**1245104 April 2000**

**Source :** CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD, 5 APRIL, 2000, (http://www.chemsafety.gov),
Disclaimer: The Chemical Incident Reports Center (CIRC) is an information service provided by the U.S. Chemical Safety and Hazard Investigation Board (CSB). Users of this service should note that the contents of the CIRC are not intended to be a comprehensive listing of all incidents that have occurred; many incidents go unreported or are not entered into the database. Therefore, it is not appropriate to use the CIRC database to perfrom statistical analysis that extends conclusions beyond the content of the CIRC. Also, although the CSB never knowingly posts inaccurate information, the CSB is unable to independently verify all information that it receives from its various sources, much of which is based on initial reports. CIRC users should also note that the CSB receives more comprehensive reports about incidents that occur in the U.S.; comparisons made between U.S. incidents and those in other nations should take this fact into consideration.

**Location :** Spencer, USA

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

**Abstract**

An explosion occurred on a transformer at a power plant. The explosion occurred during routine maintenance on the transformer, which killed an operator.
There was no interruption of electric power and no damage occurred to the plant.
An investigation into the incident is being carried out.
[burns, fatality]

**Lessons**

[None Reported]

**1234519 March 2000**

**Source :** CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD, 22 MARCH, 2000, (http://www.chemsafety.gov).
Disclaimer: The Chemical Incident Reports Center (CIRC) is an information service provided by the U.S. Chemical Safety and Hazard Investigation Board (CSB). Users of this service should note that the contents of the CIRC are not intended to be a comprehensive listing of all incidents that have occurred; many incidents go unreported or are not entered into the database. Therefore, it is not appropriate to use the CIRC database to perfrom statistical analysis that extends conclusions beyond the content of the CIRC. Also, although the CSB never knowingly posts inaccurate information, the CSB is unable to independently verify all information that it receives from its various sources, much of which is based on initial reports. CIRC users should also note that the CSB receives more comprehensive reports about incidents that occur in the U.S.; comparisons made between U.S. incidents and those in other nations should take this fact into consideration.

**Location :** Igongwe, TANZANIA

**Injured :** 40+ **Dead :** 28+

**Abstract**

A road transportation incident. A fuel tanker overturned and caught fire. The fire occurred when residents in the area rushed to the scene to extract fuel from the overturned tanker, but in the process tampered with the battery, which sparked off the fire.
[fire - consequence, fatality, sabotage, injury]

**Lessons**

[None Reported]

**1216523 January 2000**

**Source :** CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD, JANUARY 23, 2000, (http://www.chemsafety.gov).
Disclaimer: The Chemical Incident Reports Center (CIRC) is an information service provided by the U.S. Chemical Safety and Hazard Investigation Board (CSB). Users of this service should note that the contents of the CIRC are not intended to be a comprehensive listing of all incidents that have occurred; many incidents go unreported or are not entered into the database. Therefore, it is not appropriate to use the CIRC database to perfrom statistical analysis that extends conclusions beyond the content of the CIRC. Also, although the CSB never knowingly posts inaccurate information, the CSB is unable to independently verify all information that it receives from its various sources, much of which is based on initial reports. CIRC users should also note that the CSB receives more comprehensive reports about incidents that occur in the U.S.; comparisons made between U.S. incidents and those in other nations should take this fact into consideration.

**Location :** Cambridge, USA

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

**Abstract**

Apartments at a university were evacuated when carbon monoxide fumes were discovered to be emanating from a fire sparked by an explosion.
The explosion occurred on a transformer underneath the buildings.
Three residents who were affected were treated for minor injuries.
[evacuation, gas / vapour release, injury]

**Lessons**

[None Reported]

**8566 02 August 1999**

**Source :** CHEMICAL HAZARDS IN INDUSTRY, NOVEMBER 1999,; SAF. MANAGE. (LONDON), SEP 1999, 27.
**Location :** , UK

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

**Abstract**

An electrician was killed whilst trying to identify a fault within an electrical system. The electrician had been working near 415 volt conductors, which should have been made dead. A fuse blew during the testing of a switchboard and a large explosion occurred. The electrician suffered serious burns and died three weeks later. The incident also seriously injured a second worker.
The company was fined £60,000 (1999).
[electrical equipment failure, fatality, maintenance, injury]

**Lessons**

[None Reported]

**1263122 January 1999**

**Source :** ENVIRONMENTAL TIMES, VOLUME 6, ISSUE 3, SPRING 2000.
**Location :** , UK

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

**Abstract**

A road transportation incident. A lorry carrying a skip loaded with car batteries was stopped by police when clear liquid had been seen escaping from the back of the vehicle.
It was found that the liquid was battery acid, which was leaking from the skip.
A sample of the liquid pouring from the skip showed it to be highly acidic, with a pH value of less than 1. The company was fined £7,000 and costs of £1,1865 (2000).
[spill, human causes, corrosion]

**Lessons**

[None Reported]

**1106713 September 1997**

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

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

**Abstract**

At about 19:45 hrs. on the day of the incident a crude-vacuum unit operator was having suction problems with the "South" vacuum bottoms pump and was in the process of switching to the spare "North" pump when the 1200 amp breaker opened cutting all 480 volt power to the main unit switch rack. The operators attempted to close the substation circuit breaker but were unfamiliar with the switch gear. Electrical personnel successfully closed the substation breaker at 21:30 hrs. A fire occurred in the furnace causing a 10 day shutdown, and during this time the vacuum bottoms pump motor was replaced, the damaged 480 feeder cable was replaced, a 225 amp circuit breaker set at the proper instantaneous trip range. Even though the 1200 amp breaker was tested and found satisfactory, the opportunity was taken to install a modern electronic trip mechanism to replace the old style electro-mechanical trip. The electrical repair costs were $16,000 (£9,552) with a total loss of $1,001,000 (£597,612) (1997).

The facility was supplied with a 480 volt electrical power supply from an original main explosion-proof switch rack and a recently installed smaller switch rack. Both of these switch racks were supplied from separate circuit breakers on different bus bars of a 2000 KVA, double ended, 4160 volt/480 volt unit substation with high resistance grounded Y secondaries.

The "North" vacuum bottoms pump motor was approximately 10 years old and was last tested on a preventive maintenance basis in March, 1994, during the East Side maintenance shutdown. No electrical problems were detected with the motor, its feeder cable, or starter. The CrudeVac 2 480 volt main switch rack, feeder cables, and main 1200 amp circuit breaker at the substation were also tested at the same time and any identified problems were corrected. This included replacing one of the parallel 750 MCM copper main feeder cables from the substation to the switch rack due to poor insulation dielectric test results.

The Third and "B" Street 480 volt substation had a problem for about a year with a recurring intermittent ground fault on an unidentified electrical device connected to the southwest 480 volt bus. Many attempts were made to locate the problem, but none were successful as the problem would disappear before it could be found.

The initial cause of this event was a phase to ground electrical fault on a motor winding lead wire in the motor junction box of the "North" vacuum bottoms pump. This fault escalated to a phase to phase fault when the electrical arc damaged the insulation on another phase wire in the motor junction box. The 225 amp circuit breaker on the motor starter feeding this motor should have tripped on the initial fault but did not because the instantaneous setting also caused mis-coordination with the 1200 amp switch rack feeder breaker. Instead of the 225 amp breaker tripping, the 1200 amp switch rack feeder breaker at Third and B street substation opened, clearing the fault from the system and shutting off all electrical power to the CrudeVac unit main switch rack. The ground fault on the vac bottoms pump motor became an arcing fault because the switch rack already had a grounded phase. The refinery electrical system is designed such that it will continue to operate in an alarmed condition with one phase grounded. But, if a second ground fault occurs on another phase of the same transformer, a phase to phase system short circuit is created and one or both of the affected devices should then trip free of the system if the coordination is correct. In this incident, when one phase wire in the bottoms pump motor shorted to ground while there was already an existing ground on another phase wire in the systems, a system phase to phase fault was created that did not properly clear due to incorrect circuit breaker coordination. The intermittent ground fault connected to the southwest 480 volt bus was finally found and repaired in November,1995, in the 480 volt feed wiring to the Crude 2 first stage desalter grid power transformer.

[fire - consequence, electrical equipment failure, processing]

**Lessons**

Trip setting for circuit breakers should be set to defined settings and recorded and checked as part of routine maintenance.

Critical spare pump motors should be supplied with power from a separate electrical feed to limit the impact of switch rack trips.

Operators cannot be expected to operate high voltage electrical switch gear in an emergency unless properly trained and competent to do so.

The following corrective actions were taken at the refinery:

1. Install pulsing ground detection systems at all appropriate 480 volt substations to aid in locating ground faults on line while process units are operating.
2. Install more prominent operating instruction labels on switch gear circuit breakers so that individuals who infrequently operate these breakers will be able to operate them in emergency situations.
3. Check the instantaneous over-current trip settings on all other large frame molded case circuit breakers in the refinery to verify that the coordination with the substation breaker is correct.
4. Investigate transferring the electrical power supply of critical spared pump motors at CrudeVac 2 from the main switch rack to the new second switch rack so that critical spared pumps will have an alternative electrical supply in case of emergencies.
5. Communicate to all electrical personnel the importance of correctly setting the adjustable magnetic trip units on all large frame molded case circuit breakers to assure proper coordination with the supplying circuit breakers.

**1115220 January 1997**

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

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

**Abstract**

The electrical supply substation No.10, located in this power station, failed. The loss of electrical supply to equipment and other substations shutdown the refinery, power station, and cross-site plants were affected either as a direct result of power loss or indirectly via steam, cooling water, and instrument air failure.
The substation load is typically 18 to 22MVA and prior to the incident was steady at 21.3MVA. The substation voltage was controlled using on load tapchangers to compensate for changes in load and supply voltage.
Normally three transformers are used to supply power however, one of the transformers, had been taken out of service on January 14 for maintenance.
Power voltage from the local grid was falling slowly but remained within its tolerance and tapchange operations were being used to maintain the Substation voltage.
At approximately 16:54 hrs. on January 20, in response to a reduction in the 33kV voltage from the local grid, the taps were successfully adjusted from position 11 to position 12 on the other two transformers. At approximately 17:05 hrs. the 33kV voltage was continuing to fall and a request was made to carry out a further tapchange operation. The operators who had carried out the previous tap change operation went to the transformers to carry this instruction out. The tap change from tap 12 to tap 13 for one transformer was completed successfully. However, when the other transformer tap change was initiated, the mechanism started to move toward tap position 13 but then turned back toward position 12. Recognising that something was amiss, the operators contacted the electrical control room for further instructions. About the same time both transformers tripped and electrical power to Substation 10 was lost.
Immediate action to investigate the cause of the loss of power and to restore power was taken by personnel on site. During these activities some time was lost locating the correct key for the transformer compound which is non standard, and in carrying out some of the switching operations. The switching arrangements for the circuit breakers in No. 10 substation vary. Some may be operated locally others only from remote locations and the 11kV incomers for No. 10 Substation have obsolete synchronization interlocks which delayed their closure. In addition some confusion arose during the incident as to which transformer had caused the incident and this effected the sequence in which the transformers were re-energized.
The power station electrical control room staff were inundated with a large number of alarms during the incident and with telephone calls from other plants seeking information. This had the effect of hindering their analysis and management of the incident.
The immediate cause was the loss of power when the two transformers feeding the substation were tripped by their electrical protection system.
The basic cause of the failure was probably the differential relay becoming unstable during a routine tap change operation on one of the two transformers. The loss of one transformer would cause the other to trip on overload.
[electrical, electrical equipment failure, plant shutdown, electrical substation, transformer, utility failure, processing]

**Lessons**

The following recommendations were made:
1. Tight operating tolerances which require frequent operator intervention are certain to increase the risk of error.
2. Incidents that impact a number of plants require special emergency response plans. These should be prepared and periodically tested during a dry run exercise.
3. Radios and telephones are life saving devices in refinery emergencies and require a secure back-up power.
4. A system for managing alarms should be considered for all major plant emergencies.

**112021997**

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

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

**Abstract**

An electrician was using a metallic mirror to inspect the back side of a breaker connection in a 480 volt motor control centre when a metal part of the mirror came into contact with an energised portion of the breaker, causing a large electrical arc.
Two employees received second degree burns from the flash over. Two of the three alkylation units on the plant shut down from the power surge and Crude/Vac suffered reduced feed rates for a short period.
The immediate cause of this incident was the use of metallic tools to inspect hot electrical equipment.
[inspection, circuit breaker, arcing, operator error, injury]

**Lessons**

Use only non-conductive tools and proper safe work practices when required to work on live (hot) electrical equipment.

**112031997**

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

**Abstract**

An old power transformer needed to be replaced with a new more powerful one. Electricians isolated the old one to remove it from its location. They put the circuit breakers into the off position on the 6600 volt inlet to the transformer and the ones on the 415 volts outlet which supplies the wharf facilities. They then started the emergency diesel generator to supply power to the users. Since the outlet of this emergency generator is connected to the outlet of the transformer, these power cables were alive (energized). When an electrician separated the connecting cables from the transformer body, a short circuit happened and an electric spark occurred.
One electrician was exposed to spark light and his eyes were irritated. He was hospitalised for a few hours.
[modification, transformer, circuit breaker, competency lacking, short circuit, testing inadequate, injury]

**Lessons**

When working on electrical systems and equipment even it is electrically isolated from surrounding, all connections must be measured with proper instruments.

**122251997**

**Source :** CHEMICAL HAZARDS IN INDUSRTY, FEBRUARY 2000.
**Location :** South Wales, UK

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

**Abstract**

A company was fined £10,000 (2000), for polluting a watercourse with transformer oil. Allegedly the company was aware that one of it's transformers was leaking, but continued to top up the oil until it eventually contaminated the ground and was washed into a tributary.
[pollution, human causes, contamination]

**Lessons**

[None Reported]

**8671 17 January 1996**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, ISSUE 1, 1996.
**Location :** North Sea, UK

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

**Abstract**

Explosion in the control room of the natural gas platform caused by a circuit breaker (electrical switchgear). No fire followed the blast. Production was shutdown for 1 day pending investigation. Offshore.

**Lessons**

[None Reported]

**7632 09 October 1995**

**Source :** LOSS PREVENTION BULLETIN, 132, 9-11,; LLOYDS LIST, 1995, OCT, 10.

**Location :** , UK

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

**Abstract**

A fire broke out in a storage of polypropylene finished products.
A major emergency was declared and the site emergency plan was initiated. The scale of the fire escalated rapidly ultimately resulting in the attendance of some 200 fire fighters and 40 appliances which included support from an outside county.
The intensity of the fire resulted in a large thermal updraught which tended to convey the plume of black smoke over nearby buildings, over the local towns and out to sea, carried by a southerly wind. The site toxic gas alarm was sounded primarily to restrict movement around the site with the impending shift change to allow access for emergency services.
The public immediately downwind were advised by the media and police to stay indoors and to keep doors and windows closed.
The fire was eventually brought under control and the site emergency was ended.
Nobody suffered any injury as a result of the fire. There were no reported medical treatments from any member of the public. Damage was restricted to the warehouse, an adjacent pipebridge, an office and adjacent workshop and polypropylene bin compound.
A detailed examination of the warehouse, tests and other information concluded that the probable cause of the fire was related to a failure in a fluorescent light fitting which resulted in overheating and flaming acrylic sheeting dropping on to the polypropylene product stored beneath. A combination of the continuous operation of the lighting system and the age and design of the light fittings contributed to the probable source of the ignition. This developed into a fire during a period when the warehouse was unmanned.
[fire - consequence, warehousing]

**Lessons**

The following recommendations were made:
1. Lighting systems in warehouses should be checked as some of the older designs are potentially more hazardous in the event of an electrical fault.
2. The design, location, alarms and annunciation of smoke and fire detection systems should provide effective and accurate early warning of a fire.
3. The provision of sprinkler systems should be considered for large warehouses when stock losses could be high particularly if early fire detection cannot be guaranteed or if rapid fire fighting response is not possible.
4. Management systems and controls should be regularly audited to ensure that procedures and standards do not deviate from their original intent and to ensure that the potential risks associated with any changes or developments are recognised and addressed.
5. Risk assessments and hazard reviews should be prepared which consider the potential hazards and consequences of a major fire particularly where there could be an off site impact.
6. Existing warehouses and their materials of construction should be checked for potential hazards which could result from the impact of a fire or features which could encourage the spread of a fire.
7. The location of warehouses should be reviewed with respect to potential hazards they may pose to adjacent plants and services and vice versa.
8. The presence of other facilities and activities within warehouses should be reviewed from an operational and potential hazard aspect.
9. Design and maintenance of the lighting system were considered to be at fault.
10. Subsequently the light design and the previous 'breakdown' approach to light fitting maintenance were replaced by formal inspection and maintenance approach.

**7486 September 1995**

**Source :** CHEMICAL HAZARDS IN INDUSTRY, 1997, SEP.
**Location :** Oxfordshire, UK

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

**Abstract**

A fire occurred on a battery manufacturing plant. The factory produced lithium battery cells and the room on fire was used as a storage area. An investigation carried out found that the cause could have been either an electrical fault in cabling, fault in equipment or a fault in one of the lithium batteries. Estimated loss was $950,000 (1995).
[fire - consequence, electrical equipment failure]

**Lessons**

[None Reported]

**8128 25 March 1995**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, ISSUE 2, 1995.
**Location :** Brae B, North Sea, UK

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

**Abstract**

An electrician carrying out work on switchgear was injured in an electrical fire. The platform production of 25,000 bbl/day was shut down from about 0830 to nearly midnight when main power was restored and the 185 personnel could resume work.
[fire - consequence, electrical switchgear, maintenance, injury, offshore]

**Lessons**

[None Reported]

**8529 18 February 1995**

**Source :** HAZARDOUS CARGO BULLETIN, 1995, APR.
**Location :** Ontario, CANADA

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

**Abstract**

A fire occurred after a transformer blew up in NRC laboratory. Mildly radioactive material in building.
[fire - consequence, laboratory work]

**Lessons**

[None Reported]

**3317 31 January 1995**

**Source :** ICHEME

**Location :** Scotland, UK

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


**Abstract**

Overheating batteries, in a control room resulted in a strong and obnoxious smell of hydrogen sulphide. The batteries were Valve Regulated Lead - Acid (VRLA) type, in which the electrolyte (sulphuric acid) and gases produced during operation, are particularly immobilised in a porous fabric or gel.
Most of the gas re-combines to produce water, so little topping up is required.
The batteries had been receiving an overcharge current (40 amps) and had overheated with resultant battery casing damage. When high current circumstances exist, the H2SO4 electrolyte decomposes to release hydrogen sulphide.
[gas / vapour release]


**Lessons**

VRLA type batteries have a recommended lifetime of approximately 10 years. These batteries were about 6 years old. However, they had been operating at about 30 degrees C, at which temperature, lifetime would be expected to be reduced to about 5 years.
Thus, they had exceeded their effective expected life span.
Repeated earth fault alarms occurred in the two weeks prior to the incident, but this was never acted upon. The activation of this alarm is indicative of high current conductors.
The stated the following recommendations:
Recommendations were implemented to address the issues of:
1. Failure to respond to earth fault alarm.
2. Failure to respond to pressure of odour (H2S).
3. Need for improved training in the understanding of alarm situations.
4. Need for better battery inspection regimes.
5. Need to ensure a lower operating temperature for batteries.

**6792 20 December 1994**

**Source :** LLOYDS LIST, 1994, 23 DEC.
**Location :** Palatka; Florida, USA

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

**Abstract**

Two men were spray painting inside the hull of a barge under construction and moved a light when there was an explosion followed shortly afterwards by another. Fatality.
[marine transport]

**Lessons**

[None Reported]

**6775 24 November 1994**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, 4TH QUARTER, 1994.
**Location :** Kozloduy, BULGARIA

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

**Abstract**

Major breakdown following a short circuit in a circuit breaker of the main switchboard at this nuclear power plant.

**Lessons**

[None Reported]

**7609 17 October 1994**

**Source :** LOSS PREVENTION BULETIN, 129, 9.
**Location :** ,

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

**Abstract**

Heavy rains, amounting to approximately 65 cm, resulted in extensive flooding from the surface water as well as overflowing streams. Most of the water that flooded this 90-acre plant. Flood water covered the entire plant in depths ranging from 60 to 150 cm.
Plant management anticipated the flooding and was successful in shutting down all six process units in an orderly manner. Additionally, plant personnel were successful in relocating the smaller and lighter property items to higher ground. This effort notwithstanding, the flood waters caused extensive damage, mainly to computers, electrical substations, switchgear, pumps, motors and buildings. At least 350 electric motors varying in size from 5 to 20 horsepower were completely submerged and required replacement, while the larger electric motors up to 1,500 horsepower were disassembled, baked out, and repaired.
The plant was shut down for approximately two months as a result of this flooding. During this period, the ethylene, polyethylene, olefins, and acetylene black production was shut down, resulting in a business interruption loss estimated at $85,000,000 (1994).
[damage to equipment]

**Lessons**

[None Reported]

**8345 July 1994**

**Source :** ICHEME

**Location :** ,

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


**Abstract**

Electrical power supply failure and near miss at a refinery.

While replacing a fuse in the administration/laboratory building, an electrician caused a short circuit on a live system. There was power loss to the building and interruptions to lab operations. It was found that the relevant code and company procedures were not followed, and the switchgear was not isolated. The cause was lack of procedure and non-compliance even though it was established that the electrician had both adequate knowledge and adequate skill to complete the task.

[design or procedure error, refining, fatality]


**Lessons**

Even with well trained craftsmen, job task observation on a regular basis is essential to ensure that bad practices do not creep in.

Shortcuts in carrying out work on electrical equipment must not be tolerated; electrical isolation procedures must be followed, and it is essential to include all site buildings within the scope of the site permit/electrical work authorisation system.

**6566 26 May 1994**

**Source :** LLOYDS LIST, 1994, 28 MAY.
**Location :** Sydney; Nova Scotia, CANADA

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

**Abstract**

Reported that a transformer containing polychlorinated biphenyls (PCBs) suffered an explosion. Led to the evacuation of homes.

**Lessons**

[None Reported]

**1091411 February 1994**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A refinery experienced a major electrical power outage resulting in the shutdown of a substantial part of the refinery processing plant and the cooling water system. Although partial power was restored within 4 minutes, this was not quick enough to effect an immediate re-start of the shut down plants.
Costs incurred directly due to the power outage are estimated at $170,000, (1994) with additional costs and damages sustained on the FCCU indirectly related to the outage.
Due to extensive work over the last year and a half in the refinery around high voltage power lines (34.5 kV), opening and isolation of circuit breakers has been an almost daily occurrence.
Only two persons have been authorised to carry out the necessary electrical isolation. The isolation had become too routine, habit rather than procedure. On this occasion the isolating switch on the wrong circuit breaker was opened, resulting in loss of electrical power to major units.
[plant shutdown, electrical equipment failure, operation inadequate, refining, damage to equipment]

**Lessons**

The following recommendations were made:
1. Switching operations on high voltage circuits not to be done by a single person working alone.
2. Written procedures are required for such switching operations appropriate to the particular situation and circuit.
3. Communication between those making switching operations and control rooms is essential to verify the correctness of actions carried out.
4. Control room operators to be prepared to take the necessary corrective actions if power is inadvertently lost during switching operations.

**8332 February 1994**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

Electrical power outage at a refinery. A major refinery power outage occurred, causing shutdown of the FCC (Fluid catalytic Cracker), Alky, and Coker units, and the once through cooling water system which supplies the surface condenser on the turbine. The operations supervisor opened isolating switch for the wrong 34.5 KV oil circuit breaker. The basic cause was a lack of written procedure for de-energising 34.5 KV loop. The procedure had become too routine and the incorrect switch was pulled out of habit rather than according to procedure. The procedure for using two people to re-energise the loop had been recently altered to allow one person to do this alone, due to manpower limitations.
Losses: estimated $142,000 (1994), $122,000 (1994) the result of 10 hours' lost throughput, and $20,000 (1994) for maintenance on the unit.
[cooling equipment, operator error, design or procedure error, plant shutdown, fluid cracker]

**Lessons**

1. A written procedure should be prepared and used for each 34.5 KV loop switching.
Line isolation should be done with two people, one to check the other.
2. Communication between control operator and the supervisor de-energising loop serves to verify the procedures as well as to keep the control operator advised as to what exactly is happening should something go wrong.

**6374 09 January 1994**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, 1ST QUARTER, 1994.
**Location :** Tai Po, HONG KONG

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

**Abstract**

Minor fire within transformer in plastics factory.
[fire - consequence, processing]

**Lessons**

[None Reported]

**6231 21 September 1993**

**Source :** THE VICTORIA ADVOCATE, 1993, 22 SEP.

**Location :** Green Lake; Texas, USA

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

**Abstract**

A contractor working on an electrical substation was killed by an electric shock during maintenance work in a shut-down. Fatality.

**Lessons**

[None Reported]

**1156210 September 1993**

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

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

**Abstract**

Damage was sustained to three 440v motor starters in a substation. It would appear that someone gained access to the substation with an authorised key with the intent of stealing electrical equipment. Three starters were forced open without the isolator switches being used. The person who attempted this action would appear to have little knowledge of electrical systems. The door to the substation requires to the key to be placed in the lock in order to open or close the door. It is possible therefore that the door was inadvertently left open.
[damage to equipment, electrical substation, deliberate acts]

**Lessons**

[None Reported]

**8321 August 1993**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

Electrical fire occurred on a refinery. The motor control centre (MCC) faulted with resulting power outage and fire that affected an adjacent cable tray. The MCC was destroyed and cabling damaged. The exact cause is unknown due to the degree of damage. However, one suspected cause of the fault was flaking of the MCC power busbar silver plating. The initial fault persisted in the MCC due to a high fault operating trip setting on the upstream source/supply circuit breaker. The fault clearing time setting for the circuit breaker had been set at this level to prevent a fault on a motor circuit from tripping out the MCC, which would shut down more than the faulted equipment. Insufficient information available to determine basic cause. However, if flaking of the MCC power busbar silver plating was the immediate cause of the failure, then inadequate monitoring would be a root cause.
[control failure, damage to equipment, design or procedure error, fire - consequence, ]

**Lessons**

A balance needs to be achieved between the level of protection provided to protect components of an electrical system and yet maintain continuity of the system as a whole, with as far as possible avoiding wider ranging power outages.
Motor Control Centres with silver plated bus bars should be routinely inspected to ensure there are no signs of excessive flaking from the bars.

**6122 14 June 1993**

**Source :** HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1993, AUG.
**Location :** Pt Aux Trembles; Quebec, CANADA

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

**Abstract**

Explosion in transformer containing oil and polychlorinated biphenyls (PCBs).
[processing]

**Lessons**

[None Reported]

**108541992**

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

**Abstract**

A contractor was assisting with the setting of a transformer. He properly set up a 10 ft ladder to help guide the transformer into its place. The contractor went to push against transformer; and, as he did so, the ladder kicked out from under him.
The contractor fell to a lower level, approximately 6 ft. He sustained a fractured hip.
Since proper procedures for setting the ladder had been followed, weather conditions have been determined to have been the immediate cause/factor, as it had been raining and snowing and the ground surface was wet. Because of the weather conditions, the ladder became an inadequate tool.
[fall, weather effects]

**Lessons**

Always check to ensure ladder is secure before ascending. If ladder cannot be secured, determine if more appropriate equipment should be used.

**5462 November 1991**

**Source :** LLOYDS WEEKLY CASUALTY REPORTS 286/9
**Location :** Rosiori De Vede, ROMANIA

**Injured :** 8 **Dead :** 7

**Abstract**

An explosion in a welding workshop of rolling stock factory was caused when leaking gas was ignited by an electrical switch. Fatality.

**Lessons**

[None Reported]

**4839 09 January 1990**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, FIRST QUARTER, 1990
**Location :** New Hill; North Carolina, USA

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

**Abstract**

A fire occurred in a transformer and was thought to involve leaking hydrogen used to cool the generator at the nuclear power station.
[fire - consequence]

**Lessons**

[None Reported]

**4806 24 December 1989**

**Source :** LLOYDS WEEKLY CASUALTY REPORTS
**Location :** St Maurice, CANADA

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

**Abstract**

35000 litres of polychlorinated biphenyls (PCBs) contaminated oil poured into a river. The leak occurred after a hydro transformer under repair was filled. Cold may have caused the transformer to crack. The spill led to a slick 4 km wide which spread 10 km. The leak occurred on the 24th but it was not noticed until the 8th Jan when the transformer was found empty.

**Lessons**

[None Reported]

**4750 19 October 1989**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A fire occurred in a turbine transformer at a nuclear power plant.
[fire - consequence]

**Lessons**

[None Reported]

**4742 10 October 1989**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A fire occurred in a transformer at a nuclear power plant.
[fire - consequence]

**Lessons**

[None Reported]

**7573 September 1989**

**Source :** LOSS PREVENTION BULLETIN, 098, 21-23.
**Location :** ,

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

**Abstract**

A major fire occurred in a stack of wooden pallets in the grounds of a warehouse. A main 132 kV double circuit supply line passed directly overhead. As flames and smoke engulfed the overhead lines, arcing occurred and supplies became erratic for about half an hour and then were totally lost for about 15 minutes before the re-establishment of a restricted supply.
[fire - consequence, power line, storage]

**Lessons**

[None Reported]

**1212410 June 1989**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A flashover occurred between phases on a primary side of a transformer causing the main electrical system to collapse momentarily. The emergency generator was started and the emergency switchboard was isolated from the main supply, but this failed to automatically connect the generator to the emergency switchboard.
The instrument uninterrupted power supply (UPS), whose main supply is derived from this emergency switchboard continued to feed users from its battery source. Approximately fifty minutes later, with batteries fully discharged, the UPS attempted to revert unsuccessfully to its supply.
Temporarily interruption to the UPS output occurred, resulting in a large part of the refinery being shutdown. Consequent loss of product occurred.
The cause of the incident was a result of two separate failures:
1. Insulation failure of 15/5.5 KV transformer primary spouts.
2. Failure of instrument UPS system.
[plant shutdown

**Lessons**

[None Reported]

**1013304 February 1989**

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

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

**Abstract**

Three fitters were investigating the failure to start of a test engine. On assumption that the batteries were flat they applied the mobile charger across the terminals. A spark caused a local explosion. One fitter was temporarily deafened and the engine starter battery was written off. Total cost was estimated at £120 (1989).
The electrolyte level in the cells was low due to the repeated fast charge/discharge cycle. Hydrogen gas, which is evolved during the charging process, filled the cell's free space. When connecting the boost charger a spark was generated at the battery terminals. This being very close to a cell vent ignited the hydrogen. What was then experienced was a semi contained hydrogen explosion. The expansion within the battery case caused the vents to be blown off and the case to crack. The noise which temporarily deafened the fitter came from the "explosion" and cracking of the case.
[hydrogen, repair, battery, spark, damage to equipment, explosion]

**Lessons**

Battery units are high energy storage devices and consequently require caution when working on or around. Since batteries give off hydrogen, they must be installed in a well ventilated area. Personnel must avoid any possibility of generating electrical arcs or sparks in the vicinity of a battery.
Batteries contain acid or alkali electrolyte hence eye and hand protection must be adopted when handling.
Terminals on batteries are almost always exposed, thus potentially a hazard from short circuit.

**4449 27 January 1989**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A short circuit at a power station led to a fire. Equipment involved: transformer.
[fire - consequence]

**Lessons**

[None Reported]

**4384 15 December 1988**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A power failure caused damage to a transformer at a petrochemical utilities plant.
[utility failure, damage to equipment, processing]

**Lessons**

[None Reported]

**4335 02 November 1988**

**Source :** LLOYDS LIST, 1988, 4 NOV.; HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1988, DEC. HULL DAILY MAIL, 1988, NOV, 3, 4, 5, 8, 11, 15, 17. TELEGRAPH, 1988, OCT, 24.

**Location :** Hull, UK

**Injured :** 6 **Dead :** 1


**Abstract**

A drum of acetone accidentally spilt from a fork lift truck causing a devastating and fatal fire at a paint factory.
A spark from a nearby junction box in the factory's warehouse triggered off the fire. Witnesses reported seeing workers mopping up leaked fluid from the 45 gallon acetone drum seconds before a fireball ripped through the paint factory.
[fire - consequence, fatality]


**Lessons**

[None Reported]

**13123October 1988**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

When the battery was lifted from an forklift truck, some metal parts of the lifting tackle made contact with the non insulated metal bridges of the battery. This caused a short circuit with sparking and development of smoke.
[damage to equipment]

**Lessons**

Change to a newer type of battery, with covered poles and bridges.

**13124October 1987**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An electric forklift truck operating in a production building was lifting a load. Suddenly, the battery cable was on fire.
The fire was extinguished immediately with a C02-extinguisher.
Cause:
When the battery had been charged and the battery compartment was closed, the cable was caught between the cover of the compartment and its frame.
Movements/vibrations when the truck was operating finally damaged the insulation.
[fire - consequence, damage to equipment]

**Lessons**

Improved positioning of the cable.

**7929 01 September 1987**

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

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

**Abstract**

An engineer surveyor received facial burns and switchgear was damaged when an explosion occurred whilst he was inspecting and testing a 3.3kV electrical installation.
The engineer surveyor from a firm of contractors attended the premises to inspect and test the electrical installation.
On arrival he reported to the electrical craftsman as the maintenance supervisor was on holiday.
At 09.00 hours the shift controller issued a general work permit for work on the 3.3kV system. As the engineer indicated he had to work on live equipment no electrical isolation was carried out and no such certificate issued. The engineer entered the switch-room and removed the steel cover plate giving access to the incoming 3.3kV cable connection at the rear of the switchgear.
He placed his short-circuit testing equipment on top of the voltage transformer and connected one lead from the instrument to the incoming blue phase. As the electrical craftsman entered the switch-room there was an explosion followed by a second explosion a few seconds later from which the engineer surveyor received slight facial burns. Before being taken to a nearby medical centre the engineer collected together his equipment, but it was noted by the electrical craftsman that the end containing the protective fuse had been blown off and the lead was still connected to the blue phase and hanging free.
On investigation it was discovered that the circuit breaker had tripped out but not the site breaker. This had to be manually tripped. Damage to the 3.3kV switchgear was limited to slight burning on the yellow phase copper and external burn marks on the panel and voltage transformer.
It was agreed to restore supplies. The circuit breaker was closed down and when the final circuit was completed by closing the site breaker this resulted in an explosion and it immediately tripped out.
Subsequent dismantling of the site 3.3kV switchgear revealed substantial damage affecting the current and voltage transformers.
An investigation into the incident by company officials of the site drew the following conclusions:
1. The incident occurred due to the use of a 415 volt instrument on a 3.3kV system. Although the instrument and connecting cables were well insulated, as demonstrated by the fact that the 3.3kV blue phase was successfully connected whilst the instrument was standing on the earthed cover of the voltage transformer, it failed when the engineer attempted to connect the yellow phase. Thus the initial failure must have been due to a phase to phase fault.
2. On the automatic re-closure 5 seconds later another explosion occurred. This was probably an earth fault initiated by the instrument connection lead which was still clamped to the blue phase but hanging loose. It also probably explains the extensive burn marks on the side of the switchgear panel and the voltage transformer.
3. The third explosion on the restoration of supplies cannot be explained but the burn marks on the spring loaded connections to the voltage transformer indicate that the initial explosions must have caused some physical damage which could only have been found by dismantling the switchgear.
4. The Permit-to-Work on live 3.3kV apparatus should not have been issued as this is prohibited in company safety regulations.
5. If the site breaker had tripped on the initial fault the second explosion 5 seconds later would not have occurred.
[inspection, electrical switchgear, damage to equipment]

**Lessons**

Based on the conclusions drawn the following recommendations were proposed by the site:
1. All switchgear boards must be prominently labelled with their voltage ratings near access points.
2. Maintenance procedures following fault incidents on switchgear must be examined and recommendations made for minimum requirements following such incidents.

**13122March 1987**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A night guard on his rounds observed the development of fumes from a charging station. The fumes came from the battery of an electric handtruck, which was probably defective.

Note: If the incident had not been observed, an explosion of the hydrogen/air mixture being formed would have been possible.

Cause: Battery too old.

[gas / vapour release, near miss]

**Lessons**

Programmed battery checks.

**3832 1987**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An explosion occurred involving a transformer at a fertiliser plant utilities.

**Lessons**

[None Reported]

**3827 31 December 1986**

**Source :** LLOYDS LIST, 1986, 31 DEC.
**Location :** Barry; Wales, UK

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

**Abstract**

An explosion occurred following a suspected electrical fault in a transformer. 8000 ukg of oil released. Spill.
[electrical equipment failure]

**Lessons**

[None Reported]

**3822 27 December 1986**

**Source :** ICHEME

**Location :** Aberthaw, UK

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

**Abstract**

An explosion occurred involving a transformer and transformer oil at a power station.

**Lessons**

[None Reported]

**3810 10 December 1986**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A fire occurred in a substation at a power station.
[fire - consequence, electrical substation]

**Lessons**

[None Reported]

**3770 November 1986**

**Source :** ICHEME

**Location :** , SAUDI ARABIA

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

**Abstract**

A fire on a substation at a refinery utilities plant was caused by mechanical equipment failure.
[fire - consequence, refining, electrical substation]

**Lessons**

[None Reported]

**3656 July 1986**

**Source :** SEDGWICK LOSS CONTROL NEWSLETTER, 1986
**Location :** Villeurbanne, FRANCE

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

**Abstract**

A fire occurred in a transformer station causing approximately 400 litres of polychlorinated biphenyls (PCBs) to spill and contaminate surrounding soil. Nearby residents were evacuated.
[fire - consequence, toxic gas]

**Lessons**

[None Reported]

**6862 June 1986**

**Source :** LOSS PREVENTION BULLETIN, 074, 23-27, 080, 31-34.

**Location :** ,

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


**Abstract**

During unloading of a road tanker filled with 89% nitric acid to a storage tank, it was noted by the pump operator that the nitric acid delivery was "warm". Unaware of the significance of this fact, the unloading operation went ahead, and he did not report the apparent high temperature of the nitric acid. The operator also observed that the nitric acid seemed "warm" when preparing for feed to the nitrator. He reported the apparent abnormal acid temperature to his foreman. None of the people involved with the nitric acid handling on the day of the accident knew what the normal temperature of the acid should be. There was immediate concern by the process operators that there was a chemical reaction occurring in the nitric acid storage tank. For this reason the nitric acid in the measuring tank was dropped back to the outside storage tank.

A rumbling noise was then heard coming from the nitric acid storage tank. A sample of nitric acid taken from the pump showed the presence of an abnormal brown oily layer in the acid. These observations were constructed as evidence that there was a chemical reaction occurring in the nitric acid storage tank. Because of the reactive nature of nitric acid, it was decided to drain the tank to the contaminated . When gravity draining was too slow, use of the transfer pump to speed up the emptying of the tank was attempted.

The transfer pump would not start, and two fuses in the motor circuit were replaced by the foreman. It is standard procedure throughout the plant for production personnel to replace blown fuses in motor circuits. The pump still would not start, and the foreman summoned an electrician to check the pump electrically. The electrician checked the three phases for grounding and electrical continuity. Electrically, the pump was fine. The fuses were replaced by the electrician. When the pump was restarted an explosion occurred.

The foreman present at the time suffered multiple fractures to both bones of the right leg below the knee as the pump exploded.

Laboratory work determined that the cause of the explosion was the reaction between the nitric acid and the copper windings of the pump motor. Nitric oxide gas was formed, generating high gas pressure within the pump. The welds on the stator housing gave way and hurled the end flange at high velocity towards the foreman. In addition, there was a chemical reaction between the silicone fluid which immersed the electrical windings of the pump and the nitric acid. However, this is unlikely to have significantly contributed to the explosion. It was decided that the polymeric material observed in the nitric acid samples taken prior to the explosion were probably the product of that reaction. The contaminated samples did not represent the nitric acid storage tank, but rather what was in the pump.

It is concluded that the rumbling noise heard coming from the nitric acid storage tank prior to the accident was probably from the nitrogen bubbler used for the level indication in the tank.

Subsequent to the accident, the supplier of the nitric acid indicated that the shipping temperature of the acid was likely to be warm, 55 to 60 degrees C (130 to 140 degrees F.)

The principle causes of this accident were:

1. Inadequate communication of maintenance information between the pump manufacturer and the user.
2. Improper installation of the pump.
3. Improper pump selection.
4. Personnel too close to dangerous situation.

[unwanted chemical reaction, high pressure, installation inadequate, canned pump]


**Lessons**

The following recommendation were made and actions taken after the incident:

1. Removed canned pumps from nitric acid service. The pumps were replaced with conventional centrifugal pumps equipped with a Teflon seal as recommended by the acid supplier.
2. Study of the storage and handling of nitric acid. A HAZOP on the existing system which included nitric acid reviving, unloading and transfer procedures and equipment was complete.
3. Establishment of better nitric acid specification and mechanisms to deal with deviations. The expected physical characteristics of all incoming raw materials should be common knowledge for both the raw material personnel and the operating departments. Expected values of pertinent physical and/or chemical properties to be reviewed for all incoming raw materials, e.g. the expected temperature of nitric acid deliveries. Raw materials must not be unloaded unless they meet these criteria. In the case of a highly reactive material such as nitric acid, the temperature of the acid at the time of delivery to be noted on the delivery papers by the supplier, and be compared to the temperature of the acid on receipt by the plant. This could prevent the addition of contaminated acid undergoing a chemical reaction being charged to a storage tank. Deviations from expected conditions would trigger a "no go" to the unloading operation.
4. Establishment of a maintenance service reporting mechanism for pump manufacturers and other contract maintenance services. It was concluded that communications between the Maintenance Department and suppliers or contractors performing maintenance work on equipment needed to be improved. Whenever a piece of equipment is serviced by an outside contractor, they are relied to report their findings relative to the conditions of the equipment, probable cause of failure, recommendations, etc. Deviations from the previous materials of construction must not be made without agreement by the company. It was recommended that the Mechanical Department established procedures to assure that the required communications were operative.
5. Other applications in the plant with canned pumps in service. The canned pumps used in other services around the plant were studied for potential hazard.
6. Specific recommendations for canned pumps. It was recommended that the fuse boxes for all canned pumps be "locked out". It was to be assumed that these pumps are used to pump hazardous materials, and that any electrical or mechanical failure to be investigated by a qualified mechanic. Bearing wear and direction of rotation indicators available form the manufacturer on existing pumps in the plant were to be installed. Consultation with the manufacturer was underway regarding installation of these devices.

**8001 20 March 1986**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An electrical supervisor received serious burns, and an electrician minor injuries, whilst testing a 3.3 kV circuit breaker. The circuit breaker, feeding the refinery restaurant, had tripped as a result of an overload during a period of peak demand. At the time of the incident testing was being carried out between phases on the busbar side of the switch using an AVO minor test instrument with the 1000 volt AC scale selected.

The following conclusions were made:

The cause of the accident was the incorrect identification of the service voltage of the switchgear on which electrical testing was being carried out, resulting in the release of electric arc energy while unsuitable test equipment was being used. It is obvious that both the supervisor and electrician thought they were working on 440 volt equipment.

[electrical switchgear, injury]

**Lessons**

[None Reported]

**9143 14 April 1985**

**Source :** HAZARDOUS CARGO BULLETIN, 1986, FEB.
**Location :** Ontario, CANADA

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

**Abstract**

A road transportation incident. A tractor trailer was transporting three scrap transformers to a storage site. Two of the units had been drained but the third held up to 1,800 litres of transformer oil coolant with a polychlorinated biphenyls (PCBs) content of 420,000 parts per million (ppm).
The transformer was being carried in a tube like container which was not capable of preventing spilt product from leaking over the sides.
Apparently the vehicle had internally spilt PCB contaminated transformer oil over 240 kilometres of highway before the leak was discovered at a truck stop. A 40 km stretch of road was closed for four days as emergency crews began the extremely difficult task of trying to clean up the spill. A sealant coat was applied to one stretch while other sections were cold-milled, whereby the top layer of the road surface was scraped off in preparation of a new application of asphalt.
However, authorities were not sure if the entire affected section might not have to be resurfaced and were awaiting the out-come of further tests before making a final decision. The contamination of private cars following behind the leaking truck also posed decontamination problems and raised the issue of fair compensation and quick payment of damages.

**Lessons**

[None Reported]

**1255814 January 1985**

**Source :** CHEMOSPHERE, VOL.15, NOS.9-12,PP 1053-1955, 1986.

**Location :** , FRANCE

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

**Abstract**

A transformer fire occurred in the basement of a residential building due to electrical overload. The fire occurred when the transformer exploded. Fumes were released in the incident.
The building was evacuated but approximately three hundred and forty two people were exposed to the contents of the transformer, which contained:
Hexachlorobiphenyl 60%
Trichlorobenzene 40%
Analysis of the soot released found PCDFs and PCDDs.
[fire - consequence, explosion, evacuation, gas / vapour release, people, electrical equipment failure, polychlorinated biphenyls (PCBs), injury]

**Lessons**

[None Reported]

**2833 11 December 1983**

**Source :** ICHEME

**Location :** , SOUTH AFRICA

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

**Abstract**

Mechanical equipment failure at a chemical utilities plant caused a fire in an electrical substation.
[fire - consequence]

**Lessons**

[None Reported]

**2768 13 October 1983**

**Source :** INSTITUTE OF INSURERS
**Location :** Thane, INDIA
**Injured :** 0 **Dead :** 0

**Abstract**

Gasoline leak caught fire in cable trench.
[fire - consequence]

**Lessons**

[None Reported]

**2758 06 October 1983**

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

**Abstract**

Fire occurred on an electrical substation at a petrochemical polypropylene plant which was caused by and electrical fault. Substance involved: ethylbenzene. [fire - consequence, electrical equipment failure]

**Lessons**

[None Reported]

**2658 12 July 1983**

**Source :** INSTITUTE OF INSURERS
**Location :** Marino Point, IRELAND

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

**Abstract**

Lightning caused damage to transformer.
[damage to equipment]

**Lessons**

[None Reported]

**1060815 May 1983**

**Source :** CHEMOSPHERE, VOL.15, NOS 9-12, PP 1281-1289, 1986.

**Location :** California, USA

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

**Abstract**

A fire occurred in a transformer vault in a building basement. During the fire the transformer coolant, which was a mixture of polychlorinated biphenyls (PCBs), with about 42% chlorine by weight, leaked and was vaporised by the fire. Most of the smoke generated by the fire escaped through ventilation and access gratings to the outside air. Some of this smoke was drawn into the adjacent fresh air intake plenum of the building ventilation system which was operating at maximum air circulation rate with no recycling. The ventilation system supplied air to the basements and six floors of the building including several retail stores.
A few days after the fire, tests determined PCB present at above the established safe levels in air and on surfaces. Decomposition products of PCB including polychlorinated dibenzofurans and dioxins some of which have much higher toxicity potential than PCB were also identified.
An extensive and protracted clean up operation was required to decontaminate the building before it could be reoccupied.
[fire - consequence, contamination]

**Lessons**

No criteria existed for determining conditions for allowing the building to be reoccupied. New standards had to be developed by the public health services for health based criteria for PCB, dibenzofuran and dioxin levels which would allow the building to be reoccupied.
The Department of Public Health ordered that the building could be reoccupied in July 1984 which was over a year after the fire.

**2426 22 December 1982**

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

**Abstract**

Fire at a refinery jetty involving a transformer caused by lightning.
[fire - consequence, refining]

**Lessons**

[None Reported]

**2410 27 October 1982**

**Source :** ICHEME

**Location :** , SOUTH KOREA

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

**Abstract**

Machinery breakdown on a refinery utilities plant caused by operator error. Equipment involved, transformer.
[mechanical equipment failure, refining]

**Lessons**

[None Reported]

**2403 04 October 1982**

**Source :** 100 LARGEST LOSSES 9TH EDITION, MARSH & MCLENNAN PROTECTION CONSULTANTS, 1986.
**Location :** Freeport; Texas, USA

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

**Abstract**

Failure of a 15 kV transformer containing 235 gallons of mineral oil was the probable cause of this explosion and fire in the electrical power plant of a large petrochemical complex. Heavily loaded cable trays also ignited from the fire causing heavy smoke and evacuation of the power block control room and making fire fighting difficult. After 6 hours the concrete roof of the control room collapsed.
[fire - consequence, electrical, electrical equipment failure]

**Lessons**

[None Reported]

**2385 19 August 1982**

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

**Abstract**

Fire on a substation, source of ignition was electric arcing.
[fire - consequence, electrical substation]

**Lessons**

[None Reported]

**1062522 June 1982**

**Source :** CHEMOSPHERE, VOL.15, NO. 9-12, PP 1305-1311, 1986.

**Location :** , USA

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

**Abstract**

A transformer overheating. At a private school, the main power transformer in a basement transformer vault became pressurised due to internal arcing. About 50 gallons of the transformer coolant was released as a mist over a period of approximately two hours. The coolant comprised a commercial mixture of 45% polychlorinated biphenyls (PCBs), and 55% of mixed trichlorinated and tetrachlorinated benzene. Contamination of some areas of the building resulted from the release of coolant.
About 20% of the individuals at the scene reported skin irritation, unusual tiredness and headaches.
[gas / vapour release, fire - consequence]

**Lessons**

An environmental assessment of both surface and airborne contamination was undertaken to determine the extent of contamination in the school.
Blood and urine samples were collected within 48 hours from all potentially exposed individuals and analysed to determine exposure. Repeat samples were collected 4 weeks after the incident.
Serum PCB levels and mean values for blood and urine tests were within normal ranges.

**8423 26 January 1982**

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

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

**Abstract**

An explosion occurred in the batteries of an instrument 24V DC supply (40 amp) on a polyvinyl chloride plant. The unit, located behind a control panel, supplied the services and charging areas of the plant. As a result of this incident, the 24V instruments supply to the control on the reactor agitator was lost, fortunately the agitator which stopped was quickly manually re-started, thus saving the material in the reactor. The most likely cause of the explosion was the failure of the "Blocking Diode" together with the failure of at least one cell in the associated battery. This allowed the remaining three batteries to discharge through the failed unit heating it up explosively. The blocking dioxide failed due to an inherent fault (i.e. underrated PIV.)
[reactors and reaction equipment, processing]

**Lessons**

1. All sealed battery systems havetheir blocking diodes replaced with a PIV of at least 24V.
2. The sealed units involved did not have, in common with other site systems, remote alarms and property rated diodes. This shortcoming was corrected.

**1030014 January 1982**

**Source :** HAZARDOUS MATERIALS INTELLIGENCE REPORT, 29 JANUARY, 1982.
**Location :** Massachusetts, USA

**Injured :** 5 **Dead :** 0

**Abstract**

Toxic fumes forced the evacuation of over 2000 people after approximately 15 gallons of coolant consisting of trichlorobenzene and polychlorinated biphenyls (PCBs) leaked from an electrical transformer in the buildings basement. The coolant escaped from a pressure relief valve on top of the transformer after initial pressure in the transformer exceeded the systems safe operational level. The transformer automatically shutdown, cutting electrical power to the main building and to two adjacent buildings. Prior to the incident two other transformers had been shutdown in the same room as the damaged one, for repairs. The power outage stopped the building's ventilation system, allowing toxic fumes from the spilled coolant to drift through air vents into the buildings.
Wearing protective clothing and self-contained breathing apparatus, crews mopped up the spilled fluid with an absorbent material and washed down the transformer area with a high ionic industrial cleaner.
Two firemen and three maintenance workers were hospitalised for fume inhalation.
[repair, trichlorobenzene]

**Lessons**

[None Reported]

**2211 19 June 1981**

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

**Abstract**

An electrical cable fire at a refinery utilities plant involving the substation.
[fire - consequence, electrical equipment failure, refining, electrical substation]

**Lessons**

[None Reported]

**2181 16 April 1981**

**Source :** PIPELINE ACCIDENT REPORT PIPELINE COMPANY GASOLINE EXPLOSION AND FIRE, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON D.C., USA, REPORT NUMBER NTSB PAR-81-3. 1981.

**Location :** Roseville; Minnesota, USA

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

**Abstract**

Station booster cast iron pump ruptured at base and sprayed gasoline which ignited from an arcing electrical switch. Fire burnt for 2 days from gasoline and fuel oil from leaking flange gaskets. The probable cause of the pump failure was the fact that it was not hydrostatically tested at it a new installation. Contributing to the accident was the failure of the company to utilise explosion proof equipment in a potentially hazardous vapour area, and to fill the gap between the pump and its foundation with grout. Fatality.
[fire - consequence, operation inadequate]

**Lessons**

[None Reported]

**1050505 February 1981**

**Source :** CHEMOSPHERE, VOL 15, NO. 9-12, PP 1273-1280, 1986

**Location :** Binghampton, USA

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

**Abstract**

An incident occurred involving polychlorinated biphenyl (PCB) and chlorinated benzene (CB).
A surge of electricity resulted in a electrical panel malfunction, electric arcing, fire and generation of intense heat. Dense smoke, containing polychlorinated dibenzofurans (PCDF) and polychlorinated dibenzo-p-dioxins (PCDDs) and biphenylenes, contaminated the entire building. This was the first non laboratory demonstration of conversion of PCBs to PCDFs and CBs to PCDDs, thus revealing a hitherto unsuspected health hazard for workers, i.e. electrical transformers (and capacitors) not properly isolated from workers.
The following consequences occurred:
1. The building was shutdown.
2. Clean-up costs were estimated at 40 million US dollars (mid 1980s values).
3. Several hundred workers were exposed to the chemicals, some of which are highly toxic.
4. Elevated levels of some substances were found in some workers. These were not injuries but may lead to occupationally related in health.
[control failure, fire - consequence, contamination]

**Lessons**

[None Reported]

**2053 09 September 1980**

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

**Abstract**

Fire at a refinery utilities plant. Source of ignition was electrical.
[fire - consequence, refining, transformer, operator error]

**Lessons**

[None Reported]

**8516 02 April 1980**

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

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

**Abstract**

Traffolyte labels were being fitted to the covers of a miniature circuit breaker that housed busbars (440 volts and 160 amps). The equipment was "live". A prior check, as to the clearance between the circuit breaker cover and the "live" equipment had been made but, nevertheless, the screw holes for the labels were being drilled through the covers with the busbars "live". The drill bit contacted the busbar causing an electrical fuse failure and bang/flash. Nobody was hurt.
[maintenance, safety procedures inadequate, damage to equipment]

**Lessons**

The method employed was inherently unsafe. Several alternative methods existed, eg. use of adhesives to fix the label to the cover or isolating the electric power before drilling. The incident might easily have resulted in a fatality had other circumstances e.g. earthing not been adequate.

**1992 06 March 1980**

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

**Abstract**

A fire occurred involving electrical switches at a power station.
[fire - consequence]

**Lessons**

[None Reported]

**1984 19 February 1980**

**Source :** FIRE PREVENTION, NO. 141.
**Location :** Grimsby; South Humberside, UK

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

**Abstract**

Arcing caused by a breakdown in the insulation of a high voltage conductor in a transformer ignited vapours produced by the oil.
[fire - consequence]

**Lessons**

[None Reported]

**9488 27 December 1979**

**Source :** ICHEME

**Location :** , UK

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

**Abstract**

Damage to the roof of the sub-station, by person(s) unknown, allowed water to enter the H.T. switch-gear resulting in power failure.
[electrical switchgear, plant shutdown, human causes, electrical substation]

**Lessons**

Routine inspection of the substation structure to be instituted.

**1884 30 July 1979**

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

**Abstract**

A fire occurred in a fertiliser plant electrical substation.
[fire - consequence]

**Lessons**

[None Reported]

**1883 28 July 1979**

**Source :** 100 LARGEST LOSSES, MARSH & MCLENNAN PROTECTION CONSULTANTS LTD., 9TH EDITION, 1986.
**Location :** Sauget; Illinois, USA

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

**Abstract**

A electrical substation fire disrupted power at a chemical plant resulting in loss of agitation on a nitrodiphenylamine batch reactor. The batch stratified and decomposed. The reactor failed catastrophically with fragments severing the risers of three sprinkler systems protecting the area and rupturing nearby equipment containing flammable liquids. Most damage was concentrated in the reactor building.
[decomposition, reactors and reaction equipment, power supply failure, damage to equipment]

**Lessons**

[None Reported]

**9389 08 July 1979**

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

**Abstract**

A JCB mechanical digger was being used by contractors to excavate a water pipeline in the vicinity of a pond when the 3.3KV cable supplying the water transformer was damaged.
[bulldozer/jcb/digger, excavation, transportation, damage to equipment, contractor error]

**Lessons**

1. Update and keep up-dating records of appertaining to underground services through-out.
2. Excavation permits to be rigidly specific when describing the location of a proposed excavation and accompanied by a sketch or extract from a drawing.
3. When hand digging is specified the permit to be endorsed and this must be rigidly adhered to.

**1839 23 March 1979**

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

**Abstract**

A fire occurred at a production stabiliser plant electrical substation.
[fire - consequence]

**Lessons**

[None Reported]

**1785 08 December 1978**

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

**Abstract**

Fire occurred in a refinery utilities plant involving a transformer.
[fire - consequence, refining]

**Lessons**

[None Reported]

**1756 07 October 1978**

**Source :** GUARDIAN, 1978, 8 OCT.
**Location :** Flixborough; Lincolnshire, UK

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

**Abstract**

Electrical discharge injured 3 men checking electrical switchgear during rebuilding of plant.
[electrical equipment failure, injury]

**Lessons**

[None Reported]

**1591 21 February 1978**

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

**Abstract**

An explosion occurred involving a transformer and cooling oil on a steel plant.
[transformer oil]

**Lessons**

[None Reported]

**1419 12 July 1977**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An electric cable fire occurred at an electrical substation in this refinery utilities area.
[refining]

**Lessons**

[None Reported]

**1313 04 January 1977**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

Fire in electrical substation of olefin plant of petrochemical plant. Source of ignition: electrical.
[fire - consequence, processing]

**Lessons**

[None Reported]

**1168122 April 1976**

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

**Abstract**

A new 36KV/11 KV 17 MVA transformer, between the electrical distribution company and the refinery, was being commissioned. When closing the switch on the 36kv busbar side, with the circuit breaker still open, there was a short circuit to the earth. As a consequence, serious voltage drops occurred in the refinery, which at the time was importing about 4.5 MW from the grid, resulting in various disturbances of the electrical, steam and cooling water supplies. The No 2 Catalytic Cracker was shut down for a few hours and significant amounts of gases were flared. Some dry grass located at a considerable distance from the flare caught fire.
There were no injuries to personnel. The switch gear itself suffered only minor damages, but a 3 kv motor was completely destroyed in the DHT unit. Problems were also apparent on the No.2 Catalytic Cracker main fractionator column internals after recommissioning.
The investigators of the incident discovered that a temporary earth connection had been fitted some time during the six week strike period, which had concluded only three weeks before the incident. The circuit breaker chariot had at some time been rolled back into position, obscuring the temporary earth connection from view. A written notice had been left on the switch gear, "BEWARE OF TEMPORARY EARTHING", but this had been overlooked, although many other similar earths were correctly removed. Up to the time of the incident, the correct electrical procedures had been followed by the construction and process teams, and the work of installation had been followed daily by the engineering contractor and a delegate of the electrical distribution company. These people were present when the incident happened. During the power disruption, the No.2 Catalytic Cracker sustained a loss of more than 5 of its normal cooling water flow and also a serious drop in steam pressure. This resulted in surging of the blower and, finally, it's shut-down. Flaring was estimated to have been at the rate of 100,000 - 150,000 lb/hr, and, at three different times co-incident with peak flares, a minor grass fire was started at distances of 200 to 260 m downwind of the flare stack. The wind at the time was strong (6 Beaufort scale), and the grass relatively dry. However, levels of radiation were such that personnel were able to stand within 30 m of the base of the flare stack. The flare knockout pot was about 5 full of liquid and the molecular seal drain line was free.
This was an unfortunate electrical incident stemming from the abnormal industrial situation of the strike, but avoidable by closer checking. As regard the flaring, it is possible that, due to wind current effects, heat could have been directed downwards from the plume, igniting the grass at the 200 - 260 m radius, whilst still allowing personnel to remain in a cooler zone at a 30 m radius.
[commissioning, transformer, short circuit, design or procedure error, fire - consequence, damage to equipment]

**Lessons**

Electrical permits to include provision for noting the installation and removal of temporary earthing connections. The number of earthing cables per substation should also be recorded and checked before any switching is permitted.

**9359 17 March 1976**

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

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

**Abstract**

The incident involved the failure of an electrical sub-station supplying an ethylene plant., causing disruption to production.
The 3.3kV switchboard at the substation was provided with three incoming feeders however one of these was out of commission. Two feeders were required to meet the load. When a fault developed on one feeder, the other shut down on overload, so shutting off power to a section of the plant, including naphtha feed pumps. The low pressure alarm on the pump discharge was inoperative, leading to delay in diagnosis of the fault.
Failure of the standby power supply for the telephone system resulted in communication problems.
[alarm failure, processing, electrical substation, electrical switchgear, plant shutdown, product loss]

**Lessons**

1. Higher priority should be given to reinstating vital standby equipment. (The spare feeder had been out of commission for ten months.)
2. Measures should be taken to ensure back-up power supply to the telephone system
3. Consideration should be given to installing further naphtha feed pump alarms

**1167929 October 1975**

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

**Abstract**

A short circuit occurred in a busbar system in a transformer building, causing a fire in adjacent switches. This was followed by the tripping out of the three refinery turbo-alternators, cutting off the National Grid supply, and loss of refinery electrical power, steam and air supplies for some 30 minutes.
The cause of the the incident was a fault in a 15 kv circuit breaker voltage transformer which led to a busbar fault During the power loss and shutdown of plant, a hydrogen leak developed on a valve, and a tube of a fin-fan condense bank failed. Total damage attributed to the incident has been estimated at between 500,000 and 700,000 Frs.
Black toxic smoke prevented immediate access to the transformer building despite the opening of doors and ventilation panels, and difficulty was found in extinguishing the fires in the switch cubicles. The fire fighting was not fully successful in the transformer building for about 1 1/2 hours, the time being employed in dealing with the ventilation problems and to ensure that effective electrical isolation had been established before opening up electrical equipment casings.
[refining, transformer, circuit breaker, short circuit, power supply failure, fire - consequence, plant shutdown, spill, leak]

**Lessons**

[None Reported]

**944 13 September 1974**

**Source :** WILLMANN J.C ET AL, PCB SPILL, 1976 NATIONAL CONFERENCE ON CONTROL OF HAZARDOUS MATERIAL SPILLS, APRIL 25-28, NEW ORLEANS, LOUISIANA, 1976.

**Location :** Seattle; Washington, USA

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

**Abstract**

An electrical transformer was dropped while being loaded onto a barge resulting in a spillage of 265 gallons of polychlorinated biphenyl into the local waterway. Environmental clean up operations are described.
[loading, ecological damage]

**Lessons**

[None Reported]

**914 14 July 1974**

**Source :** DIEFENBACH R.E, ON-SCENE DECISIONS - THE RESULTANT IS EFFECTS - IMPACTS, 1976 NATIONAL CONFERENCE ON CONTROL OF HAZARDOUS MATERIAL SPILLS, APRIL 25-28, NEW ORLEANS, LOUISIANA, 1976.

**Location :** Alliance; Ohio, USA

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

**Abstract**

During a severe thunderstorm, lightning struck a power line leading into a pesticide and herbicide plant causing a fire which led to 500 residents being evacuated. Fire and run-off water from fire fighting efforts led to air and water pollution problems.
[fire - consequence, evacuation]

**Lessons**

[None Reported]

**1117109 January 1974**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A fire occurred on an API separator. Nobody was injured but damage sustained by the concrete walls of the separator, two walkways across the separator and nearby equipment was estimated to cost some 2,000 pounds. Within about ten minutes of ignition the fire was completely extinguished, burning on half of the separator having ceased within five minutes due to lack of fuel, the fire in the remaining half was put out by the refinery fire brigade.
Investigations carried out later the same day in daylight strongly suggested that the source of ignition was a broken cover glass from a halogen spotlight, mounted on a lighting tower some 10 metres above ground level, located east of the separator. The hot cover glass (greater than 250 degrees C) had fractured, probably as a result of thermal stress, and on striking the ground, spread over an area of about 8 metres in diameter, some pieces of glass entering the separator basin. Grass/weeds caught fire and it was concluded that vapour from the separator was ignited by sparks from the burning grass carried by the wind or by direct ignition from hot pieces of glass (sample of surface oil tested after the incident had a low flash point).
[separation, separator, light, stress, hot surface, fire - consequence, gas / vapour release, damage to equipment]

**Lessons**

The following recommendations were made:
1. Discontinue the use of halogen type lamps.
2. Fit fine mesh safety gauzes on all lamps on the lighting towers to contain any glass fragments from cracked cover glasses or imploding bulbs.
3. Extend the annual weed killing/removal programme to include the separator area.

**111891974**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An inert gas compressor had been opened up for inspection when a handlamp being used produced a spark which ignited propane issuing from the bearing housing.

[inspection, compressor, light, tools & access equipment, spark, operation inadequate, fire - consequence]

**Lessons**

This incident highlights the importance of:

1. checking that portable electrical equipment is in safe working order before bringing it on site.
2. ensuring that the procedures for purging, blanking and gas freeing of particular items of equipment are correct.

**1117331 December 1973**

**Source :** ICHEME

**Location :** , NORTHERN IRELAND

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

**Abstract**

A flash over occurred at the isolating contacts inside the starter cubicle unit for a pump motor. Nobody was injured but the starter and isolator sustained considerable damage.

Investigations revealed that the starter in use in this cubicle was suitable for a 75 HP motor but the duty on which it was being used was starting a 110 HP motor of the motor spirit pump serving the road loading gantries.

It was concluded that the incident could be attributed to electrical contract engineers fitting new labels to the wrong chassis. This work was in association with modifications being progressed to uprate the throughput of the refinery supply terminal. As a result of fitting wrong labels a shift electrician changed the chassis over to bring the labels into line with the existing labels inside the cubicles, thus putting starters on the wrong duties for their ratings.

[modification, motor, electrical substation, flashover, labelling incorrect, contractor error, damage to equipment]

**Lessons**

The following recommendations were made:

1. Duty labels are being fitted on the outside of each cubicle as well as the inside.
2. Interlocks should be fitted to prevent low capacity starters being used on higher duties. This item is currently being investigated by the starter manufacturers.
3. All starters and isolators are to be fitted with double isolating silver plated contacts.

Subsequent to the refinery's investigations and discussions with the contractors on the above incident, they forwarded information of faults that had occurred on similar switchgear three years previously.

**746 05 March 1973**

**Source :** MOEIN G.J, FOLLOW UP STUDY OF THE DISTRIBUTION AND FATE OF POLYCHLORINATED BIPHENYLS AND BENZENES IN SOIL AND GROUND WATER SAMPLES AFTER AN ACCIDENTAL SPILL OF TRANSFORMER FLUID, IN: NATIONAL CONFERENCE ON CONTROL OF HAZARDOUS MATERIAL SPILLS, 1976, 368-372.

**Location :** East Tennessee, USA

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

**Abstract**

A road transportation incident. An accidential spillage of approximately 1500 gallons of a mixture of polychlorinated biphenyls (PCBs) and a solvent of polychlorinated benzenes occurred, in a rural area, when a transformer on a road vehicle was involved in an accident. The spill resulted in the environmental contamination of two water courses.
[road incidents, environmental]

**Lessons**

[None Reported]

**112211973**

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

**Abstract**

A fire broke out at a jetty at an oil installation near this refinery when flammable vapour from a cleaning liquid (flash point 77) ignited. There were no injuries to personnel but substantial damage to pipelines and a barge.
A vessel was loading fuel oil, at 75 degrees C, when an expansion bellows, made of a non-reinforces neoprene type fitted on the pipeline, was split open and fuel oil quickly contaminated the barge, pipe-lines, jetty and harbour. Loading was immediately stopped and large quantities of cleaning fluid used to clean the jetty and barge. Some thirty minutes later a small diesel pump was stated up by the bargeman in order to clean the boat and surrounding water. The mixture of fuel oil and cleaning agent was ignited by the diesel engine which had a faulty exhaust system (one of the two baffle plates in the silencer was broken). The fire quickly reached the jetty and spread in three directions via the drainage channels under-neath the pipetrack. The majority of the pipelines had flanged joints and these soon developed leaks adding fuel to the fire. All lines were quickly isolated but the jetty fireman had difficulty in obtaining the correct pre-mix from foam nozzles on the three hydrants nearest the fire and as a result no effective fire fighting was carried out until the arrival of the fire brigade some five minutes later.
A butane carrier, loading at a nearby jetty, disconnected its loading arms and left the jetty within five minutes of the alarm being raised. The fuel barge, however, was unable to leave the jetty immediately as, although the front steel mooring cable was easily released, the rear hemp rope was inaccessible as a result of the fire. The latter finally burnt through and the vessel was unable to withdraw.
The use of this cleaning fluid has since been prohibited at this installation.
[loading, cleaning, bellows, pump motor, pump, mechanical equipment failure, fire - consequence]

**Lessons**

The following recommendations were made:
1. Care should be taken in approving cleaning agents for use within premises.
2. The flash point of some cleaning agents is low and this risk should be recognised where they are employed. If possible, materials with a flash point 55 degrees C should be used, but as is evident from this incident this does not guarantee freedom from fire hazards and due precautions must be taken in the application of these solvents.

**717 1973**

**Source :** JOHNSEN AND HOLTE, ELEKTRO-ELECTRONISH TIDSSKRIFT, 1973, 86, (22), 23-27.
**Location :** Tonstad; Sirdal, NORWAY

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

**Abstract**

An oil spray/mist explosion occurred in a transformer room of a hydroelectric power station. A flashover inside the 2 cubic metre oil filled cable junction box of a transformer caused pressure to rise and ruptured the casing. Oil sprayed out into the 800 cubic metre cell containing transformers causing the mist cloud exploded and the cell to be blown out.
[fatality]

**Lessons**

[None Reported]

**180 15 June 1972**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

On 15th June, 1972, at 0905 hours two electrical flashovers occurred inside a 3.0 kv cubicle type switchboard in the crude distillation sub-station whilst two employees were isolating the 3.0 k supply to a 75 kVA lighting transformer circuit. There were no injuries to personnel but two cubicles were damaged including one at the opposite end of the switchboard which was in its normal operating condition.

The equipment was known to have certain shortcomings in comparison with most European manufactured equipment for similar duty, for example:

1. The bus bar system was not in a separate compartment,
2. The bus bars were of bare copper supported on porcelain insulators,
3. The isolators were of the hinged fused switch type, each phase of which being for independent manual operation using an insulated wooden pole.

The cubicle concerned was fitted with a voltage transformer connected by cable to the bus bar side of the isolator, all terminals bare. Thus the voltage transformer, its connections and associated fuses and secondary wiring remained live when the main switch fuse isolator was open.

The enquiry that followed the incident revealed that the correct isolating procedure had not been followed, the work was carried out without an electrical permit to work. Due to a misunderstanding, a foreman proceeded with the high voltage switching instead of the engineering assistant authorised to carry out this duty.

The foreman after isolating the equipment correctly, used a hand held length of wire to discharge the equipment to earth instead of the insulated wooden rod and cable designed for this duty. It was concluded from the evidence that the wire used for the earthing must have come into contact, or close ionisation proximity, with the exposed live connections to the voltage transformer and this resulted in a flash over. Examination of other cubicles revealed the presence of a thin layer of dust on all insulating surfaces etc. which was likely to break down under the stress of the transient high voltage occurring when the first flash over took place.

[human causes, damage to equipment]

**Lessons**

1. Require a standing instruction covering the electrical work permit systems.
2. Draw up a proper procedure indicating the correct method of performing such isolation work. Precautions should include the use of safety spectacles, rubber gloves and safe discharging equipment.
3. Written instead of verbal communication should be used.
4. The name of the person authorised to isolate high tension equipment should be known to all electricians in the form of a standing instruction.

**229 19 January 1972**

**Source :** ICHEME

**Location :** ,

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


**Abstract**

On 19th January, a contractor's employee was operating a jackhammer to excavate for the installation of a new pump bed on the No. 1 Crude Unit. Whilst squaring off the excavation the drill slipped and penetrated the grouting on top of a cable trench, piercing a 3,300 volt cable. The jackhammer operator sustained only a slight shock.

A pump bed already existed, but to allow the installation of a larger pump, this bed had to be removed and another, bigger one, made. The work was being done by contractors, who had already installed a similar bed on the No. 2 Crude Unit.

The contractor arrived on site at 08.00 hours and enquired if an excavation permit was available.

Finding that the permit had not yet been issued he contacted the construction supervisor, who arrived very shortly with the 'permit'. The contractor witnessed the signing of the Site Acceptance by the supervisor, who then took the contractor to the job and explained what was to be done, and the precautions to be taken. The contractor marked out three sides of the excavation, but not the fourth side (the south side) which was the side on which the jackhammer was working when the 'near miss' occurred. The contractor remained on site until the bulk of the excavation was completed and told his employees that there was no need to go any nearer the cable trench, as sufficient paving had been broken out. The contractor then left the refinery. The jackhammer operator decided then to square off the corners of the excavation, and whilst he was doing this the drill slipped, and penetrated the cable trench and the cable. When the drill hit the cable it tripped the pump being supplied by the cable. Unit operating personnel immediately investigated, stopped work on the excavation, and had the pump isolated at the sub-station. Repairs were made and only a marginal loss of production resulted.

An investigation was completed it was found that:

1. The recognised procedures, both in the issue of the 'permit' and drawing, and the subsequent briefing of the contractor by the Construction Supervisor had been followed.
2. Adequate drawings had been supplied to the contractor.

[excavation damage, operator error, construction]


**Lessons**

The following recommendations were made:

1. The use of a jackhammer in close proximity to electric cables is strongly not recommended, because precise control is not possible with this tool.
2. The grouting above the cable trench was sub-standard and should have been replaced when this was known.
3. The 'permit' should have been more detailed.
4. Where concrete is broken in close proximity to electric cables the machine should be capable of precise control.
5. 'Permits' require to state in more detail the hazards associated with the job, and the limitations to be imposed because of these hazards. Contractors' employees should be permitted to read the 'permit' when supervision by the contractor is not continuous.
6. Cable trenches should be protected with timber in the vicinity of the excavation.

**380 18 October 1971**

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

**Abstract**

On 18th October, 1971 at about 18.05 hours, a fire occurred in the LPG recovery section of a refinery. Nobody was injured and damage was slight. The fire was first observed at the opening of an underground drain into which the effluent water went from the LPG overhead condenser.
Operators using dry powder extinguishers quickly put out the fire but it re-ignited five minutes later and this time covered a larger area.
The refinery fire crew arriving on site used water fog nozzles, snuffing steam and dry powder to extinguish the flames. The unit was shut down, but about a half hour after the second fire and before an investigation could be properly carried out, a third outbreak occurred with flames of 4 m (13 ft.) height. Dry powder again put the fire out and three water sprays were left playing on the plant in the area whilst the LPG fractionator was depressured.
Persons fighting the fire observed sparks coming from an electric light junction box which was about 4 feet from the drain where the first flames appeared; the gas leak was ultimately traced to a corroded seal ring on the overhead condenser which had allowed LPG to escape to atmosphere and also into the effluent water from the exchanger.
The junction box was opened and found to be in good condition but a short circuit was proven in a section of buried conduit adjacent to the box. This steel conduit pipe was dug up and found to be badly corroded and holed. It is believed that stray current then caused arcing at the screwed joint where the conduit entered the junction box when the lighting in the area was turned on.
[gas / vapour release, corrosion, fire - consequence, refining]

**Lessons**

[None Reported]

**1154110 May 1971**

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

**Abstract**

A fire occurred in a transformer bay. Damage was mainly confined to busbars, insulators and transformer seals although auxiliary cabling was badly burned and there was some structural damage. One transformer and rectifier set was out of commission for 11 days and the second set for 35 days. This resulted in considerable loss of production.
The investigation identified that the cause of the fire was insulation breakdown leading to arcing. The arcing caused failure of the transformer oil seals and the escaping oil ignited. The exact cause of the insulation breakdown could not be established but it was likely to have been due to an incident the previous day which resulted in an open circuit occurring and causing an over voltage of several times the normal operating voltage at the transformer busbars.
The fire was considered beyond the capabilities of the works fire team and it was left to the County Fire Brigade to deal with the fire. Before the fire brigade arrived, all personnel were evacuated and all electrical power had been isolated from the area.
After the incident it was discovered that a number of fire extinguishers had been used or partially used without being replaced or refilled.
[fire - consequence, damage to equipment, product loss, material of construction failure, seal failure, spill, evacuation]

**Lessons**

Although the decision to wait for the fire brigade was considered to be correct, the investigation identified a number of potential problems and deficiencies and made recommendations for corrective actions.
The works fire team does not have adequate training or equipment to deal with such fires and consideration should be given to installing either automatic or manual carbon dioxide quenching systems in transformer bays. The constitution, equipment and involvement of the works fire team should be re-examined.
Instructions regarding the use and replacement of fire extinguishers should be reviewed.
As the fire occurred during the day senior members of the electrical department were available on site but consideration should be given to providing adequate cover out of normal hours. Isolation of chemical plant also requires further consideration particularly out of normal hours.
Evacuation was successful but concern was expressed by the Divisional Fire Officer that personnel were not kept far enough away from a potential explosion risk. It was recommended that fire procedures should be reviewed.
Consideration should be given to the inspection requirements for transformer and rectifier equipment following an incident that could have exceeded their design ratings.

**9770 10 July 1964**

**Source :** LOSS PREVENTION, VOL. 3.
**Location :** ,

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

**Abstract**

An indoors transformer failed and caught fire when lightning struck external power lines. The fire was controlled by sprinklers but there was much water damage to high value finished stock.
[electrical equipment failure, damage to equipment, fire - consequence]

**Lessons**

[None Reported]

**5822 1900**

**Source :** LOSS PREVENTION BULLETIN, 024, 158.
**Location :** ,

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

**Abstract**

An electrician was asked to cut and remove an unused high voltage cable in a cable trench. He cut through a live 6,600 volt cable, fortunately escaping with only minor injuries.
[maintenance, injury]

**Lessons**

[None Reported]

**7376 14 December 1785**

**Source :** LOSS PREVENTION BULLETIN, 050, 18.
**Location :** Turin, ITALY

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

**Abstract**

A boy who was stirring some flour at night by the light of a lamp in a bakers shop. An explosion occurred when he was feeding flour to another vessel and a large quantity fell forming a cloud. The boy was burnt and another boy broke his leg but both appeared to have recovered. Dust explosion.
[mixing, burns]

**Lessons**

[None Reported]

**11494Date Unknown**

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

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

**Abstract**

An electrician suffered superficial burns to his face when he was sprayed with electrolyte while removing a plastic sealing cap from a nickel cadmium battery. He was protected from injury to his eyes by the fact that he was wearing glasses at the time.
[near miss]

**Lessons**

It was the practice of the factory which manufactured the batteries to seal them immediately after charging, without allowing any time for entrained gases to ventilate. This meant that pressure was able to build up within the battery, causing the electrolyte to spray out when the caps were removed.

**7588 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 126, 10.

**Location :** ,

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

**Abstract**

A confined explosion, due to the ignition of liquefied natural gas (LNG) vapours, destroyed a transformer building at a gas reception facility.
A leak of LNG was observed by plant supervisors shortly before the explosion, although due to inadequacies in radio communication, there was some confusion as to the location and nature of the leak, which had been identified as coming from an inadequately tightened LNG pump seal. Procedures were initiated, but when staff attempted to disengage the circuit breaker supplying power to the leaking pump, an explosion ensued which destroyed the substation itself and large oil-cooled electrical transformers, as well as heavily damaging adjacent structures. As a result of the explosion, oil leaking from the damaged transformers spread over the area, ignited and burned. Fatality.
[fire - consequence, processing]

**Lessons**

The following recommendations were made:
1. inspection of all conduits and seals to identify potential pathways for leaks to areas that are confined and/or contain potential sources of ignition.
2. fitting of gas detection and alarm equipment in all areas where build-up of flammable gases could occur.
3. closer specification of facility design criteria.
4. improved training in emergency procedures, including realistic training exercises, for those employed on such plants, and adequate location and protection of fire water mains, with sufficient isolation valves to prevent compromise of operation in the event of damage.

**8002 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An electrician was badly burned on the face and hands by a flash-over which occurred in a UFS fuse switch. The electrician was closing the isolator when the flash-over occurred. Arc gases and products of combustion blew out the bottom right-hand corner of the fuse switch door (which was closed) and impinged on the electrician's arm and face causing severe burns.

An investigation into the incident, concluded that one of the fixing screws holding the fuse assembly onto the back plate had been worked loose by successive switching operations, finally falling out and making contact between the blue phase and earth.

Subsequent inspections of other units have revealed that retaining screws in other fuse switch units are at various stages of becoming loose with some at potentially dangerous positions, being held in by as little as one thread. The screw fixings locate on a back plate with drilled and tapped holes but have neither back nuts or split washers to prevent loosening.

[electrical switch, injury]

**Lessons**

It is fortunate that the injuries to the electrician were not more severe as the heat developed by the flash-over not only blew out the bottom corner of the cubicle door but also melted the isolator handle.

From information received it would appear that the type of fixing used in the unit is common to similar types of fuse switch used within the industry. However, it would also appear that this type of fault is not common and has yet to be identified outside. Whether this failure is confined to a single batch of fuse switches (i.e. a small scale quality control problem) or has more widespread implications must, therefore, remain uncertain. It is suggested that checking the tightness of fixing screws and bolts be included in routine maintenance of switching units, if this is not already the case.

**3006 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

The electrical supply at a refinery was taken from two 90/20kV transformers in parallel. Two transformers tripped simultaneously on overload and shut down the whole refinery after an explosion occurred in a 20kV circuit breaker.
All the emergency shutdown arrangements on the units operated satisfactorily and start-ups commenced later the same day.
A flash-over occurred within the cell containing the circuit breaker and associated stepdown potential transformer due to a breakdown in the transformer.
There was a current limiting fuse in the primary circuit of the transformer but this did not prevent the gradual breakdown of insulation that subsequently led to the explosion.
[refining, ]

**Lessons**

In future, more stringent acceptance tests will be undertaken before this type of equipment is installed and potential transformers will not be installed in the same cell as the circuit breaker.

**3329 Date Unknown**

**Source :** ICHEME
**Location :** ,
**Injured :** 3 **Dead :** 0

**Abstract**

A fault occurred on the 24V. power supply to the control room instrument panel serving crude distillation and LPG units. The back-up battery supply cut in automatically but the batteries went flat after 10 minutes operation. This resulted in all control valves on the affected units moving to the safe position. Although the fault was found after 20 minutes, it was six hours before the units returned to normal operation.
[power supply failure]

**Lessons**

Frequency of checking should take account of the environment in which the battery operates. Batteries located in instrument panels or other non-ideal positions where they are exposed to local heat generation will require more frequent checking.

**5293 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

The hydrocracker complex came very close to total shutdown when the battery supplying the plant emergency system failed. Undetected overcharging caused by a faulty charger boiled many of the battery cells dry resulting in individual cell short circuits, overcurrent, severe overheating and dangerously low voltage.

The first indication of any problem was smoke emanating from the battery room situated in the main control building. The battery charging system was not fitted with an overcharging or low electrolyte alarm. Fortunately the refinery's electrical maintenance department had a spare battery available from a redundant plant and were able to install this in time to prevent a plant shutdown. An electrician sustained a minor caustic chemical burn during the incident.

[power supply failure, burns, refining]

**Lessons**

[None Reported]

**5471 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

A 3kV minimum oil type circuit breaker, on motor control duty, did not open fully when a stop control, remote from the circuit breaker, was operated. In the control room the ammeter reading was zero, but the circuit breaker position indicator light gave a closed signal.
The pump was visually checked on site to confirm that the motor was not running.
The following day, an electrician found that the circuit breaker in the substation was not in the fully open position. He regarded this as a routine fault because similar ones had often occurred, on the type of equipment concerned, over the previous few years.
Without isolating the main or auxiliary voltage supplies, he removed the front cover and manipulated the actuating mechanism with a spanner. As a result, sustained arcing occurred in the extinguishing chambers which became pressurised and failed.
Oil then sprayed into the substation with a subsequent explosion which severely damaged the whole switchgear installation and caused the almost complete collapse of the substation building.
[mechanical equipment failure, leak, damage to equipment, operational activities]

**Lessons**

[None Reported]

**5800 Date Unknown**

**Source :** ICHEME

**Location :** ,

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


**Abstract**

A 12 volt car battery exploded whilst on charge in the electrical workshop.

The battery was standing on the floor in the charging room and was connected to the charger by means of crocodile clips attached to the battery posts. It had been on charge for several hours and each cell was being vented in an acceptable manner. There were no naked lights or smoking in the immediate vicinity of the charging area.

The explosion occurred whilst an assistant electrical foreman was leaning over checking the battery. Although splashed in the face with a small quantity of electrolyte he was able to wash it off immediately and suffered no adverse effects.

Subsequent investigation failed to reveal any positive cause of the incident. However, in the light of the known circumstances it was concluded that the assistant foreman, during his check, must have knocked one of the leads with his leg as he stood over the battery.

This action moved the crocodile clip slightly and sparking occurred during a momentary break make of the circuit. This in turn ignited the hydrogen gas which is known to evolve during the charging process.


**Lessons**

In order to minimise the possibility of a similar recurrence it has been recommended that connections be made only in the manner dictated by the battery design (i.e. clamping or bolting to the battery post).

**11810Date Unknown**

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

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

**Abstract**

A short circuit in the fireye system of a refinery steam boiler caused the shutdown of the system.
Due to the lack of co-ordination in fuses and circuit breakers this caused the shutdown of the other steam boiler.
The incident affected the amount of (lack of) steam operating the hydrogen gas compressor on the catalytic reformer, releasing gas to the flare.
Temperatures were below 0 degrees C and the drain from the flare molecular seal was plugged.
venting, flare stack, overpressure, near miss, safety equipment failure, electrical equipment failure, safety procedures inadequate]

**Lessons**

1. This incident is a very good illustration of the need for regular audits on safety related equipment to ensure that it remains in working order for long periods when it is not required to operate.
2. In the present case the following steps were taken:
· The centre steam injection system was shut down in cold weather.
· The molecular seal draw was connected to the fuel gas system so that it could be checked and blown clear on a regular schedule.
· Methane was injected into the flare system in cold weather.
· A pressure recorder was installed on the flare header.

**11506Date Unknown**

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

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

**Abstract**

A fitter working on a platform required a lamp.
The worker obtained a 25V inspection lamp and transformer, but found the transformer plug would not fit a convenient socket. The plug on the lamp could, however, be inserted into the socket, so he put a 250V lamp into the inspection lamp holder and put the plug into the socket despite an adjacent 440V warning sign. The sign was dirty and corroded. The inspection lamp was of an approved industrial type. The cable and hand lamp were slung over the man's shoulder as he plugged in. When he closed the switch he fell onto the floor plates. His fall or shout alerted two others who, after receiving slight shocks, switched off at the main switch and applied artificial respiration. The man recovered in a few minutes, but suffered minor burns.
[lighting, electric shock, inspection, safety procedures inadequate]

**Lessons**

The following lessons were learnt:
1. The accident would have been avoided had the installation been such that it was impossible to insert a plug into the wrong type of socket.
2. Plugs and sockets should be selected and installed so that it is not possible for portable electric equipment to be plugged into any but the correct supply.
3. The danger of relying on printed notices is apparent. Where necessary, they should be of non-corroding material with lettering that cannot be erased, and should be kept clean.
4. The advantage of having workers trained in appropriate first aid techniques is evident.

**7878 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 110, 4.
**Location :** ,

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

**Abstract**

A number of large chemical plants were supplied with electricity via a double-circuit 132 kV overhead power line supported on steel towers, i.e. two separate circuits carried on common supports. Such a system is normally regarded as providing a firm and secure supply to that area. A fire took place in a yard situated under this overhead line. The following events took place:
1. Arcing took place on the overhead power line due to the smoke and flames.
2. The electrical supplies to the area were erratic for about half an hour as the individual circuits tripped due to the arcing and then re-closed as the arcs stopped.
3. Electrical supplies were then completely lost for a further 15 minutes.
4. Limited supplies were then re-established.
All plants suffered, many due to the severe voltage fluctuations caused by the arcing. In others the battery supplies associated with standby generators became exhausted due to the many attempts to start up during the short supply interruptions. In some cases the on-site generation was running and exporting power to the "grid". When problems arose these generators were feeding into the faults and their own electrical protection operated to disconnect them from the system. There was considerable embarrassment when several plants lost all communication and could not have called for emergency services had they been needed.
[fire/explosion]

**Lessons**

The following recommendations were made:
1. Duplicate infeeds from whatever source are NOT inviolate. Common cause failure is a frequently occurring phenomenon.
2. Batteries and their associated chargers used to start up generators or control switchgear are VITAL items of plant. All too often they become the most important item on site but are frequently the subject of neglect, abuse and poor design.
3. When standby or other generators are routinely tested for operation it is imperative that the whole system is tried and tested by loading the generator via its own control system.
4. Plant and equipment identification must be clear and unambiguous. Arrangements to be in place to ensure that plant modification and additions do not compromise the identification.
5. Pre-prepared systems and schedules to enable staff to operate and so recover from major and catastrophic electrical power failures.
6. Where there are segregated electrical power supplies the effects of failures and their possible "knock-on" effects must be carefully investigated.
7. Maintenance activity needs to be carefully programmed with active and thorough monitoring of the work that is carried out.
8. Adequate communication facilities are necessary to permit proper action in times of emergency. There needs to be control over non-essential use where there are no segregated emergency facilities.
9. There is always a need to provide priority schemes for alarms to ensure that the operators are presented with the appropriate information. Modern alarm systems provide information at incredible speed and can readily overwhelm operators.
Many investigations reveal other matters are often overlooked or ignored include:
1. The provision of adequate storage capacity for air supplies for instrumentation and control purposes in the event of total electrical power failure.
2. The provision and maintenance of proper coolant for the prime movers for standby generators.
3. The provision of adequately fault rated switchboards.
4. The provision and maintenance of electrical protection including fuses on standby systems.
5. Quality control of the installation of all standby facilities e.g. cables connecting Un-interruptible Power Supplies being damaged during laying, failing when in service and leading to total destruction of that system.
6. The need to segregate all essential electrical supplies and to provide protected routes for those supplies to ensure safe control of the plant in emergencies e.g. DO NOT route cable feeding fire pumps and deluge systems through the main highly flammable process area.
7. The possible effects of the use of mobile radios and telecommunications equipment upon Programmable Electronic Systems used for control purposes.

**6948 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 013, 2.
**Location :** ,

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

**Abstract**

During the highly exothermic condensation of o-nitrotoluene to 2,2-dinitrodibenzyl, the rate of addition of the nitro compound is controlled to keep the temperature of the batch between 5 and 10 degrees C.
When the temperature alarm, which was set at 15 degres C, was activated, the operator observed that the agitator was not running. The agitation monitor had already stopped the addition of nitrotoluene. Jacket cooling with brine was at its maximum. First, the temperature of the batch rose slightly higher, then it remained constant. The agitator was moved twice for a very short period (1 revolution). This caused again a slight rise of temperature. At 20 degrees C, the building was evacuated. When the temperature had fallen back to 16 degrees C, the agitator was again moved for short periods. Two hours later the temperature was down to 12 degrees C, and the agitator could be switched on permanently and all operators came back to continue their regular duties. When normal reaction temperature was reached the remaining 20% of nitrotoluene was added and the batch was completed without any loss. Most probably the failure of the agitator was caused by an electrical equipment failure - worn out electrical switch on the motor.
[nitrotoluene-o, batch reaction, agitation failure]

**Lessons**

[None Reported]

**6914 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 008, 17.
**Location :** ,

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

**Abstract**

Men returning from a lunch break smelled burning and saw flames coming from the base of a 100-ton silo, which was on the eighth storey of a building and extended to the tenth storey. The silo was being filled by a worm screw with animal feedstuff, thus creating a dust cloud. The men's immediate reaction was to switch off the silo light, as it was a common occurrence for the dust to ignite on contact with a lit silo light bulb. However, before this could be done, the dust cloud inside ignited and an explosion occurred. The light bulb was situated in a well, but the thick protective glass was missing and dust therefore came into contact with the hot bulb. The fire subsequently spread over 4 storeys of the 11 storey building and further explosions occurred.
[silo/hopper, fire - consequence, animal feedstuffs, dust explosion]

**Lessons**

Ignition of dust by electric light bulbs, particularly those on wander leads, has often been reported. Bulbs overheat when insulated with dust, but the hot glass can ignite the dust before the filament burns out.

**6846 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 001, 11.

**Location :** ,

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

**Abstract**

An enamelled 2000 litre kettle was charged with cyanuric chloride, allyl alcohol and water. On slow addition of liquid caustic soda, triallyl cyanurate should have been formed. However, before beginning the addition of caustic soda the temperature of the batch was 28 degrees C instead of the normal 5 degrees C. The kettle had been left without cooling.

The rapidly rising temperature and pressure caused failure of the bursting disc and the man-hole gasket was displaced. Allyl alcohol vapours escaped and subsequent ignition, probably caused by non-explosion proof fluorescent lights, caused an explosion and flash fire. Four people sustained minor injuries.

[operation inadequate, gas / vapour release, fire - consequence, overheating, high pressure, reaction, injury]

**Lessons**

[None Reported]

**7877 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 110, 4.
**Location :** ,

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

**Abstract**

A process plant was in operation. The electrical supplies were fed from a main high voltage switchboard connected to the regional electricity company. The distribution within the plant was via four other high voltage substations. When a fault occurred on a 3.3 kV motor starter all supplies to the plant were lost. This was because the regional electricity company circuit breaker protection detected the fault and automatically disconnected the supplies. This closed a large part of the complex down.
Investigation revealed that:
1. The motor starter unit was designed for indoor use, but had been mounted in a semi-enclosed outdoor location. It was found to be water-logged and this caused the initial fault.
2. The main site substation 110 V D.C. control power supply (a battery and charger system) failed and the circuit breaker was not able to open to disconnect the fault.
3. All other 110 V D.C. supplies in all the other substations were found to he faulty due to neglect.
4. Prior to this incident the organisation responsible for the complex had been warned on a number of occasions about the neglect of the 110 V D.C. control system batteries and chargers.
[power supply failure]

**Lessons**

The following recommendations were made:
1. Duplicate infeeds from whatever source are NOT inviolate. Common cause failure is a frequently occurring phenomenon.
2. Batteries and their associated chargers used to start up generators or control switchgear are VITAL items of plant. All too often they become the most important item on site but are frequently the subject of neglect, abuse and poor design.
3. When standby or other generators are routinely tested for operation it is imperative that the whole system is tried and tested by loading the generator via its own control system.
4. Plant and equipment identification must be clear and unambiguous. Arrangements must be in place to ensure that plant modification and additions do not compromise the identification.
5. There must be pre-prepared systems and schedules to enable staff to operate and so recover from major and catastrophic electrical power failures.
6. Where there are segregated electrical power supplies the effects of failures and their possible "knock-on" effects must be carefully investigated.
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9. There is always a need to provide priority schemes for alarms to ensure that the operators are presented with the appropriate information. Modern alarm systems provide information at incredible speed and can readily overwhelm operators.
Many investigations reveal other matters are often overlooked or ignored include:
1. The provision of adequate storage capacity for air supplies for instrumentation and control purposes in the event of total electrical power failure.
2. The provision and maintenance of proper coolant for the prime movers for standby generators.
3. The provision of adequately fault rated switchboards.
4. The provision and maintenance of electrical protection including fuses on standby systems.
5. Quality control of the installation of all standby facilities e.g. cables connecting Un-interruptible Power Supplies being damaged during laying, failing when in service and leading to total destruction of that system.
6. The need to segregate all essential electrical supplies and to provide protected routes for those supplies to ensure safe control of the plant in emergencies e.g. DO NOT route cable feeding fire pumps and deluge systems through the main highly flammable process area.
7. The possible effects of the use of mobile radios and telecommunications equipment upon Programmable Electronic Systems used for control purposes.

**9046 Date Unknown**

**Source :** ENVIRONMENTAL PROTECTION BULLETIN, 047, 27.
**Location :** Oslo, NORWAY

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

**Abstract**

A leakage of polychlorinated biphenyls (PCBs) containing insulator oils from stored transformer equipment had resulted in contamination of soils with up to 2000 mg/kg of PCBs at the site. The shallow nature of contamination meant that ground water pollution had not occurred and that the most heavily polluted soils (>10 mg/kg PCBs) could be excavated for treatment and disposal.
The principle objective was to treat the 1288 tones of excavated PCB contaminated material. Volume reduction was achieved by separating debris (>0.05 m) from soil (<0.05) and by treating the soil in a washing plant. 11.9 tonnes of scrap iron, plastic and wood were separated from the excavated material and hand sorted into porous and non-porous components. Nonporous debris was surface washed to remove contamination (<5 mg PCB/100 cm2) and disposed of on-site in a landfill. Porous material was sent for incineration.
[storage, pollution]

**Lessons**

[None Reported]

**598 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An instrument mechanic placed a battery on his work bench. One drop of the battery's alkaline electrolyte splashed into his right eye, causing a burn which resulted in 40% peeling of the retina.
It was found that there was a pin-head sized hole in the nickle-plated cap (positive pole) of the battery.
[burns]

**Lessons**

[None Reported]

**7879 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 110, 4-5.
**Location :** ,

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

**Abstract**

A large petrochemical complex consisted of three discrete but interconnected plants. The electrical supplies were provided by a double circuit 132 kV overhead power line, on-site generation, and a number of standbys. The 132 kV overhead line suffered a fault when the conductors were caused to clash by a third party.
The effects of the fault were:
1. Major electrical transients (disturbances) took place. These took the form of violently fluctuating voltage variations on the 132 kV in-feeds to the complex.
2. The electrical protection on the lower voltage in-feeds to the three separate plants detected these variations and disconnected plant number two from the system, but left plants one and three operating.
3. Plant one continued to produce feedstock to plant two. There was insufficient storage capacity. Overflows took place and a number of fires were started.
Investigations revealed that:
1. Electrical protection equipment detected the voltage fluctuations and inhibited startup of plant two generation equipment.
2. The control room staff were unable to cope with the volume of alarm data that was presented.

**Lessons**

The following recommendations were made:
1. Duplicate infeeds from whatever source are NOT inviolate. Common cause failure is a frequently occurring phenomenon.
2. Batteries and their associated chargers used to start up generators or control switchgear are VITAL items of plant. All too often they become the most important item on site but are frequently the subject of neglect, abuse and poor design.
3. When standby or other generators are routinely tested for operation it is imperative that the whole system is tried and tested by loading the generator via its own control system.
4. Plant and equipment identification should be clear and unambiguous. Arrangements should be in place to ensure that plant modification and additions do not compromise the identification.
5. There should be pre-prepared systems and schedules to enable staff to operate and so recover from major and catastrophic electrical power failures.
6. Where there are segregated electrical power supplies the effects of failures and their possible "knock-on" effects should be carefully investigated.
7. Maintenance activity needs to be carefully programmed with active and thorough monitoring of the work that is carried out.
8. Adequate communication facilities are necessary to permit proper action in times of emergency. There needs to be control over non-essential use where there are no segregated emergency facilities.
9. There is always a need to provide priority schemes for alarms to ensure that the operators are presented with the appropriate information. Modern alarm systems provide information at incredible speed and can readily overwhelm operators.
Many investigations reveal other matters are often overlooked or ignored include:
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5. Quality control of the installation of all standby facilities e.g. cables connecting Un-interruptible Power Supplies being damaged during laying, failing when in service and leading to total destruction of that system.
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7. The possible effects of the use of mobile radios and telecommunications equipment upon Programmable Electronic Systems used for control purposes.

**7919 Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

An inspection of gas compression equipment on an offshore installation revealed that all the cable glands used on every instrument and junction box were of an incorrect type.
Braided cable was in use throughout the gas compression package.
Glands that had been fitted, although the correct size, were suitable only for use with armoured cable.
Incorrect selection and use of cable glands on equipment located in hazardous areas would have invalidated the certification of that equipment.
[incorrect equipment installed]

**Lessons**

All operators were recommended to ensure that the following actions were taken with regard to cable glands:
· The correct type of gland is specified.
· Technicians should always ensure that when fitting cable glands the correct type for that particular cable is used.
· Inspection personnel should be aware of gland differences, and should check that the correct type is fitted.
Any modifications should be the subject of formal procedures to guard against such wrong installations.

**7454 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 102, 22,; QUARTERLY SAFETY SUMMARY, 1977, VOL.47, NO.188.
**Location :** ,

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

**Abstract**

An electrical craft assistant was cleaning the top of a battery, which was on charge, using a screwdriver wrapped with cloth. The screwdriver blade "bridged" two terminals causing an arc which ignited an explosive mixture in one cell. The cover and base of the cell were shattered. The craft assistant was struck in the face by flying debris and suffered serious eye injuries.
[explosion, safety procedures inadequate, injury]

**Lessons**

The following recommendations were made:
1. Battery tops should only be cleaned using non-conducting tools.
2. Goggles should be worn at all times when working on batteries.
3. Insulating caps should be fitted to fork lift truck battery terminals.

**7838 Date Unknown**

**Source :** MANAGING FOR SAFETY, ICHEME, TRAINING PACKAGES, 017, 4.13.
**Location :** ,

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

**Abstract**

Runaway exothermic reaction. A fire occurred in an electrical substation of a large chemical works. This resulted in loss of power to most of the manufacturing units and gave rise to many problems over the site. Eleven hours later during the afternoon of the same day there was an explosion in a reaction vessel, in which a reaction involving an aromatic nitro compound was being carried out. A secondary explosion and subsequent fires were the result of a release of flammable vapours from the reactor. There were no serious injuries. Property and consequential losses were very high.
[fire - consequence, runaway reaction, power supply failure, fire - consequence, processing]

**Lessons**

[None Reported]

**7453 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 102, 21.
**Location :** ,

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

**Abstract**

An electronic depth counter battery pack was extensively damaged due to an internal explosion. The explosion caused the container to be ripped vertically at the corner and shatter along one side. This in turn caused a plate covering the battery, along with the sealed lid, to be sheared from their anchor posts. [damage to equipment]

**Lessons**

[None Reported]

**7842 Date Unknown**

**Source :** MANAGING FOR SAFETY, ICHEME, TRAINING PACKAGES, 017, 4.33.

**Location :** ,

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


**Abstract**

At the planning stage of the refinery shut-down, it was decided that the large separation reaction vessel of the crude oil distillation section would be opened for cleaning and inspection.

After a drum inspection, it was decided that the inner coating of the drum would be repaired. A special paint was selected for the job, based on expert recommendation and it was planned that the job would be done by the local coating contractor.

The coating contractor reviewed the job internally and decided that ventilation was needed to enable the paint to dry in the time available.

A refinery inspection engineer arranged a joint meeting with the painting contractor, paint manufacturer and the refinery maintenance group to discuss all the details.

The meeting took place but the painting contractor's supervisor could not attend. A coating brochure giving details of the paint was given to the refinery maintenance group from the paint manufacturer which included the safety data sheet on the paint.

The repair work started on the same day as the meeting when damaged parts of the coat inside the drum were sandblasted.

Prior to the work, the vessel was out of operation for several days and was checked for oxygen and flammable levels. It was blanked off according to the plant procedures. The oxygen/flammable levels were in the appropriate ranges. Lighting was installed by the contractor.

With the sandblasting complete, painting commenced. Prior to painting the painting contractor's personnel had covered the 150mm vent on top of the vessel and the 600mm manhole, with a plastic bag, so that no rain could enter.

The first coating layer was applied to the areas under repair, about 30% of the inner surface. No artificial ventilation was used during painting. The paint was applied with a spray gun, using an airless spray process. After spraying, warm air was introduced through the manhole for drying.

The painting contractor asked for a permit renewal, a couple of days later, for applying a second coating. The vessel entry permit was issued. Oxygen and explosivity tests were carried out again and found to be in the acceptable range.

At the end of the spraying the painter went closer and closer to the manhole where the light was located. He stepped onto the cable and must have pulled the bulb fixture out of the lamp frame. The bulb still lit fell onto the vessel's floor, shattered and ignited the flammable mixture in the vessel from a spark or electrical short circuit. Fatality.

[explosion, entry into confined space]


**Lessons**

The following recommendations were made:

1. The work permit system is one of the most vital safety management systems in the refinery. Employees and contractors must be made aware of this.
2. The existing procedures for vessel entry and for confined spaces working must be reviewed.
3. On routine jobs requiring a special work permit such as vessel entry, a job hazard review must be passed. This review should identify the principal hazards. A trigger system must be implemented to ensure that all new work conforms to this new review step. The results of each review to be documented.
4. The safety evaluation of a contractor's work performance to be made part of an ongoing review system.
5. Regular audits must be performed to ensure that:
6. Non routine job hazard review is done and results are achieved.
7. The safety evaluation of contractors is done and leads to improvements.
8. Tools and equipment used by contractors to be of the same safety standard as the company.

**10428Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 135, 10.

**Location :** ,

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

**Abstract**

An electrician was injured when a portable battery was used in an attempt to start an offshore pedestal crane.
The electrician connected the jump leads in reverse polarity, causing one of the batteries to explode, which emitted shards of material, resulting in injuries to the electricians face.
The ensuing investigation into the incident highlighted that the jump leads were both the same colour, and that the electrician probably did not check this before connecting up the battery, rather that the electrician had made an assumption that was proved later to be incorrect.
[explosion, operation inadequate, injury]

**Lessons**

[None Reported]

**7584 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 108, 28.

**Location :** ,

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

**Abstract**

Explosion of a lead/acid traction battery. A platform truck was disconnected from the wall mounted charging unit, driven approximately 20 metres and then positioned under a stillage to be lifted. Before lifting commenced an explosion was heard from within the platform truck and smoke seen emerging from the side casing. The operator unclipped the fire extinguisher and opened the battery cover, the smoke had dispersed and the battery was seen to have exploded. The operator did not suffer any injuries.
The explosion was due to the ignition of an accumulation of hydrogen gas evolved by the electrochemical processes of the battery.
Failure of the charger unit's timer system caused severe over-charging of the battery.
Over-charging of the battery substantially increased the production of hydrogen gas within the cells.
Failure to adhere to local procedures meant that the battery charger was not manually disconnected when the timer failed.
[road transportation]

**Lessons**

The following recommendations were made:
The charging unit should be replaced by a type utilising automatic battery voltage sensing in order to prevent any possibility of overcharging and the section procedures amended to reflect this change of equipment.
Any other plant/section operating a timer controlled type of charging unit should he notified to take account of the above modification.

**10582Date Unknown**

**Source :** THE ROSPA BULLETIN, JUL 1987.
**Location :** , UK

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

**Abstract**

An electrical engineer was killed during tests on supply fuses at a power station.
The multimeter prods used for the checks were not fitted with fuses and shortly after the engineer started his job there was a sudden explosion, which quickly engulfed him.
He died later with 60 per cent burns.
Investigation into the incident it was found that a wrong switch had been turned on in the fuse cabinet and multimeter.
[fatality, testing, operation inadequate]

**Lessons**

[None Reported]

**7583 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 108, 28.

**Location :** ,

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

**Abstract**

Explosion of a lead/acid starter battery. A forklift truck was undergoing routine maintenance in the mobile plant workshop. The truck's engine was run for some 45 minutes to facilitate changing the engine oil and then switched off. After a 10 minute delay the mechanic began to remove the starter battery vent caps. The battery exploded without warning causing extensive damage to its plastic case. Protective clothing prevented any serious injury to the mechanic who sustained only a minor cut to the left middle finger.
The explosion was caused by the ignition of hydrogen gas evolved by the normal electrochemical processes of the battery.
No tools were present and no connections or disconnections of the terminals were being made. Static discharge or internal fault is the most probable cause.
The mechanic avoided serious in jury because he was wearing the recommended clothing with the exception of gloves.
Local procedures exist for working on batteries and they were being adhered to.
[damage to equipment, injury]

**Lessons**

Liquid electrolyte non-scaled vehicle batteries should he allowed to stand for 15 minutes before any work commences on the vehicle's electrical system.
The likelihood of a hydrogen explosion within lead acid batteries is much reduced by the use of sealed gel electrolyte batteries. The use of such batteries for vehicle starting should be considered for future and current applications. They are not suitable for use in electric traction vehicles.

**7541 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 092, 22.

**Location :** ,

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

**Abstract**

A plant operator was inspecting a drier which had been damaged by fire about an hour previously. To gain access he put one foot on the lower rail of the handrail and grabbed the top of a vertical, inoperative fluorescent light fitting with his left hand to pull himself up. He received an electric shock which threw him backwards off the handrail. Fortunately, he landed on his feet.

Because it was so dark and raining heavily at the time of the incident, the man had viewed the light fitting which had been damaged in the fire, as a stanchion. The top end cap of the fitting was damaged and exposed a live wire. It was thought that the damage was recent but the light had been out of service for some time and the fault had not been reported.

An investigation of all light fittings revealed that a further 24 fittings were in a potentially dangerous condition.

There were a number of actions which would improve the inspection, reporting, maintenance and auditing of lighting systems but it was recognised that the root cause of the accident was the action of the operator climbing onto the handrail.

[operator error, maintenance]

**Lessons**

[None Reported]

**7456 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 102, 25.

**Location :** ,

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

**Abstract**

The lights went out on a jetty and warehouse area. An electrician was called to resolve the reason and correct it. A permit was issued for the job. Two electricians went to identify the problem. The first isolated the cubicle and opened the door. They then re-energize the board to test the circuits. The second asked if voltage probes were required but the first one opted to use the multimeter he had with him. Unfortunately the probes were in the Amp/Resistor sockets and applied them across a phase supply to earth. This caused a flash and a probe vaporised on breakaway. The metal vapour condensed across the phases causing a blinding flash and explosion as it shorted out all three phases. The electrician suffered severe burns on the hands and to a lesser extent on the face.
[repair]

**Lessons**

[None Reported]

**6971 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 016, 5.
**Location :** ,

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

**Abstract**

A caustic leak from a drain valve left open unintentionally caused corrosion in an electrical line tracing heater. An arc occurred causing the circuit breaker to trip. This was a near miss because the arc was a potential source of ignition in an area that handled flammable materials.
To prevent a recurrence, a hose was connected to the drain point.
[caustic soda]

**Lessons**

Drain points and sample points should generally be located at ground floor level in caustic and acid handling systems to reduce corrosion hazard to the plant and to reduce the hazard to personnel from splashing and drips. A hazard in the above case.

**10960Date Unknown**

**Source :** ICHEME

**Location :** ,

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

**Abstract**

While supervising the recovery of silver from scrap metal batteries the operator added a mixture of nitric acid and waster as part of his work. He had not been warned that the batteries contained iron sulphide. A chemical reaction occurred which led to clouds of toxic hydrogen sulphide.
Inhalation of the fumes left the operator permanently paralysed, without speech, impaired vision and without hearing.
[unwanted chemical reaction, battery, gas / vapour release, poisoning]

**Lessons**

[None Reported]

**7452 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 102, 21.
**Location :** ,

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

**Abstract**

The original batteries for an emergency radio set were no longer being manufactured.
A substitute battery pack was provided by another supplier and the pack consisted of a cardboard box containing twenty seven 1.5 volt batteries with an output of 13.5volts.
When the battery packs were received and unpacked one was found to be smouldering and almost on fire.
The likely cause was overheating of wiring, connecting some of the batteries. This overheating was caused by excessive current resulting from a short circuit between the positive and negative connections behind the output socket.
The pack provided was constructed to a poor standard, there was no insulation between cells and the standard of soldering was poor.

**Lessons**

[None Reported]

**7451 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 102, 21.

**Location :** ,

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

**Abstract**

The batteries of a flameproof pocket torch were changed from the original batteries to those of a different manufacturer. After some time in the "on" position the torch was so hot that smoke was seen to be coming from it.

It appears that the new batteries have too small an isolation lid (0.5 mm) and the earth string connected the two poles causing a short circuit.

**Lessons**

Check your batteries so that they are fully compatible before changing them.

**7876 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 110, 3-4.

**Location :** ,

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


**Abstract**

The electrical supplies to a plant came via three separate infeeds at 33 kV. It was routine during severe weather warnings to run all on-site gas turbine generation to feed the essential services. At the time of the incident there was a storm warning and the electrical system was operating in this mode. The incident was:

1. An 11 kV reactor, used to limit the electrical energy flowing into part of the system, suffered a cable termination failure.
2. There was a simultaneous loss of all 110 V D.C. supplies which controlled the main 11 kV high voltage switchgear. No circuit breakers could operate to isolate the faulty system. All incoming supplies were lost because the fault was detected by the electricity supply company equipment which then operated, isolating the plant.

The subsequent investigations revealed that:

1. The cable termination failure was due to condensation in an unventilated enclosure.
2. The D.C. supply failure was associated with the cable termination failure. The 110 V D.C. system was connected to equipment on the faulted reactor.
3. These D.C. supplies were derived from a single 11 kV circuit breaker on the main 11 kV switchboard which consisted of 19 circuit breakers.
4. The 11 kV reactor circuit breaker failed to operate to clear the fault because of the D.C. supply failure.
5. The control room staff were inundated with alarm data as there were no arrangements to prioritise the alarms.

Remedial action was taken to provide independent 110 V D.C. control supplies to each section of the main switchboard and a totally separate D.C. supply was provided for the 33/11 kV transformer circuit breakers.

[electrical equipment failure, power supply failure]


**Lessons**

The following recommendations were made:

1. Duplicate infeeds from whatever source are NOT inviolate. Common cause failure is a frequently occurring phenomenon.
2. Batteries and their associated chargers used to start up generators or control switchgear are VITAL items of plant. All too often they become the most important item on site but are frequently the subject of neglect, abuse and poor design.
3. When standby or other generators are routinely tested for operation it is imperative that the whole system is tried and tested by loading the generator via its own control system.
4. Plant and equipment identification must be clear and unambiguous. Arrangements to be in place to ensure that plant modification and additions do not compromise the identification.
5. There must be pre-prepared systems and schedules to enable staff to operate and so recover from major and catastrophic electrical power failures.
6. Where there are segregated electrical power supplies the effects of failures and their possible "knock-on" effects to be carefully investigated.
7. Maintenance activity needs to be carefully programmed with active and thorough monitoring of the work that is carried out.
8. Adequate communication facilities are necessary to permit proper action in times of emergency. There needs to be control over non-essential use where there are no segregated emergency facilities.
9. There is always a need to provide priority schemes for alarms to ensure that the operators are presented with the appropriate information. Modern alarm systems provide information at incredible speed and can readily overwhelm operators.

Many investigations reveal other matters are often overlooked or ignored include:

1. The provision of adequate storage capacity for air supplies for instrumentation and control purposes in the event of total electrical power failure.
2. The provision and maintenance of proper coolant for the prime movers for standby generators.
3. The provision of adequately fault rated switchboards.
4. The provision and maintenance of electrical protection including fuses on standby systems.
5. Quality control of the installation of all standby facilities e.g. cables connecting Un-interruptible Power Supplies being damaged during laying, failing when in service and leading to total destruction of that system.
6. The need to segregate all essential electrical supplies and to provide protected routes for those supplies to ensure safe control of the plant in emergencies e.g. DO NOT route cable feeding fire pumps and deluge systems through the main highly flammable process area.
7. The possible effects of the use of mobile radios and telecommunications equipment upon Programmable Electronic Systems used for control purposes.

**7325 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 054, 22.

**Location :** ,

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

**Abstract**

Approximately 19 litres of transformer fluid containing 90% polychlorinated biphenyls spilled at a pulp plant when a transformer was being replaced.

**Lessons**

[None Reported]

**7291 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 079, 23-24.
**Location :** ,

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

**Abstract**

Truck loading was in progress on a refinery. Fire trucks were already loaded and a sixth about to be filled with gas oil when an explosion occurred. Fires broke out inside the distribution centre and outside the starter switchroom. Heavy rain and storms had occurred and the refinery suffered a total power supply failure.
After investigation it was revealed that the switchroom fed electricity from the distribution centre via two ducts, with further ducts linking the switchroom to the product pump raft. Both buildings were located in safe areas, hence all the electrical equipment was non-flameproof. The delivery line to the road loading rack ran underground. Pressure tests of the underground section of pipework revealed a leak in one of the spirit lines. This leak combined with the loading activity and general flooding meant that product rather than water, was ferried back to the cable ducts. The ducts fell from the switchroom to the distribution centre and allowed the product to migrate and enter unplugged cable entries. The distribution centre building was small and product vapour accumulated. The vapours were ignited possibly by the electrical power factor connection equipment. A flame front accelerated along the unplugged cable ducts to the switchroom detonating in an unsealed manhole outside.
[fire - consequence, storm damage]

**Lessons**

The following recommendations were made:
1. All cable ducts and manholes to be sealed and checked.
2. Duct running from the switchroom to the pump raft to be inspected.
3. Any seals which have been washed away to be replaced.
4. Ducts should ideally, run down uniformly to towards switchrooms.

**7173 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 047, 27-28.

**Location :** ,

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


**Abstract**

Early one morning a fire occurred in the electrical substation of a large chemical works. This resulted in loss of power to most of the manufacturing units and gave rise to many problems over the site. Eleven hours later during the afternoon of the same day there was an explosion in a vessel, in which a reaction involving an aromatic nitro compound was being carried out. A secondary explosion and subsequent fires were the result of a release of flammable vapours from the reactor. There were fortunately no serious injuries. Property and consequential losses were very high.

The reaction being carried out involved conversion of one aromatic nitro compound to a more complex one. The reactions involved were not in themselves highly exothermic but it had been recognised that an excessive temperature at any point in the reactor might result in a runaway decomposition of a nitro compound.

As a result of previous incidents over a number of years, provision had been made to cool the batch directly by adding water into the reactor. This involved connecting the reactor to the fire main using quick connection coupling and admitting water at a specified controlled rate. Prior incidents had shown that there was time to react to a potential runaway and that water quenching was effective. When the power failed, all utilities and instruments were lost with the exception of a few self powered instruments. The reaction was at an early stage when it was not thought to be potentially dangerous. The batch was cooled somewhat and stirred by the addition of an inert gas below the surface, but due to lack of steam (steam is used to vaporise inert gas from the liquid inert gas storage) this could not be continued. At this point the self powered temperature indicator on the reactor indicated a drop in temperature to what was considered a safe level. The significance of such a measurement in a non-agitated system is of course very arguable and with hindsight it was recognisable any such temperature was not representative and in error. However, sometime later the temperature began to rise again and there were other disturbing signs of continuing reaction. At this point it was decided to apply the quench water. Unfortunately the operator was not experienced in the procedure and it was necessary to bring in an experienced operator who was off duty at the time. By the time this operator had arrived, the situation was clearly serious and the building was evacuated, before he could make the connections and apply the water. The bursting disc failed first and shortly after this the reactor blew up. A secondary fire and explosion then took place and the original and secondary explosions did considerable damage to the building and facilities in the area.

[fire - consequence, power supply failure]


**Lessons**

The following conclusions may be drawn from this accident:

1. Emergency procedures for dealing with a hazardous situation are ineffective unless all the operators are thoroughly trained in their use and the effectiveness of the system is checked on a frequent and regular basis. As a result of this incident a new procedure has been devised in which quenching is applied as soon as any upset occurs on a fail safe basis. Training and frequent test by actual use in drills is also prescribed.
2. When evaluating the effectiveness of auxiliary power supplies the possibility of common mode failure must be taken into account.
3. The reactor exploded although it had been provided with a fairly large and complex vent system. There is still an incomplete understanding of the design of safe vent systems and this is why many companies in Europe and the United sates are subscribing to a collaborative research programme (DIERS) to develop improved methods.
4. The area of the reactor was partly enclosed and the damage due to the secondary explosion would have been less in a more open structure.

**7145 Date Unknown**

**Source :** LOSS PREVENTION BULLETIN, 030, 7.

**Location :** ,

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

**Abstract**

Fire and explosion in generating station. Flaming oil from a violent outdoor transformer explosion ignited combustible control and instrumentation cables located in an outdoor, vertical cable tray. Fire spread to the top of the 8 m (25 ft) high, open ladder cable tray, entered the metal clad building and continued to propagate horizontally along 450 mm and 600 mm (18 inch and 24 inch) wide, open ladder trays filled with ethylene-propylene-rubber insulated, neoprene jacket cables.

Lack of fire protection, inadequate fire stops, and inaccessibility contributed to the spread of fire and the extent of fire and corrosion damage.

[fire - consequence, design inadequate, damage to equipment]

**Lessons**

[None Reported]