** ,

**Injured :** 0 **Dead :** 0


**Abstract**

Laboratory work. Dry ice was used to remove a floor tile. The use of dry ice causes the bond between the tile and adhesive to become brittle, which allows for easy removal. The Safety Work Permit did not take into account the effects on personnel in the adjacent work areas and the need to ventilate the are properly and to monitor these areas for oxygen and carbon dioxide levels.

A cross draft was caused by a doorway in the work area that had been opened for fresh air. A high concentration of carbon dioxide migrated to an adjacent room, creating an oxygen-deficient atmosphere. This atmosphere caused three workers in the adjacent room to report shortness of breath. There were evacuated and ventilation procedures were implemented.

The direct cause of the incident was the migration of a high concentration of carbon dioxide produced by the dry ice removal process.

The two safety issues identified were:

1. The use of dry ice
2. That the Safety Work Permit did not cover monitoring oxygen and carbon dioxide levels of the adjacent areas.

[permit to work system inadequate, evacuation]


**Lessons**

This incident could have been prevented by performing a pre-job hazards analysis and identifying and evaluating hazards associated with chemicals to be used:

1. Monitoring the chemical properties for the materials involved and reviewing procedures for removal methods before they are implemented.
2. Considering the impact to the general and/or immediate surrounding environment, as well as the risk of potential exposure to personnel in adjacent locations, by providing adequate ventilation and air monitoring .

**124131994**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 1

**Abstract**

An explosion occurred during loading operations. The incident occurred when two instrument technicians were filling the wet leg of a level transmitter with glycol. Near the completion of the job the glycol filling container exploded and struck one of the technicians. The technician died as a result of the injuries inflicted.
[permit to work system inadequate, fatality, loading]

**Lessons**

The report stated the following recommendations:
1. Work to be undertaken on live equipment to be covered by a valid permit-to-work and to be properly supervised. Isolation of process equipment and reopening upon completion of the job to preferably be carried out by process operators / supervisors.
2. For this kind of job, clear and unambiguous, written step-wise procedures are required. The steps to be followed to be elucidated by drawings showing the particular line-up with all instrument connections, process valves, vent valves, etc. These procedures have to be strictly adhered to by the technicians under all circumstances.
3. As the small non-return valve in a filling/flushing connector may fail an extra non-return valve at the filling pump is strongly recommended.

**8325 October 1993**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Release during cutting of butylene pipeline.

An escape of butylene occurred during the cutting of a 4 inch LPG pipeline near the Fluid Catalytic Cracker Unit (FCCU) battery limits. The area in which "cold cut" was to be made had not been secured. A general work permit had been issued for modification work, but not all work required prior to cutting the line had been completed. [maintenance, permit to work system inadequate, gas / vapour release]

**Lessons**

The importance of employing contractors with sufficient knowledge to stop work
when an unexpected situation arises is clearly demonstrated in this incident. The incident could have been much more serious if "hot work" had been in progress.

**6170 August 1993**

**Source :** OCCUPATIONAL SAFETY OBSERVER, 1994, MAR.
**Location :** Shelbyville; Kentucky, USA

**Injured :** 3 **Dead :** 1

**Abstract**

Four workers at a packaging plant were performing maintenance on a parts cleaning system when an explosion and fire ripped through the room. The room contained a number of highly flammable and toxic substances including methyl ethyl ketone, ethyl acetate, acetone and toluene used as solvents. The operation consisted in the removal of a pump from the cabinet system and repairing the filter system. The pump had been removed and a welder was preparing to repair the basket cover when the explosion occurred. Some attempt had been made to clear flammable material but 2 soak tanks were not removed and their lids were unsealed. Fatality.
[packaging equipment, welding, permit to work system inadequate]

**Lessons**

[None Reported]

**1086819 February 1993**

**Source :** ICHEME
**Location :** ,
**Injured :** 0 **Dead :** 0

**Abstract**

A flashback occurred in the fired heater of a Furfural Extraction Unit (lube oil treatment) at a refinery. Two operators were under the heater at the time of the incident, but they escaped without injury. There was no damage to plant. The unit was out of production for 3 hours, but as the extraction capacity was not a bottleneck, effective production was not lost.
The immediate cause of the incident was too rapid a change made by the operator (under manual control) to the fuel oil supply to the heater.
The underlying cause was some deficiency in operator training.
[explosion / pressure release, operator error, training inadequate]

**Lessons**

The report stated the following recommendations:
1. Operator training to include study of precautions needed in taking instrument control loops onto manual, in respect of affects this may produce on process.
2. Review means of escape from heater firing fronts, especially where these are "boxed in" with acoustic panels.

**5732 29 July 1992**

**Source :** HEALTH AND SAFETY AT WORK, 1994, AUG.
**Location :** Bishopton; Renfrewshire, UK

**Injured :** 0 **Dead :** 1

**Abstract**

An explosion occurred when a supervisor entered a dispatch bay to inspect storage tanks containing highly volatile substances such as nitroglycerine.
Fatality.
[training inadequate, management system inadequate, inspection]

**Lessons**

[None Reported]

**1077126 March 1992**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 1

**Abstract**

A scaffolder was erecting an extension to a scaffold on a roof as part of a three man team. He stepped out onto a fragile roof to get a fitting and fell 30 ft through a plastic skylight. He was transferred unconscious to hospital and died 26 hours later.
The main cause was failure to prevent the fall by means of a suitable barrier or cover the scaffolder stepping outside his safe working area, and lack of a written procedure specifying the method of work. The team had no specific permit to work for this activity but had been working on the roof previously. It was thought that all team members were aware of the position of the skylight.
[scaffolding, maintenance, fall, fatality, design or procedure error, permit to work system inadequate]

**Lessons**

[None Reported]

**1049215 November 1991**

**Source :** ICHEME
**Location :** , FRANCE
**Injured :** 0 **Dead :** 1

**Abstract**

A firm of contractors was employed to carry out repair work on the roof of a building. A work permit was prepared, and access was to be via stairs and a platform inside the building. However it was necessary to place boards on the roof to provide safe access from the outside. One worker was sent to fetch these boards. He appears to have taken the boards up to the roof via some unused scaffolding and a ladder outside the building (rather than via the inside stairs). He seems to have fallen through a transparent panel in the roof whilst carrying the boards. He fell about 10 metres and was found dead.
[maintenance, fall, fatality, training inadequate, safety procedures inadequate]

**Lessons**

Immediate local actions included strengthening the roofs and reinforcing the ban on walking on roofs. The contractor concerned was banned from the site for 6 months.
More fundamental recommendations were:
1. Review of work permit system.
2. Contractors' foremen to be tested for ability to read and understand French.
3. Manuals and training for contractors to be reviewed.
4. A safety competition to be organised.
5. Company to commission an external safety audit.

**1249930 September 1991**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An incident occurred at a gas power plant when live cables were cut accidentally. The operator stopped work immediately and reported the incident to his supervisor. Cable cutting work was suspended.
[near miss, demolition, permit to work system inadequate]

**Lessons**

[None Reported]

**3987 July 1991**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 1

**Abstract**

Burns fatality at crude unit, on a refinery.

During the removal of a 24 inch blind from the crude unit oil transfer line, a large hydrocarbon vapour cloud occurred resulting in an explosion and subsequent fire injuring several employees. The basic cause was inadequate knowledge and inadequate training in preparing plant for maintenance. Contributing were unclear operating/maintenance procedures and failure to recognize the high hazard of the job.

[fire - consequence, vapour cloud explosion, refining, training inadequate]

**Lessons**

1. Departure from normally accepted preparations for maintenance work should be authorized by a senior manager.
2. Refresher training should be provided on understanding of permitting, operating and maintenance procedures and process basics.
3. Accountability and responsibility should be reviewed to ensure they are clearly understood.
4. Use of fire resistant clothing prevented additional fatalities.

**123921990**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

At the end of a maintenance stop, catalyst was refilled into a reactor vessel. No special breathing equipment was needed as the reactor was filled with air.
At the end of the working day, the job was not yet finished; the crew covered the manhole with a metal sheet, returned the work permit to the control room and left the site.
Next day, the men returned to the reactor to continue the filling operation. The supervisor went to the control room to collect the work permit. In the meantime, the rest of the crew removed the metal cover from the manhole and one of them donned his harness, to be lowered into the reactor by a crane.
Just as the man entering the vessel was disappearing through the manhole, the crane driver noticed that he suddenly collapsed. The man was pulled out immediately, and after receiving medical treatment he recovered completely.
[reactors and reaction equipment, asphyxiation, near miss, permit to work system inadequate, entry into confined space, injury]

**Lessons**

**4490 06 March 1989**

**Source :** ICHEME
**Location :** , JAPAN

**Injured :** 3 **Dead :** 0

**Abstract**

Corrosion inside one of the outlet headers of an air fin fan cooler was caused by iron sulphide scale deposits accelerated by increased chloride content of fluid which itself was caused by a process modification which had resulted in decreased flow rate. Corrosion caused release of hydrogen rich gas with oil which ignited giving an explosion which caused 800 window glass damage.
[solids deposition, modification procedures inadequate]

**Lessons**

There is a technical lesson to be learnt about the corrosion of carbon steel under iron sulphide scale deposit in fluid containing hydrogen sulphide, ammonia and water.

1. Corrosion is fairly accelerated by iron sulphide scale deposits.
2. Corrosion is accelerated by chlorides which are concentrated in the scale.
3. Corrosion speed increases under tensile stress.

Safety management system

1. For such desulphurisation plant, management system of operation and equipment should be intensified to discover early and to measure any abnormal condition such as local corrosion.
2. Safety examination system should be reinforced for modification or new installation facilities.

**1156419 January 1989**

**Source :** ICHEME
**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

A contract electrician received an electric shock whilst removing a 3.3 kV electric motor for refurbishment. He received a shock from a 250V live anti-condensation heater fitted to the motor. An electrical isolation permit to work had been correctly issued for the work. The contract electrician had little knowledge of the site permit to work system or the equipment installed. The process technician who issued the permit to work had little understanding of the system or the equipment involved. The incident could have been avoided if the technician had checked that the equipment was 'dead' using electrical test equipment. Although the power to the motor had been isolated and a certificate issued, the process technician was unaware that a anti-condensate heater was fitted to this type of motor.
[maintenance, permit to work system inadequate]

**Lessons**

1. Refresher training is required for permit to work issuers and was as awareness training of electrical equipment and its isolation.
2. The induction training of electrical contractors requires improvement to include awareness of the permit to work system, the type of electrical equipment used and the requirements of electrical isolation on site.

**4234 22 July 1988**

**Source :** LOSS PREVENTION BULLETIN 101, 1-2; SAFE USE OF CHEMICAL ADDITIVES, ICHEME, SAFETY TRAINING PACKAGE, 018, 3.6.
**Location :** Houston; Texas, USA

**Injured :** 0 **Dead :** 0

**Abstract**

A rail transportation incident. A stainless steel rail tanker carrying acid-washed methacrylic acid was in a plant siding when it was noticed that a pressure-relief valve was lifting. The area was secured and a remote fire monitor was set up to knock down the vapours. Several hours later the relief valve stopped lifting. An explosion of the tanker occurred approximately 20 hours after this incident. This was one of five tankers filled with acid-washed methacrylic acid. Previously this substance was loaded into tank cars lined with a phenolic resin material and this was the first time stainless steel had been used. The most likely cause was polymerisation of the methacrylic acid and failure of the relief valve on the tanker due to it being blocked with polymer. The polymerisation was caused by a combination of iron contamination from corrosion of the stainless steel by the lower acid layer normally present in acid-washed methacrylic acid and the hydroquinone inhibitor level being lower than the target specified for shipment.
[safety relief valve failure, incorrect material of construction, lack of stabiliser/inhibitor, modification procedures inadequate]

**Lessons**

The following recommendations were made:
1. The rail tankers normally used were coated with phenolic resin, this was the first time that a stainless tanker had been used.
2. The modification to the process should have been assessed to establish whether there was any hazard involved in the use of the stainless steel. In this case there was a hazard which had not been identified.

**4219 06 July 1988**

**Source :** THE PUBLIC INQUIRY INTO THE PIPER ALPHA DISASTER, CHAIRMAN: THE HON LORD CULLEN, DEPARTMENT OF ENERGY, HMSO, 1990, CM1310, ISBN 010113102;TIMES AND MANY OTHERS

**Location :** Piper Alpha; North Sea, UK

**Injured :** 0 **Dead :** 167

**Abstract**

An explosion and subsequent fire occurred at 22:00 on 6 July 1988 on a rig in the North Sea. 167 oil workers were killed, the platform totally destroyed and hydrocarbon production temporarily dropped by 11%. The platform produced both oil and gas. It was also the hub of a four-rig network passing oil and gas to the Orkneys. At the time of the disaster the rig was undergoing large-scale maintenance.

One process on the rig involved removing condensate from the gas and pumping it into the main oil lines. The condensate was injected into the oil line by one of two pumps, labelled A and B.

On 4 July it was decided to bring forward the maintenance of pump A by one month because it had been running noisily. Contractors were asked to carry out a recertification on the relief valve of pump A at the same time.

Pump A was isolated during the morning of 6 July. The safety relief valve was removed and the relief line blanked off by a flange. Separate permits-to-work (PTW) were issued for each job. The flange should have been made `leak-tight' with a spanner but at this time it was left `finger-tight' only. The plan was to refit the relief valve by 18:00.

The relief valve was recertified on 6 July, but not replaced on the relief line as the crane was unavailable. After some work on pump A had been completed, the maintenance manager had decided not to continue with the planned maintenance but had not yet informed staff.

On shift hand-over at 18:00, the night shift were told that pump A was operational. However they were not informed of the work which had been carried out on the relief valve. At 21:40 pump B tripped and attempts to restart the pump failed. Operations staff decided to reinstate pump A to maintain production. The isolation on pump A was removed and an electrician called in to restore power. The feed valves on pump A were then opened.

A low level gas alarm was recorded at 21:56 and this was followed by a high level alarm at 22:00. An explosion equivalent to 50 kg of condensate occurred. This explosion killed a number of people and destroyed the fire-fighting system. A mayday was issued but the ensuing fire rapidly engulfed the control room and severely damaged the rig's communications systems.

Emergency isolation valves on the rig failed to close and the fire escalated to a major jet fire. Flame impingement, due to the continuing leakage of gas flows from the other rigs, caused the gas risers to fail. This led to a series of massive explosions. The platform controller tried to enact the practised emergency plan, but failed due to the conditions. Fatality.

[offshore, fire - consequence, permit to work system inadequate, blind/spade/slip plate, shift change]

**Lessons**

The root causes of the incident included:

Inadequate permit-to-work system. The PTW for the relief valve should have been suspended, however, evidence suggests that the maintenance staff were unaware that the valve had not been refitted and it was unlikely that the operations staff signed off the PTW as required.

1. Poor organisation between production and maintenance.
2. Inadequate shift change over procedures.
3. Inadequate allocation of time to complete the job.
4. Failure to manage change as rig processes were extended.
5. Unclear assignment of responsibilities.
6. Poor emergency planning, no plans for evacuation by sea or for loss of services. The majority of the fatalities were caused by smoke inhalation and occurred in the galley or accommodation areas.
7. Inadequate display and access to information.
8. Inadequate emergency control centre.
9. Lack of isolation from gas lines of other rigs. The adjacent rigs continued to feed gas and oil to the rig for over a hour.
10. Large volume of gas stored in risers.

**9988 15 April 1988**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

As a result of a safety relief valve failure during the start-up/ commissioning of a second naphtha cracking furnace, "cracked gas condensate" (light hydrocarbons) was able reverse flow through the overpressure relief system, and leak out through an expansion joint. The leaking liquid spilled over a furnace and was ignited. The fire consequences were substantial, involving plant shutdown and major damage to equipment. Although the main fire was extinguished after about 20 minutes, several smaller fires ensued and it was about 1 hour before they were under control. There were no injuries.
[fire - consequence, training inadequate]

**Lessons**

An inquiry team reported that reverse flow through the relief valves was well known, as there had been a previous incident. The reason why four methods for detecting this relief valve leak had not been carried out was attributed to training inadequate. The procedures were to be revised.

**8741 1988**

**Source :** COMMUNITY DOCUMENTATION CENTRE ON INDUSTRIAL RISK, MAJOR ACCIDENT REPORTING SYSTEM LESSONS LEARNT FROM ACCIDENTS NOTIFIED, INSTITUTE FOR SYSTEMS ENGINEERING AND INFORMATICS, COMMISSION OF THE EUROPEAN COMMUNITIES JOIN RESEARCH CENTRE, 1991, ISBN 9282622894.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Due to a defective connection on the suction line of a pump, several tonnes of gaseous hydrocarbons escaped. The cloud ignited at a distance of about 50 m from the leakage source. An attempt to isolate the system failed. The pipeline between the pump and the gas column separator was isolated to avoid fire propagation to other installations, but the jet fire was not extinguished in order to avoid explosive cloud formation. After this accident, the following measures have been established to prevent similar accidents to occur in the future periodic leak test of critical flanges, training of maintenance personnel in assembling these flanges.
[explosion, fire - consequence, training inadequate, operator error, refining]

**Lessons**

[None Reported]

**8724 1988**

**Source :** COMMUNITY DOCUMENTATION CENTRE ON INDUSTRIAL RISK, MAJOR ACCIDENT REPORTING SYSTEM LESSONS LEARNT FROM ACCIDENTS NOTIFIED, INSTITUTE FOR SYSTEMS ENGINEERING AND INFORMATICS, COMMISSION OF THE EUROPEAN COMMUNITIES JOIN RESEARCH CENTRE, 1991, ISBN 9282622894.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A wrong mixture in a reactor caused explosion and fire (i.e. addition of a new product to the silicon oil caused a release of hydrogen and perhaps also sodium hydride due to wrong pH control). Laboratory experiments confirmed this hypothesis. Inspector investigations established also that the operating procedures were not well defined and training of personnel was insufficient. There was risk of intoxication for the rescuers and risk of explosion of nearby vessels. The water used to cool these vessels and to extinguish the fire (500- 600 m3/h) caused the pollution of a river crossing the site. A dyke was built a few hours after starting of the fire to prevent discharge of used fire water to this river. Despite these measures, phenols were found in another nearby bigger river fed by the first one. The authorities decided to interrupt the distribution of drinking water to 200,000 people. Drinking water needs were estimated to 45,000 m3/d and were covered by various sources (interconnection with water networks of nearby communities, use of water sources not affected by the pollution, use of deep wells, extended use of bottled mineral water, and use of two trains of 3,000 m3 capacity each). Due to the formation of a toxic cloud it was decided to evacuate a building in which 200 handicapped people were hosted. The inquiry ascertained the total lack of an internal emergency plan and violation of the existing safety rules.
[evacuation, fire - consequence, training inadequate, unwanted chemical reaction, reactors and reaction equipment, processing]

**Lessons**

[None Reported]

**9984 August 1987**

**Source :** ICHEME

**Location :** , SOUTH AFRICA

**Injured :** 0 **Dead :** 0

**Abstract**

A debutaniser reflux pump, which normally pumps LPG (mainly butane), had become blocked with hydrates. Whilst the pump was dismantled for maintenance, a solid deposition of ice and hydrates in the isolation valve was melted using a steam hose, allowing a major release of LPG. This was ignited on a near-by furnace and resulted in a vapour cloud explosion. The ensuing fire lasted for about 100 minutes and the fire consequences, were severe involving major damage to equipment, and a prolonged plant shut-down.
[training inadequate, safety procedures inadequate, fire - consequence, damage to equipment, plant shutdown]

**Lessons**

Training inadequate the properties of hydrates was not understood, and it was mistaken for ice. Safety procedures inadequate due to lack of understanding the exact point of release was not communicated to the emergency team for over 30 minutes.

**9987 29 May 1987**

**Source :** ICHEME
**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

A contract technician employed to carry out NDT inspection work fell from a ladder, whilst carrying a radioactive source. Although the fall was over 12 feet, it was not as serious as it could have been, as he received only minor injury.
[training inadequate, injury]

**Lessons**

Such loads should be hauled by rope leaving hands free.

**1064007 October 1986**

**Source :** NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D.C. 20594, VOL 6, NO. 9.
**Location :** , USA

**Injured :** 0 **Dead :** 2

**Abstract**

A marine transportation incident took place at a marine terminal. A marine tanker was discharging a cargo of acetone, and two tank barges were discharging methyl tertiary butyl ether. An idle hose lying on the dock suddenly developed a kink and ruptured. A white vapour cloud formed and exploded, engulfing the dock, the ship and one of the barges. The first officer of the ship and a dockworker were fatally injured: the fire on one of the barges lasted for 5 days. (The dockhand had no reasonable means of escaping from the fire).
It was established that the 'idle' hose which caused the incident had been left full of propylene after partially discharging another tanker. Instead of being disconnected and purged (in line with procedures) the line had been left full of propylene and capped. It had apparently ruptured below its design pressure (several dock hands testified that they had noticed the hose was worn, but did not report it).
[material transfer, explosion, fire - consequence, training inadequate, safety procedures inadequate, inspection inadequate, gas / vapour release, fatality]

**Lessons**

The NTSB concluded that the incident would not have happened if the terminal operator had followed its own procedures (ie emptied and purged the 'idle' hose). The NTSB made a number of recommendations, including:
1. The requirement that persons in charge of transfer of hazardous materials should be certified.
2. The establishment of effective means of protection or escape for those in charge of hazardous materials transfer.
3. Improved procedures for checking that hoses are adequately rated for their duties, and for regular inspection for damage.

**1054802 September 1986**

**Source :** ICHEME
**Location :** , BELGIUM
**Injured :** 1 **Dead :** 0

**Abstract**

Whilst dismantling some old temporary buildings in a construction yard, one man was injured when the building frame collapsed onto him. The men were on-site without the knowledge of the site supervisor, and were not experienced in dismantling buildings. The structural design of the frame was deficient, in that there were no bracing angles, and also the wooden frame had become rotten and incapable of maintaining integrity.
[demolition, temporary equipment, training inadequate, design inadequate, injury]

**Lessons**

The lessons relating to the accident recorded in the report were:
1. Unauthorised access to site - refresh Gateman's instructions.
2. No safety awareness instruction.
3. Revised Engineering Dept procedure to ensure the earlier removal of "sheds" before rotting starts.
4. Lack of experience was the main cause, with the structural problems contributing.

**7978 13 August 1986**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0


**Abstract**

A fitter fell from the flat roof of a single story extension to a larger building whilst taking measurements for the installation of a safety rail which was to form part of a fire escape from the upper storey of the adjoining building. He sustained a fractured femur and cracked bones in his back and foot and was off work for several months.

A safety rail was fabricated and prepared for installation. The fitter, who had informed his supervisor that he was to commence the installation, went on to the roof to fix the new safety rail and whilst estimating the distance of the wall fastenings from the south face of the building fell down the light well. No suggestion of poor weather, slippery roof surface or other physical feature can be made as a contributory factor. Following the fall, which was fortunately noticed by persons working in offices looking into the light well, some difficulties were experienced in extricating the injured fitter since there is no door access into the light well.

[safety procedures inadequate, permit to work system inadequate, injury]


**Lessons**

In this case the job was not covered by a work permit although the site does employ a work permit system for process related work. While, under some circumstances a work permit system may not be applied to non process related building works, the hazards of working at heights make it necessary to institute a checking routine by supervisors and the discipline inherent in the work permit system of identifying hazards and stipulating precautions to be taken may be the best way of achieving this.

**1064418 May 1986**

**Source :** NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D.C. 20594, VOL 6, NO. 9.
**Location :** , USA

**Injured :** 177 **Dead :** 0

**Abstract**

A rail transportation incident. A steam excursion train became de-railed after travelling over a section of line which had recently been repaired. The high number of injuries was partly attributed to the 'historic' rolling stock in use, some of which did not use 'tightlock' couplings between the carriages and were not fitted with safety glass or proper emergency exits. The absence of the 'tightlock' couplings increased the tendency of the carriages to jackknife.
The NTSB concluded that improper repairs, combined with track expansion in the heat of the day, caused a displacement of the rails at a track switch. The subsequent track inspection was inadequate (the relief track inspector had not performed that task for 9 years previously).
[rail transport, derailment - consequence, training inadequate, inspection inadequate, maintenance inadequate, injury]

**Lessons**

The NTSB issued a total of 21 recommendations for improvements, covering:
1. Improved inspection procedures.
2. Better training in, and control of maintenance procedures.
3. Application of the same safety standards to excursion trains. (as to other trains)

**8025 12 July 1985**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0


**Abstract**

A maintenance craftsman was sprayed on his face, arms and legs with hot bitumen as he attempted to remove a pump suction filter for cleaning. The positive displacement screw type bitumen pump, normally operating at 180 degrees C, had been shutdown about two hours earlier as it was suspected that the filter was blocked by coke. Although the pump had been valve isolated and the depressuring procedure carried out, the craftsman was sprayed by hot bitumen released under pressure as he attempted to remove the filter cover. Colleagues immediately helped remove contaminated clothing and placed him in a safety shower. Nevertheless the craftsman remained in hospital for 14 days for treatment to his burns and did not return to work for nearly 10 weeks. No other person was affected by this incident.

An investigation of this serious incident by the refinery has identified a number of contributory factors.

After the pump was valve isolated, the depressuring procedure was carried out which involved opening the discharge drain and running the pump for a short period. This technique had become common practice as the suction filter drain was difficult to access and was reportedly blocked. In this case, however, a number of factors are thought to have prevented the suction filter from being depressurised:

1. The pump discharge drain was blocked or restricted.
2. The relief valve protecting the pump discharge lifted.
3. The suction side of the pump was repressurised by reverse flow through the pump body (excessive clearances between the screws).

Following completion of the depressuring procedure the craftsman removed all bolts holding down the filter cover and then tried to break the joint by pulling on the handle of the cover. Bitumen sprayed out under pressure onto his unprotected face and forearms (as it was a hot day the craftsman had rolled up the sleeves of his overall) and over his thighs. The foreman subsequently noticed that the pump discharge pressure gauge was registering 4 bar g.

Although a work permit had been issued it did not, apparently, contain any specific protective clothing requirements for this job.

[flow restriction, spill, permit to work system inadequate]


**Lessons**

The following recommendations were made:

1. Relocation of the suction drain lines and valves to allow easy access.
2. Develop a method for removing the filter without the need for persons to be standing close by.
3. Flushing the filter with a cooler material.
4. Enforcing the wearing of the correct protective clothing, i.e. long gauntlets, face visors.

**1081818 April 1985**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An operator on inspection found a leak on a polymer waste line, near the waste tank in a utilities area. The waste line transfers non reactive acrylonitrile and styrene together with tetranethylsuccinonotrile and methanol to the waste tank. The operator informed the production service manager who on his return informed the polymer polyol unit operations people. The product specialist went to the spot to investigate the situation and decided to set off the fire alarm and stop the transfer from the unit to the tank was stopped. Air samples were taken to measure the acrylonitrile content in the surrounding area. It was decided to evacuate the area.

Assisted by the fire squad who put up a water spray protection, fitters equipped with breathing apparatus and protective clothing repaired the leak.

The leak was caused by a one and a half inch flanged connection, which was not properly hooked-up as 2 bolts were missing and the two mounted bolts were only hand-tight. The gasket was replaced by a new one.

The cause of the incident was due to the preparations on the line which consisted basically of blowing the line empty and flushing a flanged connection was loosened. The main danger tag and the hazardous work permit issued for the work were filed with the documents of already completed jobs before being signed for completion.

The following conclusions were made:

Several errors were made in the application of the hazardous work permit and danger tag procedures. Also controls and testing by operation were insufficient before taking this line in service.

Actions taken during the fire alarm and the repair were effective. The only deficiency here was that two fire alarm buttons did not function.

[material transfer, evacuation, operation inadequate, permit to work system inadequate,

**Lessons**

The following recommendations were made:

1. Inform all operations personnel about the incident and repeat good practice and danger of AN operations.
2. Refresh hazardous work permit procedure and danger tag procedure and stress correct application of these procedures.
3. Write a procedure for toxic gas cloud.
4. Issue safety bulletin to inform total plant population.
5. Fire alarm buttons to be regularly tested.

**8318 March 1985**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A fire and explosion occurred on lube oil hydrotreater on a refinery. A malfunction of the lube oil hydrotreater resulted in an explosion and fire. The proper action was not taken when problems in the unit developed. It was found that inexperienced operators were involved in the block switching procedure which had only been carried out on one previous occasion.
[training inadequate, fire - consequence, refining]

**Lessons**

When operators are required to make process changes for the first time or very rarely, senior staff should ensure that the operators are provided with sufficient information as to what to expect.
When unexpected conditions develop on a unit, operators must draw these to the immediate attention of more senior staff.

**1054723 September 1984**

**Source :** ICHEME
**Location :** , BELGIUM
**Injured :** 1 **Dead :** 0

**Abstract**

As a result of lack of knowledge of the precise construction of a valve, a pressure release occurred during maintenance work on the valve. The valve stem and handwheel were violently ejected causing injury to one worker. The jet of escaping nitrogen hampered rescue operations.
[safety procedures inadequate, training inadequate, explosion / pressure release, injury]

**Lessons**

The following recommendations were included in the report:
1. The potential hazards of working on equipment under pressure must be re-emphasised. (safety procedures inadequate).
2. Knowledge of the equipment is of utmost importance. No one had ever seen the valve stripped down.
3. The valve had been installed in the wrong direction.
4. The shaft key was damaged by excessive force in an attempt to open the valve. The shear pin did not operate correctly.
5. The training of the fire squad to rescue people from restricted areas should be reinforced. (training inadequate)

**2610 26 May 1983**

**Source :** PIPELINE ACCIDENT REPORT COMPRESSOR STATION EXPLOSION AND FIRE, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON D.C, USA, REPORT NUMBER NTSB PAR-83-04, 1983.

**Location :** Bloomfield; New Mexico, USA

**Injured :** 2 **Dead :** 0

**Abstract**

Natural gas pipeline. Natural gas at 815 psi began to escape through a failed gasket in a compressor. The compressor exploded and severely burnt 2 operators. The cause was believed to be due to improper tightening of the compressor head bolts and inadequate training. Gasket failure. Leak. [operation inadequate, training inadequate, explosion, burns]

**Lessons**

[None Reported]

**2415 12 November 1982**

**Source :** ICHEME
**Location :** , UK
**Injured :** 0 **Dead :** 0

**Abstract**

A permit to work was issued for checking the unloading valve on an ethylene compressor. The compressor was locked off and when the fitters withdrew the cam the spindle shot out under pressure. The compressor had not been depressured and vented due to a misunderstanding about the nature of the job being carried out.
[permit to work system inadequate]

**Lessons**

[None Reported]

**1030516 February 1982**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

During demolition work on a redundant styrene plant, an explosion occurred as pipework was being demolished. No-one was injured and no damage was caused.
The work was being carried out under a Hot Work Permit and was located near a 'live' sump The permit conditions were subsequently found to be inadequate in that a vent from the sump had been overlooked as a possible source of flammable vapour.
[permit to work system inadequate]

**Lessons**

The following conclusions were made:
1. The explosion was due to ignition of a flammable mixture within the styrene sump.
2. The flammable mixture was present due to draining of water/hydrocarbon mixtures to the sump and the presence of atmospheric air.
3. Flammable mixtures are present in the sump at all times but higher than normal rates of draining from the styrene tank farm area increased the displacement of the mixtures into the atmosphere via the vent pipe during the morning of the incident.
4. The flammables were ignited by a burning torch being used by a member of the demolition team.
5. Although no conclusive evidence exists, it is highly probable that the flashback occurred via a short 2 inch vent pipe fitted to the sump.
6. Personnel responsible for supervising the work and certifying and authorising burning failed to fully recognise the potential danger and consequently did not provide adequate precautions against the possibility of igniting the flammable vapours present. This occurred in spite of the fact that they were aware of the operational nature of the sump and of the probability of flammable vapours being present. Specifically, none were aware of the presence of the 2 inch pipe.
7. Completion of Hot Work Permit issued for burning was satisfactory.

**1015302 February 1982**

**Source :** ICHEME
**Location :** , CANADA
**Injured :** 0 **Dead :** 0

**Abstract**

At 5pm, the flame of a flare stack was extinguished. As a direct result of an abnormal operating condition at the cat cracking unit and because acid gas was being flared at the time, the flameout resulted in a significant release of hydrogen sulphide gas which led to a nearby traffic highway to close until the gas dispersed.
The immediate causes of the incident were attributed to a failure of a light ends drum level controller which led directly to an unstable fuel gas system and excessive flaring. To cope with the flaring, excessive steam was used to control smoking and when flaring stopped abruptly, the steam contributed to snuffing out the flame. The basic cause was the inadequate design and operation of the pilot gas system. Underlying causes were lack of training and skill for pilot reignition and minimal routine checking and maintenance. Two motorists were reported to have been affected by the gas while driving on the highway.
[design inadequate, training inadequate, maintenance inadequate, inspection inadequate, flameout, mechanical equipment failure, gas / vapour release]

**Lessons**

Immediate corrective steps were that acid gas stream to the flare would be eliminated and that acid gas would not be produced until the sulphur plant was restarted. H2S production was minimized and there was an immediate review of the flare reignition procedures and facilities. Appropriate personnel were retrained in the use of these facilities.
Recommendations were:
1. A review of flare ignition procedures and proper pilot operating conditions
2. Retraining of all process personnel
3. Establishment of an emergency procedure to deal with a flare flameout
4. Evelopment of a regular inspection of the pilot system and the ignitor system as a preventative maintenance program for pilot gas regulators and ignition equipment
5. Development of guidelines to deal with an emergency sulphur plant shutdown

Improvements to facilities were recommended to:
1. Installation of a pressure regulation system for pressure control of the pilot gas at the burner.
2. High and low pressure alarms were provided on the pilot gas downstream of the regulator to warn the operators in the control room and an automatic backup fuel gas system was also provided.
3. Dual pilot flame detection thermocouples were installed on each of the 3 pilots so that a low temperature alarm in the control room if the flare and the pilots were extinguished.
4. Facilities were provided to automatically add fuel gas to the flare whenever acid gas needed to be flared on an emergency basis
5. Thermocouple installation to detect a pilot flameout.
6. Installation of an infra-red detection device which can operate in all weather conditions.
7. The establishment of a need for an alternative facility for the incineration of acid gas.

**122901982**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An incident occurred due to temporary plant modification. The incident occurred when a temporary start-up filter was put in a compressor suction line. As it was unfortunately placed between the compressor inlet and the low suction pressure trip, this modification set up the possibility of an incident.
This initiated a decomposition reaction further on in the process. The resulting high pressure caused pipe joints to spring, the escaping gas ignited and the ensuing fire caused over £100,000 (1982) damage.
[modification procedures inadequate, leak, fire - consequence, maintenance]

**Lessons**

[None Reported]

**1048212 August 1981**

**Source :** ICHEME
**Location :** , UK
**Injured :** 1 **Dead :** 0

**Abstract**

On 12 August 1981, a contractor working on the site of a large chemical company was overcome by chemical fumes whilst working inside a vessel. Fortunately he was rescued, but not without difficulty, and subsequently recovered.
The man was re-coating the inside of the vessel with a mixture of rubber and resin dissolved in toluene. A gas test on the vessel, a Vessel Entry Certificate and a Permit to Work had all been obtained. The safety requirements had been stipulated, and included the need to wear protective clothing, air supplied face mask, the provision of a fresh air line into the vessel to give forced ventilation, explosimeter tests, and the need for an observer outside the vessel.
A number of the safety conditions were broken. The man entered the drum without a mask (it was handed down to him, but there is doubt as to whether he put it on). A dedicated observer was not present. There was no air line into the vessel. Explosimeter tests were not conducted.
A colleague, alerted by the lack of activity in the vessel looked in and saw the collapsed contractor. He then entered the vessel without mask or harness, failed to lift the contractor, and had to leave the vessel because the fumes were overwhelming. The site emergency services were summoned, but their arrival was seriously delayed because the telephone was faulty and they did not hear the nature or location of the emergency. Finally, the rescue was made more difficult because the contractor was not wearing a harness. When he started to revive in the fresh air he became violent and abusive, and had to be physically restrained.
[maintenance, entry into confined space, repair, air line, breathing apparatus, tank, asphyxiation, operator error, shift change, competency lacking, maintenance procedure error, contractor error, atmosphere not tested, management system inadequate, permit to work system inadequate]

**Lessons**

The following recommendations were made:
The report:
1. Emphasises the need for implementing fully the requirements of the Permit to Work and related certificates.
2. Recommends a clear requirement to use harnesses.
3. Emphasises the need for a caller reporting an emergency to wait until the fireman on duty repeats any message.
4. Asks for the findings to be relayed to the contractors.
In addition, the main body of the report makes it clear that the supervision of the job was less than satisfactory. This was exacerbated by the timing of the work which was started just before a shift change-over.

**2063 08 October 1980**

**Source :** HAZARDOUS MATERIALS INTELLIGENCE REPORT, 1980, 17 OCT.; GUARDIAN, 1980, 9 OCT.
**Location :** Xalostoc; Mexico City, MEXICO

**Injured :** 29 **Dead :** 9

**Abstract**

144,000 litres of ammonia escaped from hose during transfer operation from a road tanker to a rail tanker. Thousands evacuated. An official report attributed the gas escape to poor operator training and defective equipment. Fatality. Training inadequate.
[leak]

**Lessons**

[None Reported]

**12581June 1980**

**Source :** DUST EXPLOSIONS IN THE PROCESS INDUSTRIES. ECKHOFF.
**Location :** St. Paul, Minnesota, USA

**Injured :** 13 **Dead :** 0

**Abstract**

An electrician repairing live terminals in a truck receiving cross tunnel while unloading grain trucks caused a dust explosion resulting in damage estimated to cost US$ 0.3 million (1980). The flame front moved along the tunnel into the bucket elevators. Secondary explosions occurred in other bucket elevators and dust extraction equipment. Pressure relief occurred by the wall panels blowing out. The level of house keeping was particularly poor.
[grain, storage, maintenance, silo/hopper, dust explosion, design or procedure error, permit to work system inadequate, injury]

**Lessons**

Dust layers of 0.5mm may be sufficient if raised to propagate a flame. A rule of thumb was developed that if footprints could be seen then the housekeeping was unacceptable.

**9956 28 March 1980**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

An incident occurred during maintenance work involving a caustic head tank level controller, when the protective lead plug became displaced from the radioactive source.
The radioactive source was unplugged and unprotected for between 24 to 48 hours, it is fortunate that the source was so week that it caused no harm to personnel exposed to the radioactivity during this time.
The following conclusion was made:
The removal and replacement of the radioactive source during the maintenance job was carried out without due regard to the conditions laid down in the Certificate of Registration. This resulted from lack of written operating and maintenance procedures and failed to appreciate the procedures required due to inadequate training of those involved in the incident.
[protective safety equipment, design or procedure error, spill, near miss, training inadequate]

**Lessons**

[None Reported]

**5170 1980**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0


**Abstract**

A tube ruptured in a desulphuriser reactor charge heater due to a blockage caused by accelerated coking. Flames spread over an area of some 100 feet outward from the bottom of the heater and in excess of 50 feet out from the stack. Burner connections were blown loose adding to the fire at the base of the heater.

Within minutes operators reacted to shut down and block in feed, H2 make-up and product streams, to isolate fuel at battery limits and to initiate steps to get the unit depressured. Fire control forces were set up quickly and began applying cooling water to surrounding equipment and on the furnace skin and stack. Special attention was given to the reactor and nearby exchangers. With all systems secured and isolated, the fire was allowed to burn itself out, which took approximately 30 minutes.

Feed (diesel stock) preheat is supplied via effluent exchange and a bottom fired vertical tube, four pass "can type" furnace. Each heater pass consists of 10 rows of 9-chrome tubes around the circumference of the radiant section and 12 rows of extended surface 9-chrome tubes in the convection section. External inlet block valves on each pass have been used for flow balancing. Combined heater outlet (reactor inlet) temperature regulates the fuel gas to four combination burners.

The failure was caused by accelerated coking in the furnace tubes as a result of insufficient H2 recycle coupled with severe flow imbalance. As the system H2 (hydrogen) supply was depleted and the heater continued to be fired harder, the problem was compounded. Heater pass temperatures became unstable but operator attention was geared entirely towards improving mechanical flow balance using the pass inlet gate valves.

On the day of the incident a recycle (and make-up) compressor was shut down due to hot valves.

This resulted in a drop in recycle gas rate from 1,200 MSCFH to just under 390 SCFH. Of this, some 50 MSCFH was being taken in as inter-bed quench. No corresponding move in feed rate was made since the then current operating practice did not call for maintenance of a minimum H2 /HC ratio and because the operators knew from past experience that one compressor fully loaded was sufficient to sustain feed rates below 20 MBPD. What they did not recognise, however, was that this compressor was operating at less than 50% of its normal capacity.

[tube failure, reactors and reaction equipment, fire - consequence, training inadequate, processing, flow restriction]


**Lessons**

Operators must be trained such that they understand thoroughly the operation of complex plant with special attention to the significance of deviations from design operation.

**7423 1980**

**Source :** ICHEME

**Location :** ,

**Injured :** 3 **Dead :** 0


**Abstract**

Two maintenance contractors and a process operator were gassed during a blanking-off job on a acid gas knock out drum associated with a sulphur unit. The process operator lost consciousness but was revived by the refinery's firemen.

A number of factors contributed to the accident but the prime cause was a breakdown in accepted methods of safe working where there was a potential risk of exposure to H2S (hydrogen sulphide) i.e. breathing apparatus was not worn, supervision and control of the job were inadequate and the permit-to-work arrangement was loose. In addition, the design of the system prevented positive isolation so that there was a strong possibility that loss of containment would occur.

After investigation the following was found:

1. Inadequate supervision in relation to the potential risk of exposure to H2S, the work was being supervised by an inexperienced operator.
2. Inadequate isolation for minimising the possibility of H2S leakage from the K0 drum. An isolation valve which can be locked shut should be installed between the check valve and the K0 drum.
3. Failure to wear breathing apparatus.
4. Failure to recognise the limitations of canister masks which provide inadequate respiratory protection in the event of exposure to high concentrations of H2S.
5. Inadequate permit-to-work arrangement. A cold work permit issued for any maintenance work where respiratory protection is required should be given special status by limiting permit signatories e.g. to those persons who would normally sign hot work and entry permits.

[safety procedures inadequate, permit to work system inadequate, slip plate insertion/removal, isolation inadequate, blind/spade/slip plate]


**Lessons**

A full set of precautions must always be in place when work is carried out on any systems involving toxic or inert gases.

1. The time factor is as important with respect to resuscitation that consideration should be given to placing resuscitation equipment in control rooms of plants handling toxic materials.
2. It can then be administered on the spot by operators trained in its use. The resuscitation equipment and training of operators in its use should remain the responsibility of local qualified medical staff. The presence of such equipment on a plant must not be allowed to diminish the importance of existing emergency facilities and the need to summon medical staff immediately.

**1140502 February 1979**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

During a full pressure hydrostatic test at 420 psig, a thimble which had been expanded into the rear steam drum on a boiler was ejected. Two thimbles had been fitted to replace a cross-over tube and installed with the thimbles facing into the steam/water space, a departure from previous practice. This was done because of internal fouling of thimbles fitted in the usual manner, where they form pockets in the steam water space. Due to inexperience and a failure in communication, the thimbles were inadequately expanded and not provided with a beading or any projection.
[testing, steam, operational activities, inspection, boiler, expanded thimble, near miss, modification procedures inadequate]

**Lessons**

The following recommendations were made:
1. The need for recognition and formal treatment of modifications must be emphasised.
2. Where plugs rely on a friction or other mechanical fit, i.e. non-welded, special precautions should be defined for hydrotesting.

**4083 03 May 1978**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Due to an unanticipated demand, the normal day operation of a Residues/Waste Oils incinerator was to be put on a shift basis. The shift operators had been trained to maintain normal operating conditions, but had not been instructed on how to deal with unusual fuel conditions. Residues in the fuel had caused blockages in the burners and the incinerator had been shutdown. Several attempts were made to start-up the incinerator, and after lighting one of two burners excessive overheating occurred, causing damage to the induced draft fan.
[damage to equipment, flow restriction, training inadequate, heating]

**Lessons**

The management and training needed to be improved to ensure that personnel were only asked to perform duties in which they had been adequately instructed.

**107461978**

**Source :** HEALTH AND SAFETY, MANUFACTURING & SERVICE INDUSTRIES 1978.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A major incident occurred at a chemical plant when there was an escape of 9000 litres of LPG. Shipping and rail traffic in the area was brought to a halt. The leak happened due to a pair of flanges on a 100mm line had been left unbolted. Three pipelines had been split to allow hydraulic valves to be fitted and the reconnection of the lines was left to the night shift to complete. A supervisor using a torch thought he had located all the unbolted flanges but in the dark he missed one.
When the plant was taken back into use, LPG leaked. Unfortunately the operators on the plant had not had training on the new hydraulic valves and thought that they had been closed. The LPG continued to escape for twenty minutes, until the plant engineer arrived and closed the valves. Employees were caught in the control room which was almost surrounded by the vapour, fortunately it did not ignite. Investigation of the incident revealed that no system had been laid down for work on pipelines at this plant. Action was taken and a penalty of £300 (1978) was imposed.
[gas / vapour release, operation inadequate, training inadequate, permit to work system inadequate, maintenance, near miss, inspection]

**Lessons**

[None Reported]

**1203907 October 1977**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0


**Abstract**

An acuated ball valve in the discharge line from a motor spirit blending pump was found not to be shutting fully, as denoted by positional marks on the valve indicator. The actuator was checked first and found to be satisfactory and therefore a cold work permit was issued authorising work on the ball valve itself. The permit stated "repairing and making movable valve", but no special measures or precautions were indicated.

When the fitter started to work on the valve on the 7th October 1977, he noticed that the line was under pressure, and he contacted the control room operator to check the situation. The operator established from the control panel that butane and straight run gasoline were being blended into tankage, that the blending pump was shutdown and the control valve 1 and valve 2 were indicated shut, with no indication of flow through this leg of the system. However the operator did not visit the site. The fitter was then allowed to open and close the valve to his own satisfaction. He then removed the valve's actuator and attempted to put the valve spindle into the shut position manually, but this was not found possible. The fitter then loosened the nuts on the studs of the gland of the valve spindle, to attempt to free the spindle by moving it to and fro. Whilst doing this the spindle, gland and its packing were suddenly blown out of the valve releasing a butane/straight run gasoline mixture.

A gas cloud formed and drifted towards the refinery separators and jetties. The escaping vapour was dispersed with water spray jets.

Following an investigation meeting the following points were established and conclusions drawn:

1. The gland nuts were covered with a paint layer which made it impossible to see the right position of the nuts on their stud bolts.
2. The danger of paint layers was generally understood by members of departments concerned, but overlooked in this incident.
3. The fitter had only intended to loosen the gland nut by two threads on each stud bolt.
4. The threads of the stud bolts were not damaged.
5. The practice of making a valve spindle movable by loosening gland nuts and turning the spindle to and fro had become accepted by fitters as common practice, even when the valve was under pressure.
6. It was theorised that if a nut was pushed off a stud bolt this would result in damage to the thread, unless the nut was in fact only on the stud bolt by one or two threads. It was therefore considered that the nuts were loosened too far by the fitter and that the paint layer may have contributed to his difficulty in controlling the degree of loosening of the nut.
7. When the cold work permit was initially issued it was not appreciated that a blend would be in operation with valve under pressure when the valve was to be worked on.

[ maintenance, mixing, ball valve, operation inadequate, permit to work system inadequate, gas / vapour release, butane, gasoline]


**Lessons**

1. The refinery recommended that more attention must be paid to the correct preparation of work permits taking care to ensure that any change in working conditions are noted on the permit.
2. The dangers of painting over parts of equipment such as valve spindles, nuts etc. be drawn to the attention of the various departments.
3. Working on valves under pressure is to be generally prohibited, especially so when the valve concerned is on flammable toxic, corrosive or steam duties.

**4063 September 1977**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A fire-fighting water tank was disconnected for alteration and modification, which was then deferred. Alternative arrangements for fire fighting water supply were not made for over one year.
[modification procedures inadequate, near miss]

**Lessons**

Modification procedures inadequate: projects which rely upon other projects to provide alternatives must be cross referenced in the project management system.

**1445 12 August 1977**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A road tanker made a delivery of 80% acetic acid to a company storage tank. The receipt tank collapsed after delivery. An investigation concluded the cause to be:

1. The tank was correctly designed and installed, with both a vent and an overflow line.
2. At some time the vent was sealed, presumably to prevent the release of acid vapour when tankers were discharging. The overflow then became the only vent. This modification was not submitted for plant design approval.
3. It had become established practice to put a few inches of water into the bund surrounding the tank, to ensure that any acid which overflowed was immediately diluted.
4. On this occasion the hose supplying water to the bund was left running. The water level continued to rise until it covered the lower end of the overflow line.
5. When the automatic pump supplying the head tank in the process building started to withdraw acid from the receipt tank, water was drawn up the overflow pipe creating a barometric leg. The partial vacuum thus formed in the tank then caused it to collapse.

[modification procedures inadequate]

**Lessons**

[None Reported]

**1070629 July 1977**

**Source :** ICHEME
**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

An operator seriously injured when trapped against structural steelwork by forklift truck.
A team of workers were awaiting the arrival of a powder tanker in a loading bay, when a fork-lift truck was noted to be in the path of the vehicle. An operator reached over, while standing next to the forklift truck, and operated the fork-lift controls to move it out of the way. Another operator, standing in front of the forklift truck, moved out of the way but inadvertently stepped the wrong way and was struck by the fork-lift truck and trapped against structural steelwork. He was reportedly seriously injured, but the nature of his injuries was not disclosed.
Investigation by a factories inspector concluded that the person who operated the fork-lift was not trained in the operation of fork-lift trucks, and also that the slow override switch on the fork-lift truck had been disengaged and thus rendered non-operational. According to the inspectors report, "the operator said he had been detailed by the supervisor to drive the truck for the duration of the works shut-down".
Investigation by the company, however, found that the operator had never been instructed to operate the fork-lift truck because he was not trained, and that there were two trained fork-lift operators present at the time of the accident. He had thus misled the factory inspector, and on further investigation was subsequently dismissed by the company. The inspector raised the possibility of the operator being prosecuted for his actions.
Disengagement of the slow override switch on fork-lift trucks had been reported before at the company (this switch slows the truck when the forks are in the extended position).
The inspector of factories noted another unsafe practice when investigating this particular accident, that of filling the tanker by emptying bags into it from the top. He considered this practice unsafe because it exposes the operators to unnecessary risks. The company procedure, however, required operators on the tanker to wear safety harnesses and was considered safe. This method of filling the tanker was not standard procedure at the company, and was reportedly only carried out on rare occasions. A mechanical system of filling the tankers is routinely used, and plans were in place for it to be replaced by a new bulk silo loading facility.
In conclusion, it appears that the operator who was injured made a mistake and stepped the wrong way in attempting to avoid the fork-lift truck. He may have sustained fewer injuries if the fork-lift truck slow override switch had not been defeated.
[training inadequate, people, injury]

**Lessons**

1. A suitable notice should be posted drawing the attention of all company employees to the consequences of tampering with safety features of equipment to prevent its correct operation (in this case defeating the function of the slow override switch on the forklift truck).
2. The filling of powder tankers from the top by means of bags is to be discontinued.
3. Groups of relatively new operators should be more closely supervised.
4. The incident and its ramifications should be discussed in union works councils.

**1170414 March 1977**

**Source :** ICHEME

**Location :** ,

**Injured :** 2 **Dead :** 0


**Abstract**

Two maintenance fitters sustained second degree burns on their legs (30% body surface), from being scalded with hot condensate and were detained in hospital for two weeks.

The incident occurred when the vacuum distillation unit was shut down for statutory inspection of its two steam generators and the steam drum.

A process assistant operator drained condensate from the suction side of the condensate pump which effectively drained the steam drum but did not remove the condensate from the steam generators. The operator then gave permission for the fitters to open the flanges in the pipework beneath the steam generator.

The fitters after releasing all the bolts of the flange but one, found that this last bolt could not be moved. They therefore sawed the bolt through and the flanges suddenly sprang apart and a large amount of hot condendsate poured out.

[inspection, maintenance, distillation, operator error, identification inadequate, permit to work system inadequate, spill, burns, condensate]


**Lessons**

The refinery made the following observations and recommendations:

1. That the process assistant operator had opened the wrong drain valve for the system to be worked on. This was partially understandable due to heavy lagging sections on the pipework which could have caused confusion as to identification of pipework, this will be modified.
2. At least one of the fitters was a very experienced man and would have known the correct way for breaking flanges, i.e. to leave some loosened bolts in position until the last tight bolt has been removed. Maintenance fitters have been reminded of this good practice
3. A more detailed planning and permit system will be instigated for work on partial shut down units.

**1078008 February 1977**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

A road transport incident. A drum containing acrylonitrile (part of a larger consignment of drums) developed a leak which was discovered when a container was being unloaded from a lorry. Some material was lost to drain, and two men complained of eye irritation.
The drums had been stacked in the container in such a way that the lower layer of drums was 'on end', with a further layer stacked 'on the roll' on top of them. No 'dunnage' (protective packing material) had been used between the two layers. Vibration during the journey had caused the rim of one of the lower drums to penetrate the 'runner' of one of the upper drums, causing a split and consequent leakage.
The employees of the transport company appeared to be unaware of the hazardous nature of the material.
[transportation, spill, training inadequate, safety procedures inadequate, unloading]

**Lessons**

The following recommendations were made for the transport of hazardous materials in drums:
1. Drums should be stacked on end.
2. Adequate 'dunnage' (protection) must be provided.
3. Drums should not be double stacked.
4. Drums should not be transported in closed containers.
5. Drivers should be made more aware of the hazardous properties of materials being transported.

**1159328 November 1976**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

This explosion in a slops tank, eventually involved six tanks in the same area, the fire being fuelled from a 24 inch rupture in the slops tank base. A control room wall, 400 ft. away was cracked by the heat.
Ambient temperature at the time was 34 degrees F, but earlier temperatures had been below 10 degrees F and product demands had caused many tank levels to be much lower than normal. All the process units were operating normally but some pipelines (especially waxy distillates) were having blockage problems. In an attempt to clear one line a light furnace oil at about 150-160 degrees F was put into the line. The contents of the line were fed to the slop tank. About 1 hours later the explosion occurred.
The subsequent investigation arrived at the following conclusions.
About 30 barrels of furnace oil had been fed to the line which was just sufficient to displace the contents of the line into the slop tank. The steam tracing had heated these line contents to about 160-180 degrees F during the static condition. The tank level was raised by about 1-2 inches. Also, an unknown stream was added to the tank raising the level a further 12 inches. This brought the steam coils (which were at 250 degrees F) into contact with the tank contents.
Heat transfer to the tank water layer eventually raised the temperature to above 212 degrees F. Frothing and steam formation then caused a rupture in the tank roof and release of a vapour cloud. Ignition was probably obtained from this metallic rupture; the 10,000 bbl tank was over 20 years old and not in perfect condition.
Refinery actions included replacing the slop tank further away from the process area and equipping it with remote level indication.
Operators were instructed to keep comprehensive records of disposal of materials to tankage.
[shutdown, modification, repair, commissioning, modification procedures inadequate, accidental mixing, unwanted chemical reaction, explosion, fire - consequence, hydrofluoric acid, potassium hydroxide]

**Lessons**

There should be provision for adequate temperature, level indication and alarms on any heated slop, or other heavy oil tank which might be contaminated with free water or light product. Wherever possible, heating of slop tanks should be avoided and the heating coils blanked off.
Frequent drainage and bottoms level checks and care with the use of any installed mixers must be included in operational procedures.
In the past years, refineries have been warned in a variety of ways of the potential hazards of slops tanks, where these are fitted with heating coils. The introduction/accumulation of water or light oils in slops tanks containing heavy oils can well have serious results with heat transfer from the coils preferentially to one layer, causing rapid vapourisation and overpressure of the tank, leading to rupture

**9346 28 November 1976**

**Source :** ICHEME

**Location :** , USA

**Injured :** 0 **Dead :** 0


**Abstract**

At a major shutdown, repairs and modifications were carried out on this HF Alkylation Unit. The modifications included replacing the liquid caustic neutraliser with a tower containing solid potassium hydroxide. Not all the associated controls and alarms for this modification were installed at the time.
The plant was subsequently recommissioned, and on the 28th November 1976 there was a plant upset which resulted in the carryover of a slug of hydrofluoric acid into the potassium hydroxide tower. It would appear that just before the incident the HF stripper tower was not operating satisfactorily. Although they were aware of this, their operating manuals had not been updated, the operators were therefore unaware of the implications and of the corrective actions to be taken.
The exothermic reaction between the HF and KOH caused an explosion and fire. The force of the blast carried away the side of a cooling tower sited some 300 feet away from the source of explosion. (However if this was a wooden construction it might not be a significant parameter of the force of the blast).
The fire fighting facilities were sufficient to contain the fire in the area of the tower, although it is considered that additional fixed monitors would have eased the task of the firemen. There were no problems with HF, although small quantities undoubtedly were released from the stripper tower these did not affect the fire fighting operations.
[shutdown, modification, repair, commissioning, modification procedures inadequate, accidental mixing, unwanted chemical reaction, explosion, fire - consequence, hydrofluoric acid, potassium hydroxide]


**Lessons**

The incident again illustrates the dangers of uncontrolled mixing of acids and alkalies which are capable of producing sufficient heat of reaction to rupture equipment. This is obviously not specific to Alkylation Plants but could occur with other processes, and therefore refineries are reminded of this hazard.
The release of HF under fire conditions with diffusion in the rising combustion products did not produce problems in this particular incident, and the same situation has been observed in other HF unit fires. Escape of HF without an associated fire could obviously present toxicity problems, depending on the leak size, atmospheric conditions etc.

**1010708 July 1976**

**Source :** ICHEME
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

A 30 ton mobile crane on a chemicals site ran into a stationary platform truck, which in turn ran into a stationary 100 ton crane. All 3 vehicles sustained some damage.
It was established that an untrained driver of the 30 ton crane had started the engine of the vehicle without setting the handbrake and selecting neutral gear. He then left the vehicle to get a pair of gloves. During this time, operation of the engine primed the hydraulic transmission of the crane and built up normal operating pressure in the air brake system, thus releasing the brakes. The crane moved forward without a driver.
The crane was found to be in good mechanical condition, but a small stone was found under the accelerator pedal, which would have increased the engine speed above the normal idling condition. Tests showed that under these conditions the crane would, in fact, move forward.
[maintenance, damage to equipment, driver error, competency lacking, training inadequate, design or procedure error]

**Lessons**

The following recommendations were made:
1. Enforcement of the training and certification of crane operators .
2. Provision of clearer indication of the handbrake condition
3. Improved operating procedures.
4. Other changes to the crane controls.

**1154214 June 1975**

**Source :** ICHEME
**Location :** , UK
**Injured :** 0 **Dead :** 0

**Abstract**

A fire occurred in and around the 'air box' of a boiler. The boiler normally used two out of three burners which were mounted centrally in holes in the wall between the 'air box' and the furnace. There was a fourth burner hole which was unused and plugged.
A trainee operator carrying out a routine visual inspection of the boiler observed smoke coming from the sight holes. By the time the regular operator was summoned, flames were issuing from the sight holes indicating a fire in the 'air box'. The operator notified the shift manager who called the works fire team and the County Fire Brigade before going to the boiler house. On arrival at the boiler house the shift manager agreed that the boiler should be shutdown immediately. About 15 minutes elapsed between discovery of the fire and the decision to shut down the boiler.
The works fire team arrived while the boiler was being shutdown and fought the fire with carbon dioxide until this was exhausted. The fire brigade arrived a few minutes later and fought the fire with foam until it was extinguished. The brigade remained for a further hour to ensure that the fire did not recur.
During the investigation of the incident, it was discovered that one of the burner holes had been modified in a manner which reduced the hole diameter and extended the wall thickness. This modification caused the flame to impinge on the hole and reduced the combustion efficiency. The design of the hole allowed unburned oil to flow back into the 'air box'. This oil accumulating in the 'air box' ignited.
From the residue in the 'air box' it was estimated that at least 40 gallons of oil was involved in the fire.
[fire - consequence, normal operations, modification procedures inadequate, reverse flow]

**Lessons**

The fundamental cause of the incident was the modification to the burner hole. The original burner hole was designed to avoid flame impingement and even if impingement occurred the oil would preferentially flow towards the furnace not back to the 'air box'. No record was found of why or when the hole was modified or who authorised the modification. A previous modification by the boiler supplier was identified after the original incident report was issued.
The investigation team recognised that this was the same type of managerial failure as occurred at Flixborough.
It was recommended that new procedures were introduced so that all proposed modifications were reviewed, the technical implications were thoroughly examined and details of the modification were recorded.

**899 01 June 1974**

**Source :** THE FLIXBOROUGH DISASTER. REPORT OF THE COURT OF INQUIRY, HMSO, 1975, ISBN 011361075 0.
**Location :** Flixborough; Lincolnshire; Uk, UK

**Injured :** 400+ **Dead :** 28

**Abstract**

During March the caprolactam plant was shut-down and the No 5 reactor taken out of service. A 20-inch pipe was used to fabricate a dog-leg bypass pipe. The plant was started up on 1 April. On Wednesday 29 May a leak was discovered in the bottom isolation valve on a sight glass fitted to a reactor. The plant was depressurized and cooled down, the leak repaired and the plant restarted. Normal operating conditions of 8.8 bar g and 155 degrees C were achieved on 1 June with the plant on hold pending the arrival of high pressure nitrogen needed for the commencement of oxidation. Shortly before 17.00 hours the bypass in place on the No 5 Reactor became unstable (squirmed) with the result that the two bellows units attached to the Nos 4 and 6 reactors failed into many pieces and the bypass pipe fell down. Hot cyclohexane was emitted with flash vaporisation and massive entrainment. Two distinct clouds were observed, a larger elevated cloud and a base cloud.
A minor explosion took place in the control room some 10-25 seconds after the release. When the base cloud reached the hot hydrogen unit, part of it was carried up by the thermal draft and ignited by the open burners at the top. This occurred some 22 seconds before the explosion of the elevated cloud. Flames were seen moving back to the escape point from the hydrogen plant and control room area and probably caused the elevated cloud to ignite some 54 seconds after the escape started. The main aerial explosion then occurred followed by a major fire with fire-storm characteristics. For 20 minutes the fire raged over an area of 180 m to 250 m with flames over 100 m in height. At the time of deflagration it was believed that the large aerial cloud contained about 45 tonnes of cyclohexane. 90% of buildings on the site suffered damage, with blast being the primary factor. Fire extended the damage where the blast breached the containment of flammable inventories. The incident killed 28 people, all on the plant site. Over 400 people received treatment for injuries.
[fire - consequence, damage to equipment, vapour cloud explosion, management system inadequate, manning levels inadequate, design inadequate, fatality, fatality]

**Lessons**

The lessons include both public controls on major hazard installations and the management of such installations by industry.
1. This disaster raised the general awareness of the hazard from chemical plants and to make the existing arrangements for the control of major hazard installations appear inadequate. This led to the setting up of the Advisory Committee on Major Hazards to advise on the means of control of such installations. This work was a major input to the development of the EC Major Accident Hazards Directive which was implemented in the UK as the CIMAH regulations 1984.
2. The casualties from the explosion might have been greater if the site had not been in open country. The siting of major hazard installations is a matter of utmost importance.
3. The need for greater control of the licensing of storage of hazardous materials was also highlighted.
4. The escape of cyclohexane was caused by a failure of the integrity of a pressure system. This led to recommendations that the existing regulations relating to the modification of steam boilers should be extended to apply to pressure systems containing hazardous materials. This finally emerged as the Pressure Systems regulations 1989.
5. Deficiencies in the management system at the works were highlighted. The works did not have a sufficient complement of qualified and experience people. There were no works engineers in post and no adequately qualified mechanical engineer on site. In addition individuals tended to be over worked and thus more liable to error. The management system, however, is more than the individuals. It includes the whole structure which supports them. Thus the system must provide, for example, for the coverage of absence. The use of a comprehensive set of procedures is another important aspect of the management system. A crucial procedure which was deficient at the works was that for the control of plant modifications. In addition the role of safety officer was not well defined.

**2743 1973**

**Source :** ICHEME
**Location :** , UK
**Injured :** 0 **Dead :** 0

**Abstract**

A small horizontal multi-tubular boiler operating at 160 p.s.i. had been installed about five years. The alarm system was designed to operate each time the high pressure limit was reached. The wiring was modified by inserting two relays so that the alarm operated only when the high pressure limit was actually exceeded. All the safety devices and controls worked perfectly satisfactorily and no problems with the boiler were experienced. Unfortunately no one altered the wiring diagram or recorded that the modification had been made.
It became necessary to carry out some rewiring and the original diagram was used, with the result that the low water and look out devices became bypassed although the warning light operated correctly. The boiler operator carried out a partial check on the controls and observing that the warning light operated he was led to believe that the safety devices were in order. He unfortunately did not carry out a full thorough check.
When an emergency arose, the operator was temporarily elsewhere and the warning light was not seen. The audible alarm did not sound, the oil burner did not cut out and the boiler ran short of water, and over heated. It was so badly damaged that it was necessary to renew the furnace rings and retube the boiler.
[damage to equipment, control failure, operator error, modification procedures inadequate]

**Lessons**

Every company should have a system of control such that no modification may be carried out until it has been vetted and critically examined with respect to all its consequential effects, in particular, the safety of the plant itself and operators.
Plant modifications should therefore be sanctioned only after the approval of works management has been obtained.

**112281973**

**Source :** ICHEME
**Location :** , FRANCE
**Injured :** 0 **Dead :** 1

**Abstract**

A contractor's employee was killed as the result of a fire at a depot. It occurred when an outside maintenance firm was fitting a valve to a line supplying product to the gantry.
They were using a diesel engined winch in the pumping area to facilitate the "springing" of the flanges. This was unsuccessful, however, and instead the flanges of two adjacent valves were parted resulting in a leak of product. Vapour was sucked into the diesel engine causing it to over-speed. A serious fire broke out almost immediately. Ignition was most certainly due to the over-speeding engine. The fire was extinguished in some thirty minutes by foam. A pump motor was burnt out and the winch vehicle damaged beyond repair. Unfortunately, one of the contractors men was so severely injured that he died later.
It was later established that no work permit had been issued for the job.
The incident illustrates the problems that may be encountered when contractors are employed. Contractors are not always aware of the hazards that exist in the Oil Industry. It is therefore imperative that they are made aware of the safe working standards required and are adequately supervised to ensure that these standards are adhered to.
[maintenance, valve, winch, leak, contractor error, permit to work system inadequate, fatality, fire - consequence]

**Lessons**

In this incident, failure to issue a work permit and enforce its conditions must be regarded as the fundamental cause of the accident. The practice of using a winch for this purpose is not recommended and the use of a diesel engine in these circumstances should not have been sanctioned.

**591 17 November 1971**

**Source :** PIPELINE ACCIDENT REPORT NATURAL GAS DISTRIBUTION SYSTEM, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON D.C, USA, REPORT NO. NTSB-PAR-72-2, 1972.

**Location :** Pittsburgh; Pennsylvania, USA

**Injured :** 3 **Dead :** 6

**Abstract**

When attempting to replace a valve on the low pressure side of a regulator station in a vault without stopping the gas flow first, 2 men were overcome. 4 others were also overcome in attempting to rescue the other 2. All died from asphyxiation. The cause was contributed by lack of a procedure, lack of breathing apparatus and lack of training. Fatality.

[safety procedures inadequate, training inadequate, maintenance]

**Lessons**

[None Reported]

**584 19 October 1971**

**Source :** RAILROAD ACCIDENT REPORT DERAILMENT OF RAILROAD COMPANY'S TRAIN, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON D.C, USA, REPORT NO. NTSB-RAR-72-6, 1972.

**Location :** Houston; Texas, USA

**Injured :** 50 **Dead :** 1

**Abstract**

A rail transportation incident. 20 cars of a 82 car freight train derailed. The derailed cars included six tank cars containing vinyl chloride monomer and two cars containing other hazardous materials. Two tank cars were punctured in the derailment. The vinyl chloride monomer escaped and ignited. Approximately 45 minutes after the initial derailment one tank car ruptured violently and another car rocketed approximately 300 feet from its original resting place. The probable cause of this accident was an unexplained emergency brake application which induced lateral forces exceeding the holding capacity of the track fasteners. The severity of the accident was increased by the abrupt rupture of the tank car and the lack of adequate training, information, and documented procedure for identifying and assessing the threats to public safety. Fatality.
[derailment - consequence, training inadequate, external causes, vinyl chloride monomer (VCM)]

**Lessons**

Conclusions:

1. Inspections of the train and track before and after the accident did not reveal any apparent cause of the derailment.
2. The rocking tank car observed by one witness, the broken rails and the loose wheel discovered in the wreckage all resulted from the derailment.
3. The speed of the train was within the speed limits, even though the train crew did not have the correct information to determine the authorised speed.
4. The speed of the train contributed to the seriousness of the accident because it directly affected the kinetic energy that was dissipated by braking and derailment.
5. When the train approached the accident site, all switch ties were in place and tamped. Alternate switch ties were spiked.
6. The stability of the track had been affected adversely by work in progress on the installationof continuous, new switch ties, which involved the removal of rail anchors, and the spiking of alternate switch ties.
7. The derailment of the 38th carand 52nd occurred at almost the same time.
8. The cause of an emergency brake application could not be established, but it was determined that the brake application was propagated before the 48th car passed over the newly installed switch ties.
9. The unusual noise that various witnesses heard just before the derailment may have been the chattering, associated with a brake application.

**1072502 April 1971**

**Source :** NATIONAL TRANSPORTATION SAFETY BOARD, 20591, NTSB-HAR-71-7.
**Location :** , USA

**Injured :** 6 **Dead :** 0

**Abstract**

A road transportation incident. A hose used for transferring a bulk liquid chemical cargo from a semi-trailer to a storage tank was incorrectly attached to a fill line leading to an indoor open-top tank. When the transfer began, the cargo mixed with the incompatible chemical stored in the indoor tank resulting in a chemical reaction which generated toxic hydrogen sulfide gas. Six workers died from the inhalation of the toxic gas.
The cause of the accident was the failure of the carrier's drivers and the tannery foreman to establish an error-free exchange of information required to accomplish the safe transfer of the cargo from the vehicle into a plant storage tank. The likelihood of this happening was increased by the absence of instructions or training in information validation procedures during such exchanges and by the absence of markings, devices or other measures on the vehicle or tannery property which would have permitted such validation to be made unilaterally by either party.
[storage tanks, material transfer, gas / vapour release, training inadequate, accidental mixing]

**Lessons**

The National Transportation Safety Board recommended that:
1. A comprehensive investigation should be conducted into the risks associated with the delivery of bulk liquid cargoes from motor carrier vehicles, and initiate the implementation of risk-reduction measures.
2. Trucking associations and councils to call their member's attention to the risks associated with communications failures during bulk liquid deliveries and to the need for development of training and enforcement of procedures which incorporate information validation techniques to be used during such deliveries.
3. To consider the establishment of rules, regulations or standards which require the display of the name of the material to be delivered into each fill line connection at these connections inall facilities where bulk liquid materials are delivered from a motor carrier vehicle
4. To develop and implement requirements which would reduce the risks to employees and carrier personnel in the event of accidental mixing of incompatible bulk liquid materials at all locations where such materials are delivered by motor carrier vehicles.
5. To initiate rulemaking action to require all carriers to report accidents occurring in connection with the delivery of bulk liquid materials from motor carrier vehicles, whether or not the carrier's employees, vehicle, or cargo suffered damages in the accident.

**414 1971**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0


**Abstract**

An electrician, whilst working on an injection pump was sprayed with aqueous ammonia from a 40 gallon barrel sited some eight feet away, and suffered burns to his face and eyes on a site.

The 40 gallon barrel (placed on its side) was being used as a storage and make up drum for aqueous ammonia injection to control corrosion in a debutaniser overhead system.

The aqueous ammonia was made up by injecting ammonia from a cylinder into the barrel which held 30 gallons of water. The aqueous ammonia was then injected by a pump into the debutaniser overhead system.

The injection pump was faulty and an electrician was requested to check the motor rotation. No work permit was issued, and protective clothing was not worn. The liquid suction line from the barrel to the pump had been disconnected.

Whilst the electrician was checking the pump terminal leads, the 2" rubber bung in the side of the barrel blew out and sprayed the electrician. The ammonia cylinder valve was immediately shut but the barrel continued to spray out liquid until only a small quantity of aqueous ammonia was left in the barrel.

The 2" bung carried two lengths of 1/4" O.D. copper tubing, one length from the ammonia cylinder to the barrel and the other a vent line from the barrel attached to a hose venting into a drain.

It is considered that the most probable cause of the blowout was the rapid evaporation of a quantity of liquid ammonia at the bottom of the barrel.

The apparatus used for the make up of aqueous ammonia was unsatisfactory, as essentially a pressure vessel was connected to a non-pressure system with inadequate venting arrangements.

[human causes, safety procedures inadequate, permit to work system inadequate, evaporation, blowout]


**Lessons**

1. A work permit should be issued for all work carried out which is of a non routine nature.
2. A permanent system should be installed for the manufacture of aqueous ammonia solutions, or alternatively, aqueous solutions of the correct dilution purchased for this operation.
3. Warning notices should be displayed and where necessary fencing provided in any work where hazard from chemicals exists.
4. All refinery chemical injection systems should be examined for safe working procedure and a report submitted.

**395 04 March 1968**

**Source :** ICHEME
**Location :** ,
**Injured :** 30 **Dead :** 2

**Abstract**

An explosion occurred in the reactor system of the acetic acid plant during shutdown. The explosion occurred when using an abrasive wheel on a waste heat condensibles line and just when the line was perforated. The dome of the reactor which was being unbolted at the time was lifted off. After investigation, it was found that the abrasive wheel was capable of generating red heat inside the pipe of a sufficiently high temperature at the cutting point to provide a source of ignition. The procedure for shutting down the plant did not intend to make the system free of flammable gases. Fatality.
[modification procedures inadequate, operation activities, reactors and reaction equipment]

**Lessons**

1. Revised routine procedures for preparing the reactor system for engineering work should be adopted.
2. The existing procedures for preparing plants or individual sections of plants for engineering work or entry should be examined in accordance with the revised routine procedures.
3. As far as is practicable, the introduction of sources of ignition into areas where there may be flammable material should be avoided. Where their use is necessary, each situation must be treated as one of an extraordinary nature demanding special attention.
4. Within the general principles of the existing permit-to-work system, a review should be carried out to bring the sytem up-to-date. In particular, this review should cover the following points:
a. An improvement of the current definition of sources of ignition.
b. Consideration of the additional hazards involved when a number of men are working, in a confined area, on different jobs, often covered by different types of permit.
c. Consideration of the case for instituting separate hot work and entry permits.
d. A further examination of the precautions required before entry into a confined space is permitted.
5. The programming of engineering work should include arrangements for the provision of appropriate permits-to-work, and this should be an important feature in the consideration of the work lists by production and engineering personnel.
6. Improved training of permit signatories, highlighting the hazards involved on particular plants and with particular engineering equipment, is required. Refresher courses for permit signatories should be carried out annually and should provide a critical review of the system.
7. An effective monitoring of the operation of the permit-to-work system should be instituted.

**1022506 June 1966**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

A coker resid tank was damaged due to the sudden over-pressuring of the tank with steam. Some of the steam was produced when hot oil contacted water in the tank. The damage consisted of a forty foot rupture in the roof to shell seam, buckling of roof plates and a forty foot section of top shell ring, displacement of roof support columns and numerous broken or twisted roof girders and rafters, and dislodged roof refractory.
Under normal circumstances, a temperature target of 180 degrees and 200 degrees F had been established. However, when necessary it had run with temperatures in excess of 250 degrees of because of difficulties with the air cooler.
Before the incident, an operator making usual checks noticed that vapour was coming out of the southeast vent. This was reported who reviewed the tank temperature, found discrepancies that had been ignored by previous shifts and ordered checks to be made. Vapour coming out of the vents and gauge hatch was not observed until the instrument people had finished their checks. By this time the tank roof was bulged and steam was blocked in.
When the steam was closed off, the roof to shell seam ruptured, pressure was released and the roof settled back on the rafters. The combination of the steam break-through and contact of hot oil with water was sufficient to over-pressure the tank.
The accident could have been prevented if unit personnel had been more alert and had noticed the rapidly climbing temperatures over several days. Also the operator who noticed the steam had only a limited amount of experience.
[tank, processing, overpressure, rupture, damage to equipment, inspection inadequate, operator error, training inadequate]

**Lessons**

1. Operators should be more experienced and operator alertness should be maintained.
2. Operations involving all steam heated tanks have been reviewed to determine that adequate safeguards have been established to prevent over heating.
3. Mounted TI's and alarms for tank temperatures should be provided.
4. Remove all existing steam coils and replace with a heating system void of water..

**106521963**

**Source :** ICHEME
**Location :** , USA

**Injured :** 1 **Dead :** 0

**Abstract**

Methylene chloride was being drained from a refrigeration unit. Two maintenance men were sent to install a 25mm valve on a drain point, which was approximately 6m above the ground. When they removed the cap, refrigerant escaped and soaked one mechanic's clothes, he became dizzy, but climbed down without incident, later losing consciousness. Neither man wore any safety equipment except goggles.
[draining, gas / vapour release, poisoning, procedures inadequate, permit to work system inadequate, protective equipment inadequate, design or procedure error, refrigeration unit]

**Lessons**

The following recommendations were made:
1. Install permanent drain valve.
2. wear necessary safety equipment.
3. when in doubt about a job - call your foreman.

**4616 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 024, 161.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A process supervisor phoned the shift fitter and asked him to come over and remake a joint. He expected the fitter to report to him but did not actually tell him to do so.
The fitter went to the control room and reported to the process worker.
The process worker assumed the fitter had seen the supervisor and that he had come to break a joint, another job that had to be done. He showed the joint to the fitter. The fitter broke the joint and a jet of liquid came out.
No permit-to-work had been issued and the joint was not tagged.
[management system inadequate, permit to work system inadequate, labelling incorrect]

**Lessons**

1. Issuing a permit-to-work would not have prevented liquid coming out of the joint when it was broken but the supervisor knew that liquid might be trapped under pressure, he would have put this on he permit and would have asked for protective clothing to be worn.
2. The importance of the handover system cannot be over stressed. Communications from one person to another are fraught with difficulty but the risks can be minimised with proper discussion concerning the job to be done and an accepted system of permits-to-work.
3. Tagging of jobs with numbers, which relate to certain permits, is one system. What is of primary importance is that a proper system is established and is accepted by the whole work force.
4. The instruction or permit-to-work is issued only when at least two safeguards can be envisaged in the work. The first safeguard is in the isolation or preparation of the equipment. The second safeguard is in the protective clothing or method being used. Both of the safeguards should be written into the instructions or permit.

**1429 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A batch reactor used for nitrating benzonitrile was fed from two charge tanks, tank 1 and tank 2.
Tank 1 was used to feed benzonitrile to the reactor via a measuring vessel M and a feed line 1.
Tank 2 was used to feed nitration acid and sulphuric acid directly into the reactor via a second feed line 2. This system worked satisfactorily for many batches.
In order to carry out a different reaction, the feed system was changed so that both tank 1 and tank 2 fed via the measuring vessel.
The system was again used to nitrate benzonitrile without separating the two feed lines - thus both nitration acid and benzonitrile were fed to the reactor via the measuring vessel. During the manufacture of the second batch, an explosion occurred in the measuring vessel.
[batch reaction, chemicals added incorrectly, modification procedures inadequate, uncontrolled reaction, benzonitrile, explosion]

**Lessons**

Clearly an uncontrolled reaction had occurred between benzonitrile and the nitration acid in the measuring vessel M.
It was recommended that, wherever possible, each charge tank should have a separate feed line to the reactor. In the event of alterations to the equipment, the possibility of hazardous interactions between chemicals should be investigated by risk analysis.

**7625 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 130, 7.

**Location :** ,

**Injured :** 0 **Dead :** 0


**Abstract**

An incinerator used to burn waste gases and non-recoverable solvent streams overheated and suffered structural damage due to accidental overloading of the combustion system.

The incinerator shut down automatically due to high stack temperature. The gases which were being fed to it were automatically transferred to another incinerator which was operating on standby mode burning diesel only. However, this too suffered an emergency shutdown due to high stack temperature after just 65 seconds.

Fire-fighters were called when it was noticed that the cladding of the cooling duct on the first incinerator was glowing. The incident was brought under control by cooling the incinerator and its ducting with water jets, and spraying water into the incinerator.

[overheating, material transfer, modification procedures inadequate, heating]


**Lessons**

The following conclusions were made:

The practice of transferring hot liquids to vessels that vent directly to the incinerator has been discontinued. Vents feeding incinerators should not be used as vessel overflows. Hazop studies, through application of the guide word more, should have identified the hazards of overloading incinerators via vents/overflows. A number of the overflow/venting arrangements were modifications and the possibility of overloading the incinerator should have been addressed if an effective modification procedure had been followed.

**4767 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Work, correctly authorised by permit, was being carried out on an ammonia convector neater.
The permit expired on the Friday evening. On the following Monday morning, a welder, who claims to have personally seen a permit (probably the one which had expired) went to the top of the vessel and started welding.
A relatively small gas explosion occurred, with no-one being hurt.
[permit to work system inadequate

**Lessons**

[None Reported]

**7989 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

During an overhaul, on a refinery, a fitter was removing a plug from a furnace tube on a distillation unit. When loosened, the plug, weighing approximately 20 lbs., was ejected by pressure from within the tube. The plug was later found approx. 30 yards away from the furnace. A quantity of oil was also emitted from the tube. When loosening the plug the fitter fortunately positioned himself to the side of the tube rather than in front of it. It was later found that the work permit for the job was inadequate and incomplete.
[maintenance, refining, permit to work system inadequate]

**Lessons**

[None Reported]

**4421 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 1

**Abstract**

Brackets were to be welded on the man-holes of fleet of road tankers, which are owned and operated by a firm of contractors, to install wooden cross-bars as a security measure.
The method of gas-freeing employed was to carry gas oil as the last product prior to welding. The tanker in question had been loaded with gas oil and three days later was driven to the fabrication workshop of a local contractor. A work permit system was not used. The driver confirmed to the welder that the last load had been gas oil. The welding on three compartments was successfully completed but while welding the fourth an explosion occurred. The welder died from his injuries and his assistant was seriously burned. Subsequent examination revealed motor spirit dripping from the compartment.
[testing inadequate, permit to work system inadequate, burns, injury]

**Lessons**

[None Reported]

**4425 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A team of fitters wished to remove a redundant pump from a 1 LPG line within a terminal. The depot supervisor was not given prior warning about the nature of this work and it was started without a work permit. Although the supervisor, once aware of the situation, remonstrated with the fitters, the work was allowed to continue.

Despite assurances that all valves were closed and the operation was safe, there was a leak of LPG when the line was opened. The resultant gas cloud ignited in an adjacent canteen area. The fire brigade arrived promptly and an LPG isolating valve, which had been left open, was closed.

Although no-one was injured, the canteen was destroyed by fire.

[vapour cloud explosion, fire - consequence, permit to work system inadequate, maintenance]

**Lessons**

[None Reported]

**4574 Date Unknown**

**Source :** ICHEME
**Location :** ,
**Injured :** 0 **Dead :** 0

**Abstract**

A fitter was instructed by his superior to repair a drain valve on the 1 1/2" foul water line from the Hydrofiner LP Separator. He was shown the valve location by an operator and it was confirmed to him that the line was not under pressure. However, a work permit was not issued. When the valve bonnet and spindle were removed, foul water containing H2S (hydrogen sulphide) was released from the line under pressure, catching the fitter on the chest and his assistant in the face. After copious washing with water neither suffered ill effects.
[spill, permit to work system inadequate]

**Lessons**

[None Reported]

**11837Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

Distillate from a new delayed coking unit was routed to the suction of the charge pump on an existing distillate hydrotreater, along with the existing feed stocks. As can happen in batch coking, distillate flow and level was lost in one occasion. Gas then flowed to the hydrotreater charge pump and made it lose suction. The loss of flow damaged the hydrotreater catalyst.
[hydrocarbon gas, modification, pump, design inadequate, modification procedures inadequate, damage to equipment]

**Lessons**

1. In making plant modifications or interacting a new plant into an existing system, care must be taken that a fault on due plant does not cause a dangerous condition on another.
2. A hazard and operability study (HAZOP) should reveal such problems.
3. In the present case some additional instrumentation and a non return valve corrected the problem.

**11771Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

Over a period a crude oil distillation unit had been modified to double its capacity. This required the crude sure drum capacity from 6 to 3 minutes holding time and required turbine driven pumps to operate close to the overspeed trip stetting. Due to a minor upset the pump taking solution from the surge drum tripped out. The surge drum filled and the relief valve received to before the operators realised there was a problem. A fire followed.
[normal operations, modification, level meter/control, vent, control valve, spill, fire - consequence, overflow, design inadequate, safety equipment failure, modification procedures inadequate, crude oil]

**Lessons**

[None Reported]

**11794Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

Hydrocarbon vapours entered the regenerator of a catalytic unit during shutdown. The resulting air hydrocarbon mixture exploded and blew the head off the vessel. The incident occurred due to operator error, when the operator cut off the stripping steam and dispersion steam from the reactor. This allowed hydrocarbon to flow down through the slide valve which though closed was not intended for tight shut off. Due to recent modifications, operators were not clear on shutdown procedures.
[cracking, catalytic cracker, explosion, safety procedures inadequate, modification procedures inadequate]

**Lessons**

[None Reported]

**11806Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 2 **Dead :** 0

**Abstract**

A pipe fitter and laboratory technician were testing pressures and temperatures on a gas recovery plant. They made use of one inch connections fitted with a valve and screwed plug. In one case the valve was open and on removing the plug there was large leak of light hydrocarbons. Fortunately it proved possible to close the valve and the hydrocarbon did not find a source of ignition. However two operators were affected by the vapours while closing the valve. [sampling, LPG, blowout, near miss, competency lacking, safety procedures inadequate, training inadequate]

**Lessons**

1. This was a one off rather than a routine job so supervision and instructions should have been more detailed.
2. All personnel should be warned of the great care required in breaking joints on pressure equipment. Many accidents have been caused by wrongly assuming that it is already isolated.
3. For this reason it is a wise precaution to have both operator and maintenance personnel to independently check the isolation.

**11812Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

A fuel gas knockout drum which a hydrocarbon level control was found to be blocked off causing the water boot interface level control to fail and discharge to the sewer under an adjacent fuel gas blend drum. Shutdown of the alkylation unit greatly increased the flow of C3/C4 vapour to the drum. Apparently the interface level control valve stuck open and discharged C3/C4 liquid to drain after all the water had been dispersed. The vapours drifted to a heater and ignited.
[propane, butane, separation, modification, separation equipment, blowout, fire - consequence, instrumentation failure, safety equipment failure, modification procedures inadequate, leak]

**Lessons**

1. Due to modifications, which had increased C3/C4 production, there was inadequate C3/C4 storage when the alkylation unit shut down. Thus the fuel gas system was overloaded. This should have been corrected.
2. The hydrocarbon level control should have been put into service when the alkylation unit shutdown.
3. The water draw should have been piped to a safe location.

**11814Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

During shutdown a 150 kW electric motor was cleaned and the bearing filled with fresh oil. When cleaning was complete, mechanics found a tube which had not been replaced, this was not a vent pipe or coil fill pipe. As they could not determine its' function it was discarded. Two bearing failures later a check showed that a balancing pipe was missing. In its absence, oil was pressured out of the bearing housing.
lubricating oil, maintenance, modification, motor, damage to equipment, maintenance inadequate, modification procedures inadequate]

**Lessons**

[None Reported]

**11831Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

On a fluid catalytic cracking unit a leak was noted at a one inch connection on a 350 °c slurry oil line. While trying to inspect the leak by removing insulation a screwed nipple and valve blow off. A fire and shutdown followed. The screwed connection had been installed for hydrostatic testing during a plant modification. It should have been replaced by a back welded plug after the test.
[hydrocarbon, inspection, cracking, modification, coupling, catalytic cracker, blowout, fire - consequence, joint failure, modification procedures inadequate, installation inadequate, inspection inadequate]

**Lessons**

1. Failure of screwed joints in severe services is not uncommon.
2. Inspection of plant on completion of modification needs to be as thorough a for new plant.
3. This is not he only case where removal of insulation for inspection has caused a leak to worsen drastically. If the potential risk is high as in the present case the equipment concerned should be depressured before doing so.

**11909Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

An installation for injecting a chemical to boiler feed water had an atmospheric tank for the additive. This was supplied in 200 litre drums and the service company devised a method of pressuring the drum contents into the tank. Plant air at 7 bar was passed through a pressure reducing regulator. However the regulator was faulty and the end of the drum bulged and blew off when over pressured. Luckily no one was injured.
[air, unknown chemicals, modification, loading, drums, rupture, overpressure, design inadequate, modification procedures inadequate]

**Lessons**

1. All modifications to equipment and procedures need to be reviewed for possible hazards before being implemented.
2. Procedures must be in place so that this rule is applied to service companies as well as plant personnel.
3. Where pressuring with an inert gas is necessary to protect the chemical from oxidation, a pressure relief valve should be fitted.
4. Except as above a drum pump to be used for transfer. One was fitted in the present case after the incident.
5. HAZOP would detect this hazard.

**11844Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

Modification to a hydrocracker compressor resulted in seal oil flow increasing by more than 1000% sour gas was carried into the seal system and caused a build up of iron sulphide. Due to an addition of antifoam much of the iron sulphide went into suspension and this plugged both seal oil filters. The compressor shutdowns actuated, but one relay failed to shutdown the fresh feed pump. The cold feed backed into the recycle gas heater through a faulty non return valve and thermal shock opened a flange joint.
[hydrogen, non-return valve, gas liquid separation, filter, blowout, fire - consequence, modification procedures inadequate, safety equipment failure, reverse flow]

**Lessons**

1. Modifications to proven designs should not be approved without a full review of the possible consequences.
2. In this case there had been indications of problems before the incident occurred. The dose of an antifoam was then five times the normally effective dosage, in response to seal oil foaming problems.
3. The shutdown relay had corroded because it was not adequately protected from a temporary water pray system.
4. Non return valves can not be relied on to prevent reverse flow as previous experience on this plant and many others have demonstrated.

**11861Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

Hydrocarbon solvent was treated with a mixture of caustic soda and chlorine in a line mixer. The caustic solution was then settled out in a separator and recirculated to the mixer. The chlorine was added to the caustic recirculation line in batches of 7.5kg using welch scales. Operating procedures had recently been changed so that the caustic circulation was shutdown while injecting the chlorine was added an explosion occurred when caustic flow was restarted. [chlorine, hydrocarbon, caustic soda, batch reaction, modification, mixer, pipe, explosion, fire - consequence, runaway reaction, modification procedures inadequate]

**Lessons**

1. It is known that runaway reactions can occur between hydrocarbons and chlorine.
2. The probable explanation is that the introduction of the chlorine as a slug rather than dissolved in a stream of caustic soda triggered this runaway.
3. For even minor changes to operating procedures a safety evaluation is required before implementation.
4. In this case the use of chlorine has discontinued.

**11907Date Unknown**

**Source :** ICHEME
**Location :** , USA

**Injured :** 0 **Dead :** 0

**Abstract**

In a light hydrocarbon vapour recovery unit after 20 years satisfactory operation, severe hydrogen blistering appeared in the top of the adsorber column. Ruptured blisters to a depth of one third of the vessel wall thickness were present. It was found that the water wash on the feed to the adsorber had been discontinued 6 months before due to a faulty rotameter. This water wash was there to remove cyanides and sulphides from the feed to the adsorber. These were the cause of the blistering.
[hydrogen cyanide, sulphides, separation, modification, absorption, damage to equipment, near miss, modification procedures inadequate, hydrogen blistering]

**Lessons**

1. Modification to operating procedures should not be implemented before an analysis of potential hazards has been made.
2. Hydrogen probes were installed in the vessel and the water wash flow was controlled so that rise in the probe pressures was minimal. There was then no further hydrogen blistering.

**7925 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An accident, which occurred within a contractor's compound, when a contractor's employee welded one of the product nozzles of a vacuum road tanker without first ensuring that the tank was free from flammable vapours. The full diameter end cover of the tank was blown a distance of about 12 metres by the force of the explosion.

It became apparent during the investigation of the accident that, despite the careful vetting and selection of the cleaning contractor, the induction training given by the refinery to all the individuals involved, most of whom had had three or four years experience on site, the regular participation of the contractor's representative in refinery organised safety meetings on site and the written instructions to the contractor which required an additional Hot Work Permit for the type of work which caused the accident, those involved neither recognized the hazards they were facing nor the need for an additional Hot Work Permit to cover the work.

[cleaning inadequate, permit to work system inadequate, safety procedures inadequate]

**Lessons**

In the light of the tragic experience, it was recommended that blanket Hot Work Permits covering workshop areas should explicitly prohibit the entrance of equipment contaminated with flammable liquids or vapours. It was also recommended that consideration should be given to providing each cleaning vehicle with a document, akin to a Transmittal Permit, to apply for as long as it is on site or likely to be contaminated. This would state the vehicle's limits of access, the standards to which it must be maintained for safety in hazardous areas and the precautions necessary before carrying out any hot work in its vicinity.

**8756 Date Unknown**

**Source :** COMMUNITY DOCUMENTATION CENTRE ON INDUSTRIAL RISK, MAJOR ACCIDENT REPORTING SYSTEM LESSONS LEARNT FROM ACCIDENTS NOTIFIED, INSTITUTE FOR SYSTEMS ENGINEERING AND INFORMATICS, COMMISSION OF THE EUROPEAN COMMUNITIES JOIN RESEARCH CENTRE, 1991, ISBN 9282622894.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Padding line from bulk chlorine storage tank to road tanker unloading chlorine (few hundred kg).
Material damage (12" of a 2" diameter pipeline destroyed)
An iron-chlorine fire developed during stress relieving by heat treatment at 400 degrees C of a tanker padding line. The chlorine detection system warned the operators who put on self-contained breathing apparatuses and isolated the storage tank using remotely operated shutoff valves. This accident is mainly attributed to confusion in issuing the work-permit. The issuer thought that another pipeline was to be heat-treated, whereas the co-signer assumed that isolations instituted earlier for pipeline replacement were still in place.
[storage tanks, fire - consequence, permit to work system inadequate]

**Lessons**

[None Reported]

**9264 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

A mechanic was burned by a chemical solution after removing the actuator from a plug valve in a line that he though had been de-pressured and drained. The actuator could only be removed from the valve by unbolting the bonnet, because the actuator and the bonnet were attached to the valve by the same bolts. The mechanic had not obtained a permit for "Breaking into Process Equipment", because he though that unbolting the valve bonnet could be safely done even if the valve were under pressure. The mechanic was wrong on two accounts, (1) There was pressure in the line, and (2) The pressure in the line did blow out the valve plug when he unbolted the bonnet.
[burns, permit to work system inadequate, maintenance, unknown chemicals, injury]

**Lessons**

1. Only install valves whose bonnets do not need to be unbolted in order to remove actuators.
2. Issue specific maintenance procedures for existing valves whose bonnets so require unbolting for actuator removal.
3. Any work on dismantling valves and valve actuators require conformance to procedures for "Breaking into Piping and Equipment".

**10116Date Unknown**

**Source :** ICHEME

**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

A mobile crusher (driven by a diesel engine) was being used to reduce the size of broken concrete. It was being operated by two men standing on a platform near the input hopper. There was no protection to prevent the men from overbalancing into the hopper, and the (frequent) bridging which occurred was cleared by a man climbing into the feed hopper whilst the machine was still running.
No accident occurred, but the operation was investigated as a (potentially fatal) 'near miss'.
The machine apparently complied with the Health and Safety at Work Act, and the operators had been given a safety indoctrination talk on joining the site.
[demolition, milling, solids processing equipment, personal protective equipment, training inadequate, safety procedures inadequate, inadequate guarding, near miss]

**Lessons**

A number of changes to the method of working were stringently enforced:
1. The operators wore safety harnesses secured to the structure.
2. The crusher must be stationary before anyone entered the hopper.
3. Supervision was improved.

**7064 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 021, 79.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Some product was transferred to tank B instead of the usual tank A. The level in A rose, due to a leaking valve, the level was entered on the record sheet but its significance was not realised. Later on, another movement was made into B, again the level in A rose and again the new level in A was entered on the record sheet. When a third movement was made, A overflowed.
[material transfer, training inadequate]

**Lessons**

Fundamental training of process operators and supervisor should not be overlooked.
In addition the following:
1. It has been suggested that the control limits should be printed in red at the top of each column on the record sheet. The operator would be expected to report any readings out side these limits.
2. Alternatively, a master copy of the record sheet might be marked up with these limits and displayed in the control room or the limits might be marked on the individual instruments.
3. The key readings might be collected together on a "Key Readings Sheets". Record sheets are often so big that supervisors on their tours do not always look through a small number of readings on a key readings sheet. (Why have the full reading sheets?) The information may be useful to the manager or foreman when he is trying to diagnose the cause of a fault, but on at least one subscriber's plant no readings are taken apart from a handful required for record purposes.

**7827 Date Unknown**

**Source :** BARTON J AND ROGERS R, CHEMICAL REACTION HAZARDS, 2ND EDITION, ICHEME, 1997, APPENDIX 1, 192.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A 10 tonne resin reactor was initially charged with 5.5 tonnes of polybutadiene, heated to 423 K and 1 tonne of maleic anhydride was then added. The temperature of the mix was maintained at 453 K for one hour. On the day of the incident, the maleic anhydride had been added and when the temperature had reached 448 K the operator instructed a trainee to switch the heating to auto when the temperature reached 453 K. The trainee left the reactor to carry out another task and did not return until 25 minutes later. The temperature had risen to 503 K. Attempts to control the reaction failed. When the mix reached 641 K, the chargehole cover on the vessel was blown through the roof of the building. The batch ejected and ignited spontaneously. As well as operator error, the investigation revealed inadequate cooling and an inadequate pressure relief system.
[operation inadequate, design inadequate, explosion, reactors and reaction equipment, batch reaction, fire - consequence, training inadequate]

**Lessons**

[None Reported]

**7828 Date Unknown**

**Source :** BARTON J AND ROGERS R, CHEMICAL REACTION HAZARDS, 2ND EDITION, ICHEME, 1997, APPENDIX 1, 192.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An exotherm occurred during the production of an alkyd resin in a 5 tonne reactor. The contents spilled out of the chargehole and ignited. Inadvertent polymerisation occurred due to a gross imbalance of reactants. It is likely that an insufficient amount of one reactant was added due to a metering fault. The operator in charge did not know what to do when he saw the temperature rising, and a more experienced operator did not recognise the fact that the reaction was proceeding much faster than normal was a matter for concern.
[chemicals added incorrectly, fire - consequence, training inadequate, instrumentation failure, reactors and reaction equipment]

**Lessons**

[None Reported]

**7826 Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

During the loading of a road tanker with isobutane at a refinery, the vehicle's relief valve lifted.
Following the incident, it was discovered that the driver had little knowledge or interest in the type of cargo he was carrying and a strong protest was sent to the road tanker company concerned.
[training inadequate, operator error, safety relief valve failure]

**Lessons**

[None Reported]

**7553 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 091, 12.

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

In order to replace the mixer blades in a resin tank the trichlorofluoromethane solvent was drained to a level of 0.23 m from the tank bottom when a departmental manager, with the knowledge of one of the company directors, arranged for a maintenance fitter to enter the tank. He came out immediately complaining about the fumes and was given a cartridge respirator but found it difficult to breathe when wearing it. The black cover for the filter of the respirator had been left in place, the plastic hose was connected to the compressed air supply and the end poked inside the respirator. The fitter re-entered the tank and had difficulty breathing and was asphyxiated.
[entry into confined space, training inadequate, breathing apparatus, asphyxiation]

**Lessons**

[None Reported]

**7497 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 119, 17.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Tank overflow during material transfer. Approximately 10 tonnes of chemicals were lost to a drain during a transfer of material between two plants. The system for controlling the transfer relied upon the operators observing the tank levels and stopping the transfer when the correct amount had been sent. In fact, although the operating instruction stated that this should be controlled by the plant sending the material, a procedure had been adopted whereby the receiving plant informed the sending plant when enough material had been transferred or when a high level alarm signalled.

On this occasion an equipment problem elsewhere required the attention of the operator at the sending plant, but there was an answerphone/bleep to enable contact if necessary. However, the operator at the receiving plant was also working away from the control room on new duties and therefore was not present when the high level alarm sounded. The tank overflowed to the site drains.

After investigation it was found that previously there had been a panel operator present at all times because of continuous monitoring requirements. When this monitoring requirement ceased it was thought no longer necessary to have an operator present all the time.

However, the control room staffing arrangements had implications for the response to alarms which were not fully considered before making the change.

[manning levels inadequate, spill, unknown chemicals]

**Lessons**

The following recommendation was made: To install an automatic high level trip to prevent an overflow.

**7413 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 090, 13-14.
**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

An operator had dispensed 105 kg (23 lbs) of glacial acetic acid into a 18.9 litre (5 gallon) plastic bucket which was approximately half full. He placed a lid on the container and started carrying it from building A to building B.
After carrying the container a short distance, approximately 9 metres (30ft) he noticed that the lid was beginning to fall off. As he set the container down to straighten the lid it bumped a pallet. This caused the container to tip, splashing glacial acetic acid in his face and eyes.
He immediately went to the safety shower, approximately 12 metres (40ft) away and began to wash his face and eyes. The water in this safety shower was so cold it took his breath. After approximately five minutes, he got help from other operators. Since there were no eye baths in the immediate area, he was taken to the bathroom and water was poured into his eyes from the sink.
The employee was transported to hospital after approximately 20-25 minutes. Although he had received acid burns to the face and eyes he returned to work two months later with no permanent damage.
The causes were;
1. The bucket used to transport glacial acetic acid was not big enough.
2. The bucket had a lid, but it could not be secured without going to a lot of trouble. Once secured, it would have to be cut in several spots to be removed. This meant the container could no longer be used.
3. When lifted the bucket loses its shape, causing the lid to slide off.
4. In addition, the area through which the bucket was carried was congested and there was inadequate operator training and lack of enforcement of procedures.
[training inadequate]

**Lessons**

1. Provided an adequate closed container for handling or transporting corrosive material.
2. Label containers.
3. Train people to handle corrosives.
4. Enforce rules that will prevent the use of inadequate containers.
5. Determine what method will be used to ensure the proper procedures are followed.
6. Supervision must detect and instruct. Employees must follow procedures.
7. Specify what equipment is required. i.e. goggles, face shields, jacket, trousers, gloves, when handling corrosives.
8. Specify how this equipment will be obtained.
9. Colour code acid gear.
10. Involve operators in the selection process of personal protective equipment.

**7208 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 039, 15-16.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Routine recovery of a toxic material from process waste required oxidation at 850 degrees C, in carbon dioxide, to burn off organic contaminants. Access to the furnace was by means of a glove box although the off-gas scrubber system was situated outside the box. Furnace boats were available in either stainless steel or molybdenum, the latter being intended for use at higher temperatures under reducing conditions. The appearance of these boats was superficially identified when viewed through the glove box window. In order to improve the process it was decided to replace the CO2 by a flow of air, the operator loading the furnace was unaware that different boat materials were available and used the first boat to hand.

During the heating cycle a sharp report was heard and a cloud of blue fume was seen issuing from the off-gas system to the laboratory, which was immediately evacuated. Controlled re-entry found none of the toxic material had been released, although the off-gas pipework had split before the scrubber system, i.e. outside the glove box, and the gas flow to the furnace had not been reduced. Later inspection of the furnace revealed that it and the off-gas system were full of blue crystals which were identified as being oxides of molybdenum. The off-gas pipework before the scrubber system had been seriously weakened by corrosion. The furnace boat when extracted was confirmed as being molybdenum although damaged beyond repair. An investigation concluded that inadvertent use of the incorrect furnace boat had let to the formation of highly volatile molybdenum oxides which in condensing in the cold off-gas system had increased in volume sufficient to split the corroded off-gas pipework.

[training inadequate, identification inadequate, laboratory work, damage to equipment, evacuation, gas / vapour release, protective safety equipment]

**Lessons**

Recommendations resulting from this incident included:

1. Furnace off-gas systems should be protected by a glove box until after the clean-up stage.
2. Different types of furnace boats should be readily distinguishable and the use of each type restricted to a particular furnace whenever possible.
3. The training of operators for working in glove boxes requires particular care.

**7200 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 053, 23-24.
**Location :** ,

**Injured :** 2 **Dead :** 0

**Abstract**

This incident involved entry into confined space. Two men were instructed to install pipe connections to the bottom section of a 3 m by 6 m cone-bottom aluminium tank. One man went inside the tank while the other remained outside. The man outside heard a noise as if someone had fallen into the tank. Upon investigation, he saw the man lying unconscious on the bottom. He called to a third man for help, and rushed in to rescue his fellow worker. He too fell unconscious in the tank.
Inert gas was suspected, so other workers inserted several air hoses to flush the tank. Rescue was made by members of the Safety Department wearing self-contained breathing apparatus, and by quick thinking of the fellow workers. Both men were revived.
The causes of this accident were:
1. Standard safe practices for entering tanks were disregarded.
2. The feed and return lines to the tank had not been removed or blanked off.
3. A work permit had not been issued.
4. An approved safety harness, with life line attached was not being used.
5. Neither ventilation nor an oxygen check had been provided. Inert gas had leaked into a diverter valve. Also, a 200 mm return line had been tied into the pneumatic conveying system about 6 m from the feed bin. Neither of these two lines had been blanked off from the feed bin.
6. Finally, and all too often through good intentions the cause of multiple fatalities, the failure of the fellow worker to protect himself by entering the tank without adequate protection.
[safety procedures inadequate, permit to work system inadequate]

**Lessons**

[None Reported]

**7197 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 053, 22.

**Location :** ,

**Injured :** 1 **Dead :** 0

**Abstract**

Six workers were removing gravel from the sand filter of a spin bath. Because hydrogen sulphide was present the entry permit stated that breathing masks must be worn. One of the men, whom it was subsequently found had never been trained in the use of the breathing equipment, happened to be one of the two delegated to work inside the filter filling buckets. He put the mask on without adjusting it or regulating the volume of air supply and went into the filter. Starting to shovel, he felt dizzy and weak. He looked to tell his fellow worker not to get in, lifting the mask at the chin. His fellow worker turned around and saw him lying on the gravel without the mask. Another man, without using the emergency mask, got into the filter and with help lifted him outside.
This accident, like so many others, could have resulted in two fatalities. The injured man had not been properly trained and the supervision was inadequate. Also the vessel entry permit was not properly used, the filter should have been inspected by a supervisor and should have been adequately ventilated. [entry into confined space, breathing apparatus, training inadequate, injury]

**Lessons**

[None Reported]

**7130 Date Unknown**

**Source :** LOSS PREVENTIONBULLETIN, 035, 4-5.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

Originally, the inner cone of a cyclone dust separator was clamped with its own flange between the upper flanges of the cyclone. Since the cyclone was earthed, the inner cone was also earthed. A check revealed that the flanges of the cyclone had to be reinforced to withstand a possible internal dust explosion. When the modified cyclone was reassembled, the inner cone was no longer electrically bonded to it, being isolated by a non-conductive gasket. Shortly after start-up sparking was observed on the outside of the cyclone between the flange of the inner cone and the flanges of the cyclone due to electrostatic charge generated by the dust.
[lack of earthing, modification procedures inadequate]

**Lessons**

This is an example of a near miss which illustrates the hazard of a non-earthed conductive element of a comparatively high capacity in an environment where static electricity can be generated. It also emphasises the dangers of hazards which can be introduced into a plant when a plant modifications are made without proper hazard analysis, even when such modifications are intended to improve the safety of the plant.

**6813 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 004, 11-12.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A 25 tonne telescopic jib crane overturned onto a plant. A relief valve weighing 258 lb was being removed from the plant when the incident occurred. The crane fell on to some process pipework and, to recover the machine, the plant was de-pressured, thus interfering with production.
The crane was working with a jib length of 124 feet and the maximum safe radius for this jib length is 80 feet. The driver omitted to observe this, and, in fact, went out to 102 feet radius. The crane was fitted with a safe load indicator of the type that weighs the load through the pulley on the hoist rope, it does not take into account the weight of the job, because of this, the driver got no warning of an unsafe condition and, as he lifted the valve, the crane was overturned. Although the driver had been driving telescopic jib cranes for several years, he did not seem to appreciate the need not to exceed the maximum jib radius. [training inadequate]

**Lessons**

An investigation highlighted a number of needs, the most important of which are:
1. The need for effective training of crane drivers.
2. The need for an audible warning when the crane approaches unsafe conditions, such as a radius greater than that for which the machine has been designed.
3. The need for all those concerned with lifting operations to be kept up-to-date with developments in the type of crane available.

**7092 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 020, 52.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A man was working in a confined space wearing a compressed air mask supplied from two large cylinders. The one in use was nearly empty and the other was full. The man who was standing by the cylinders failed to change over from the empty to the full cylinder in sufficient time and the supply to the mask ran out. The man in the pit pulled off his mask and scrambled out, fortunately without ill effects. The air in the pit was smelly but not harmful to breath for a minute or two. If the air had contained a poisonous gas or had been deficient in oxygen, the result might have been more serious. The investigation showed that the man standing by had been trained in the use of compressed air breathing apparatus but his training did not include the use of the large cylinder sets. [training inadequate, entry into confined space, breathing apparatus]

**Lessons**

In general, when dealing with gas cylinders the following lessons can be learnt:
1. Gas cylinders should be handled with care, should be stored in areas defined for the purpose, outdoors, away from sources of heat, corrosion and other hazards, and should be properly secured.
2. Flexible hoses, fittings and equipment should be designed for the duty required in their use and kept in good condition by regular maintenance.
3. It a cylinder has to be heated use hot air rather than steam or electricity and check that when isolated with the hot air left on the cylinder cannot exceed safe working pressure.
4. Operators should be competent and trained in safe methods of handling and use of gas cylinders and associated equipment.
5. All users should be aware of the hazards involved in the use of gas cylinders and precautions to be taken.
6. Gas cylinders should not be used if they cannot be clearly identified from the label or colour code.

**11270Date Unknown**

**Source :** INSTITUTE OF GAS ENGINEERS, COMMUNICATION 451, UNUSUAL INCIDENTS AT GAS WORKS AND THEIR LESSONS, PART 2, 28 SEP, 1954.
**Location :** , UK

**Injured :** 1 **Dead :** 0

**Abstract**

A cradle supporting a charging system in a gas production works retort house collapsed causing injury. The cradle is elevated by means of wires on an electric winch unit fitted with a crutch and worm reduction gear. An enquiry determined that a safety pin designed to retain the cradle when disengaging from the motor jammed. The clutch should not have been disconnected before the safety pins were in position. Modifications to the system allowed this to occur. The worm reduction gear was not self-supporting and the heavy load fell. Previous minor mishaps had not been reported.
[lifting equipment, modification procedures inadequate, operational activities, injury]

**Lessons**

The following recommendations were made:
1. Importance of correctly operating machine so as not to over-ride the safety device.
2. The safety device fitted to prevent the cradle from following had been subjected to modification, defeating the original design intent.

**11279Date Unknown**

**Source :** INSTITUTE OF GAS ENGINEERS, COMMUNICATION 451, UNUSUAL INCIDENTS AT GAS WORKS AND THEIR LESSONS, PART 2, 28 SEP, 1954.
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

An explosion occurred within a booster house on a gas production works causing a fire and localised damage. A bypass was being installed to a booster fan. Due to cramped conditions the fitter could not use a normal drill, and he therefore used a compressed air drill to create a ring of small holes. He knocked out through a hole and trimmed the hole with a compressed air emery wheel. Sparks from this equipment ignited the gas-air mixture in the pipeline, causing an explosion which ruptured a gas valve. Gas escaped into the booster house causing a fire which was quickly brought under control.
[fire - consequence, damage to equipment, leak, maintenance, permit to work system inadequate]

**Lessons**

Importance of purging the gas line prior to carrying out hot work on this system should have been identified by the permit to work system.

**7073 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 022, 102.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

An operator was filling drums on a pre-set weighing machine. When the drum being filled reached the set weight, a pneumatic signal from the weighing machine closed off the supply valve.

The incident took place because, as the valve was sticking slightly, the operator decided to jam the valve wide open using a bolt. Consequently the drum overflowed, the operator being splashed as he closed the main isolation valve situated on the actual control machinery.

Clearly the operator did not realise that the valve closed when the drum was full.

[operator error, spill, training inadequate

**Lessons**

Recommendations included the writing of a proper plant instruction, the demonstration to operators of the mechanical and instrument side of the filling operation and the tightening up of supervision.

**7847 Date Unknown**

**Source :** MANAGING FOR SAFETY, ICHEME, TRAINING PACKAGES, 017, 4.59.

**Location :** ,

**Injured :** 0 **Dead :** 1

**Abstract**

A filter housing in a nitrogen housing circuit which provides seal gas to a turbo expander ruptured while an operator was pressurising the system. Fragments from the 360mm long by 100mm diameter cylindrical housing struck the operator inflicting fatal injuries.
Investigation revealed that the filter housing rupture was caused by overpressurisation of the housing to about three times its design pressure. The overpressure regulator in the circuit failed to maintain the system pressure within the design limits. Also the excess pressure could not be relieved by the pressure relief device because it had been inadvertently isolated from the circuit during a piping modification. Fatality.
[isolation inadequate, processing, modification procedures inadequate]

**Lessons**

[None Reported]

**11511Date Unknown**

**Source :** UNUSUAL INCIDENTS AT GAS WORKS AND THEIR LESSONS (PART III), COMMUNICATION NO. 564; TRANS. INST. GAS ENG.
**Location :** , UK

**Injured :** 0 **Dead :** 0

**Abstract**

Two carburetted water gas sets were used to make carburetted water gas and blue water gas at the same time. The gases were purified separately, but in the case of the carburetted water gas the air for purifiers was supplied from the blast main of the plant due to a breakdown in the blower normally used. The carburetted water gas set was shut down when the relief holder was full. It was later due to start up but, as the holder was very high, the exhauster was started first. Immediately an explosion occurred in the naphthalene washer on the outlet of which the air to purifiers was admitted. The air valves had not been properly closed, so air was fed into the gas main at a pressure higher than that of the relief holder, and passed backwards through the naphthalene washer. Deposits here were allowed to dry out and, being pyrophoric, probably supplied the source of ignition to the gas/ air mixture formed when air was being pushed forward by the exhauster.
[start-up, purification, modification procedures inadequate]

**Lessons**

Air admission to purifiers is always a possible source of danger, particularly if provision is not made to shut down the supply of air when gas flow ceases.The best method of controlling air supply to purifiers is by a gas / air ratio-proportioning device, which, when gas flow is reduced, proportionately reduces the flow of air by means of a volumetric governor connected by an impulse pipe to an orifice plate in the gas stream.
Air supply should come from a small air blower, with a non-return valve on the outlet. The inlet to the blower should never be in a room containing any source of ignition.

**7063 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 021, 79.

**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

The temperature controller on the base of a still went out of order at 5 a.m. and drew a straight line but this was not noticed. Between 5 a.m. and 12 noon the temperature of the 19th tray rose from the normal 145 degrees C but this was not noticed. Five other temperatures also rose, as indicated by charts or by entries on the log sheet. The level in the base of the still fell, the level in the reflux drum rose and the take-off rate also rose. All these readings were put down on the record sheet but their significance was not realised.

Finally at 12 noon liquid came out of the reflux drum vent.

The operator was a trainee but a leading hand was in the control room throughout and two supervisors visited it from time to time.

[temperature meter/control, spill, training inadequate, instrumentation failure]

**Lessons**

Fundamental training of process operators and supervisor should not be overlooked.

In addition the following:

1. It has been suggested that the control limits should be printed in red at the top of each column on the record sheet. The operator would be expected to report any readings out side these limits.
2. Alternatively, a master copy of the record sheet might be marked up with these limits and displayed in the control room or the limits might be marked on the individual instruments.
3. The key readings might be collected together on a "Key Readings Sheets". Record sheets are often so big that supervisors on their tours do not always look through a small number of readings on a key readings sheet. (Why have the full reading sheets? - the information may be useful to the manager or foreman when he is trying to diagnose the cause of a fault, but on at least one subscriber's plant no readings are taken apart from a handful required for record purposes).

**10551Date Unknown**

**Source :** ICHEME

**Location :** ,

**Injured :** 53 **Dead :** 0

**Abstract**

An explosion occurred during turnaround of a combination crude-topping/catalytic cracking unit.
During the turnaround gas compressors associated with the unit were not completely shutdown since it was necessary to compress a small amount of gas produced in another section. On the day of the incident, the flow to the compressors in operation was rearranged to permit isolation of equipment that had been in service for routine inspection and maintenance. The rearrangement activated the main wet gas line from the shutdown unit and furnished the route by which gas was eventually released in the shutdown area. The sequence of events was as follows:
· A supervisor inspected the gas line to determine that it could safely be put back in service. After inspection, the gas flow to the compressors in operation was rearranged. The supervisor who made the inspection and agreed to activate the gas line did not give this information to the hourly operating personnel working under his supervision.
· A maintenance foreman using the shutdown work order as a guide discussed with hourly operating personnel a small job requiring rotation of a valve in the gas line that was in the process of being put in service. An operator showed the location of the valve to the maintenance mechanic assigned to the job. The operator did not realize that the mechanic assumed that he had been given approval to proceed.
· Mechanics proceeded to remove a blank from the valve and lift the valve from the line. Soon after, gas was observed to be flowing from the opening.
· Twenty minutes after the valve had been removed, the explosion occurred. The source of ignition was believed to be a welding torch.
A breakdown in communications provided the circumstances required for the explosion to occur.
[cracking equipment, design or procedure error, permit to work system inadequate, crude oil]

**Lessons**

The following conclusions were made:
It was unfortunate that the mechanic did not attach more significance to removing a blank in a shutdown area. This reflects the casual discussion associated with this job and the absence of knowledge by the operating personnel.
To attach more importance to adding or removing blanks and blinds, a 'blanking' permit which is required to install, change or remove a blind was developed and its use established as a standard procedure.
An audible alarm was installed in operating areas to provide a quick warning when welding should be stopped.
More formal control is required in situations where secondary activities are continuing during turnarounds.

**6826 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 003, 12.
**Location :** ,

**Injured :** 0 **Dead :** 0

**Abstract**

A sludge wagon was hired to empty a pit. The driver reported to the works gate. The gateman contacted the plant supervisor and the supervisor arranged for someone to show the job to the driver and stay with him throughout the day.
The next day the driver arrived to finish the job. As this was a continuation of the previous day's job, the gateman allowed the driver to go straight to the plant. The driver knew what to do and carried on by himself. As the pit was nearly empty, he found a ladder, put it in the pit and climbed in so that he could position the hose accurately. The atmosphere in the pit had not been tested and no entry permit had been issued.
Fortunately, the driver came to no harm.
[atmosphere not tested, near miss, permit to work system inadequate]

**Lessons**

Until this incident, the works staff believed that it was impossible for a visitor to do anything like this. No one broke any rules, or any instructions they had been given, but there was a loophole in the rules.