1288927 July 1999

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A relief valve on a HF alkylation unit acid settler failed to operate under overpressure during an emergency shutdown of all process units following a power failure.
A subsequent release of hazardous materials occurred.
[valve failure, overpressurisation, gas / vapour release, damage to equipment, power supply failure, processing, chemicals unknown]

Lessons

[None Reported]

1209905 July 1999

Source : CHEMICAL HAZARDS IN INDUSTRY, DECEMBER 1999,; OCCUP. HAZARDS, OCT 1999, 61(10), 22,24.
Location : , USA

Injured : 24 **Dead :** 0

Abstract

An explosion occurred at an aluminia refinery injuring 24 workers, who mostly suffered with burns. The cause of the explosion is thought to have been due to a power supply interruption. The flow pumps stopped operating due to the power interruption, pressure built up in the last sealed vessel in the digestion area where caustic alumina cools down from the process temperature of 300 degrees C.
[electrical equipment failure, power supply failure, refining, injury]

Lessons

The company is to review its safety procedures.

1231205 July 1999

Source : CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD, 16 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 : Gramercy, Los Angeles, USA

Injured : 29+ **Dead :** 0

Abstract

Three explosions occurred at a chemical plant, which caused a natural gas leak and blew out a cloud of sodium hydroxide and bauxite ore, a caustic chemical from which aluminium is obtained, into the air.
The explosion occurred in a part of the plant where electricity is generated and where the bauxite ore and liquid sodium hydroxide are mixed.
Twenty-one workers were injured in the blast, two critically. Injuries ranged from severe burns, breathing difficulties and eye irritation. Nearby residents were also treated for nausea and respiratory problems.
An investigation into the incident found that the cause was due to power failure at the plant. The power to a vat holding chemicals failed. The material was supposed to move from the vat to another part of the plant, but the pressure built up after pumps failed, causing the explosion that destroyed approximately 25 percent of the plant.
The company was fined $533,000 (2000).
[gas / vapour release, power supply failure, processing, injury]

Lessons

[None Reported]

1180021 June 1999

Source : HAZARDOUS CARGO BULLETIN, SEPTEMBER 1999.
Location : Pennsylvania, USA

Injured : 0 **Dead :** 0

Abstract

A fire occurred in a sulphur extraction unit at a refinery after power failure. A plume of smoke was released.
[fire - consequence, power supply failure, gas / vapour release, refining, separation equipment]

Lessons

[None Reported]

1136503 July 1997

Source : LOSS CONTROL NEWSLETTER, 1997.

Location : , USA

Injured : 0 **Dead :** 0

Abstract

Power failure due to lightning caused a plant to shut down for approximately one hour. Safety valves, which opened automatically when the plant shut down, released large plumes of gas over the plant. These were not toxic.

[power supply failure, plant shutdown, gas / vapour release, safety relief valve, operational activities]

Lessons

[None Reported]

1108907 November 1996

Source : ICHEME
Location : , FRANCE

Injured : 0 **Dead :** 0

Abstract

An off-site crude unit charge pump operating in parallel with another, caught fire from the mechanical seal about one and a half hours after a common alarm had sounded. The initially small fire spread to the adjacent pumps and the crude unit was shut down for 24 hours until one of the pump's electrical wiring and instrumentation could be repaired. The cause of the vibration leading to the seal failure is either motor bearing failure or coupling failure due to loss of alignment, and there was evidence of cavitation an hour before the initial vibration alarm.
On this refinery the Crude Distillation Unit control room is fed from three identical crude oil feed pumps (A), (B), (S) located off-site in the crude tank farm area about 1 km from the unit. In normal operations two pumps are running in parallel with one spare. Each pump is fitted with a common alarm for six bearing temperatures (two on the electric motor, four on the pump itself) and a vibration detector. At the time of the incident (A) and (S) were running. Analysis of flow recordings and tank levels shows a reducing flow rate as tank level (1) fell. This was a usual event and the new tank (2) was placed in service at 05:50 hrs., about an hour before the first common alarm. Vibration analyser charts show evidence of cavitation in (S) at 05:50 hrs. and this disappeared after the tank change. The common alarm sounded in the control room at 06:48 hrs. Because no vehicle was available and because the alarms were considered unreliable, it was left to the day operator to check the alarm on his rounds, about one and a half hours later. By this time the pump operation had deteriorated seriously, crude was leaking and the fire developed. It was promptly extinguished by the fire crew but the crude unit was shut down until the electrical wiring for one of the other pumps was restored allowing start-up.
Two potential immediate causes have been identified. These are:
1. Rupture of the coupling membranes.
2. Failure of the bearing on the coupling side of the motor due to lack of oil or mechanical misalignment.
[fire - consequence, mechanical equipment failure, excessive vibration, design or procedure error, fire - consequence, refining, pump bearing, plant shutdown, lubrication failure]

Lessons

The following recommendations were made:
1. Operators must respond to alarms, no matter if they may be nuisance alarms.
2. Equipment does have a limited performance capacity, and operating at extremes places operations at risk.
3. Monitoring devices must be maintained in proper working order, especially those for remote operating areas where operator surveillance is less frequent.
4. Mechanical integrity must be maintained by use of the correct part of the equipment, as designed by the equipment supplier.

1760 20 October 1995

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 3RD QUARTER, 1995.
Location : Meraux, Louisiana, USA

Injured : 1 **Dead :** 0

Abstract

A fire occurred at the start-up of the refinery after a power supply failure.
[fire - consequence, refining]

Lessons

[None Reported]

8167 02 August 1995

Source : SEDGWICK LOSS CONTROL NEWSLETTER, ISSUE 3, 1995.
Location : Kurnell, Botany Bay, AUSTRALIA

Injured : 0 **Dead :** 0

Abstract

Following a power supply failure at the 110,000 barrel per day refinery, two out of four power plant boilers were shut down automatically in trying to cope with the overload. This resulted in black smoke coming from the boilers. Fire damaged the crude distillation unit and led to the shut down of the Fluid Catalytic Cracker Unit (FCCU). During the FCCU shut down, it too was damaged. Normal running was expected within seven days.
[fire - consequence, refining, damage to equipment, plant shutdown]

Lessons

[None Reported]

3368 23 June 1995

Source : LLOYDS LIST, 1995, JUL, 1.
Location : Los Angeles, USA

Injured : 0   **Dead :** 0

Abstract

An explosion and fire occurred in a crude feeder causing power outage at a 68,000 barrel a day refinery.
[fire - consequence, power supply failure, refining]

Lessons

[None Reported]

1786 02 June 1995

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 3RD QUARTER, 1995.
Location : Wilmington, California, USA

Injured : 0 **Dead :** 0

Abstract

Explosions ignited fires in a crude unit shortly after start-up. Power was being restored following a total electric power failure.
[fire - consequence, power supply failure]

Lessons

[None Reported]

2997 13 May 1995

Source : LLOYDS LIST, 1995, JUN,; KNIGHT-RIDDER FINANCIAL NEWS
Location : Los Angeles, California, USA

Injured : 0 **Dead :** 0

Abstract

Explosion in coker plant at refinery during start-up after power outage caused shut down of all units.
[power supply failure, refining]

Lessons

[None Reported]

7587 27 November 1994

Source : LOSS PREVENTION BULLETIN, 126, 3-6.
Location : ,

Injured : 13 **Dead :** 0

Abstract

A breakdown of operations occurred on plant which was caused by the bursting of an acrylic acid tank. This resulted in a large-scale fire fuelled by the escaping acrylic acid/polyacrylic acid. The polyvinyl alcohol storage facility nearby also caught fire
The following combination of events lead to the accident:
1. A power supply failure.
2. External temperature of around 5 degrees C, with a north wind.
3. The open-topped building.
4. Crystallising out by the acrylic acid in both pipeline circuits.
5. Warming-up and polymerisation caused by the pump working against a blocked delivery route.
6. Thawing of the crystallised acrylic acid in the bypass pipeline.
7. Transfer of polymers into the acrylic acid storage tank.
8. Slow warming of the tank's contents by around 0.5 degrees C/hr due to the pump passing against a throttled valve,
9. Ineffectiveness of the temperature monitoring system, since the large circulation pipeline remained blocked all the time.
[cold weather, rupture, fire - consequence, polymerisation, chemical missing, instrumentation failure, temperature meter/control]

Lessons

The following safety procedures were introduced to avoid the reoccurrence of a similar incident:
1. A continuous independent temperature measurement of the tank contents will be provided.
2. The circulation pump will be equipped with a temperature control safety switch.
3. Safeguards put in place to ensure that temperatures in acrylic acid storage facilities and in rooms containing acrylic acid pipelines do not fall below a certain level. This will avoid crystallisation of the acrylic acid in the event of a power failure.
4. Analytical surveillance will ensure that the inhibitor concentration within the acrylic acid does not fall below 200 ppm.
5. A measuring device will be installed to monitor the throughput of the major pipework.
6. An emergency reaction inhibition system will be installed.

6779 27 November 1994

Source : LOSS PREVENTION BULLETIN, 126, 03; EUROPEAN CHEMICAL NEWS, 1994, 5 DEC.; THE CHEMICAL ENGINEER, 1994, 15 DEC.
Location : Burghausen; Bavaria, GERMANY

Injured : 13 **Dead :** 1

Abstract

Incident at a polyvinyl acetate plant. A faulty power switch cut off the electricity supply to a circulating pump in an acrylic acid tank. The temperature of the acid in the pipes then fell from the safe range of 15 - 25 degrees C to 12 degrees C when it crystalised. The crystalised acid material polymerised uncontrollably destroying the storage unit, a manufacturing unit and a warehouse. Fatality.
[polymerisation, power supply failure, processing]

Lessons

1. The temperature of the tank to be monitored.
2. The circulation pump to be equipped with a temperature control safety switch.
3. Safeguards to ensure that the temperature of the storage tank and building do not fall below the crystallisation temperature.
4. Analytical surveillance to ensure inhibitor level does not fall below 200 ppm.
5. Measurement of large cycle throughput
6. A stopper system installed.
7. Pressure release system for storage tanks.

8544 14 November 1994

Source : SEDGWICK LOSS CONTROL NEWSLETTER, ISSUE 1, 1995.
Location : Plock, POLAND

Injured : 0 **Dead :** 0

Abstract

Explosion and fire in 50 m high vessel at a 300,000 tpy naphtha cracker. Plastics production restricted. False readings on controls suspected after weekend power cut.
[fire - consequence, power supply failure, cracking]

Lessons

[None Reported]

6672 19 August 1994

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 3RD QUARTER, 1994.
Location : Deer Park, USA

Injured : 4 **Dead :** 0

Abstract

Power supply failure caused the release of 2 tonnes of vinyl chloride monomer (VCM) and 35 kg of chlorine. Vapours dispersed within the fence lines.
[gas / vapour release, processing]

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.

6605 26 June 1994

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 4TH QUARTER, 1994.
Location : El Palito, VENEZUELA

Injured : 0 **Dead :** 0

Abstract

Explosion on a catalytic cracker following the failure of a hydraulic supply to a control valve, regenerator/reactor equilibrium was lost and oil impregnated catalyst entered the regenerator.
[hydraulic failure, catalyst regenerator, cracking]

Lessons

[None Reported]

8344 May 1994

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Total refinery power supply failure. All external electrical power supply was cut from the duplicate feeders to the refinery, resulting in an of all process units. It was found that there had been unauthorised switching of electric power. It is not clear why the unauthorised switching of electric power was allowed to take. Had there been adequate leadership/supervision, this event would not have occurred. An independent air supply would have enabled steam generation until emergency power was available.
[safety procedures inadequate, refining]

Lessons

Sites need to be aware that, even with two separate electrical feeders, power can still be lost from circumstances beyond their control.
Alternative instrument air supplies back up for essential users should be available.

11530 23 March 1994

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

An electrical fault in a substation resulted in a complete power failure to the plant, and some collateral damage to a starter column as a result of arcing. The resultant power loss also affected an adjacent research department, causing the shut down of two pilot plants. All affected plants failed to a safe condition following loss of power.
Investigation of the incident found that there had been ingress of rainwater into the electrical equipment in the starter column 1. leading to arcing between the busbar droppers, which then developed a three phase to earth fault. The ingress of water was due to a defective substation roof (reported to have been caused 'by normal wear and tear').
[electrical equipment failure, power supply failure, plant shutdown, electrical]

Lessons

[None Reported]

6064 04 May 1993

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 2ND QUARTER, 1993.
Location : Mathura, INDIA

Injured : 0 **Dead :** 0

Abstract

Fire caused total power failure. Equipment involved turbogenerator.
[fire - consequence, power supply failure]

Lessons

[None Reported]

1087918 April 1993

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

High pressure steam at 600 psig is generated in two supplementary fired CO boilers at the refinery.
Combustion air to each boiler is supplied by individual (non-spared) forced draft fans.
After a period of observation, starting with noisy running, the outboard bearing of the forced draught fan of one of the boilers became sufficiently hot to enforce a controlled steam load shedding and shutdown of the boiler. It was subsequently found that a build up of sludge de-posits in the bearing housing of the fan had prevented adequate lubrication to the outboard bearing, causing the bearing to fail.
Total losses from the forced shutdown were $161,000 - $95,000 (1993) in unit throughput adjustments, $56,000 (1993) benzene to gasoline adjustments, and $10,000 (1993) repair costs to the fan bearings. One air violation was incurred as the result of having to vent CO.
Although there were no injuries sustained and no fire damage, it is considered that there was a significant potential for fire and equipment damage.
[lubrication failure, bearing failure, plant shutdown]

Lessons

The report stated the following recommendations:
1. It is essential that high integrity and well maintained lubrication systems are used for equipment, which can be proved in service to be effective, and flushed out as necessary.
2. Quantities of lubricant used to be monitored to detect changes up or down, either of which can indicate potential problems. Qualities of lubricants supplied should be the subject of routine proof testing.
3. For some equipment - e,g., such as large electric motors with a constant volume lubricant system - at major overhauls labyrinths/oilways to be inspected/cleaned.
4. Other monitoring systems, such as bearing temperatures and vibration, routine checks on oil quality of samples taken from the lubrication system, is necessary especially if it is critical equipment without a standby.

5988 17 March 1993

Source : HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1993, MAY.; LLOYDS LIST, 1993, 19 MAR.

Location : Ulhasnagar; Bombay, INDIA

Injured : 123 **Dead :** 9

Abstract

After a power supply failure, 11% sulphuric acid leaked from pipe and produced hydrogen sulphide in fabric factory. Fatality.
[spill, processing]

Lessons

[None Reported]

5802 October 1992

Source : CHEMICAL WEEK, 1993, 3 MAR.
Location : Corpus Christi; Texas, USA

Injured : 0   **Dead :** 0

Abstract

Electrical failure caused disruption of plant and venting to flare stack of butadiene which vented unburnt emissions for about an hour. The emissions affected people 5 miles away.
[gas / vapour release, power supply failure]

Lessons

[None Reported]

5723 23 July 1992

Source : ASSOCIATED PRESS; HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1992, OCT.
Location : Orem; Utah, USA

Injured : 0 **Dead :** 0

Abstract

Power supply failure while adding materials, trimethyl phosphite and methyl chloroacetate, to a vat stopped a mixer and the mixture overheated causing a release of vapours.
[overheating, agitation failure, gas / vapour release, mixing]

Lessons

[None Reported]

5529 1992

Source : LOSS PREVENTION BULLETIN, 120, 3-4.
Location : ,

Injured : 0 **Dead :** 0

Abstract

In an organic chemical plant, a hydroextractive distillation column produced hot water at the bottom of the column. This hot water was used to wash out a fertiliser plant where hot work, welding, was taking place. A factory steam and power failure caused organic material to exit from the column base and to be released from the drains of the fertiliser plant where it was ignited by the welding operation.
[steam failure, power supply failure, fire - consequence, chemical - organic]

Lessons

[None Reported]

5474 15 November 1991

Source : HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1992, FEB.
Location : Botlek; Rotterdam, NETHERLANDS

Injured : 31 **Dead :** 0

Abstract

Power cut and backup generator failure caused chlorine to leak for 10 minutes from plant.
[power supply failure, gas / vapour release]

Lessons

[None Reported]

5177 23 November 1990

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 1ST QUARTER, 1991.
Location : Wilton; Teeside, UK

Injured : 0 **Dead :** 0

Abstract

During maintenance work on 1 of 4 feeders alternators, a power trip occurred. All steam supply was lost resulting in tubes being damaged in the furnaces of the olefins plant. Subsequent damage to offsite lines occurred as a result of pipe supports fracture caused by a surge effect of condensing vapours.
[power supply failure, maintenance, damage to equipment, steam failure, furnace tube]

Lessons

[None Reported]

1013208 August 1989

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

Early on the 8th of August one of three power boilers was taken out of service to repair a safety valve that had failed in the open position. The resultant steam escape caused significant noise. A second boiler was shutdown on the same day following failure of the power supply to the boiler instrumentation. All plants were taken offline. The lack of steam caused smoke problems from flaring. 55 telephone complaints were received during the evening and night.
Local media interest was high and a local Government representative insisted on a private meeting with the site management. On arrival with a camera crew the management requested a private meeting with the representative. Subsequent television coverage hinted at a cover-up. The plant was restarted 5 days after shutdown.
[shutdown, vent, flare system, power plant, plant shutdown, gas / vapour release, noise, power supply failure, valve failure]

Lessons

A 24 hour rota was set up to receive telephoned complaints, which were dealt with in a courteous manner and an apology and explanation give.
Proper and early contact was made with the relevant authorities.
The company placed an advert in the local paper explaining the situation and apologising to the local community.

4673 07 August 1989

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Power supply failure caused a fire at this refinery aromatics plant.
[fire - consequence, refining]

Lessons

[None Reported]

1254225 July 1989

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A fire occurred on an ethylene plant. An investigation into the cause of the fire found that an incorrectly set lubricator was to blame which resulted in a lubrication failure the reflux pump.
No one was injured in the incident.
The total cost off damages is thought to be around £1,554,420 (1989).
[fire - consequence, design or procedure error, damage to equipment, lubrication failure]

Lessons

The report stated the following conclusions:
1. The fire started at the reflux pump as a result of a rapid thrust bearing failure, which allowed the seal to relax. The hot bearing housing most probably ignited the escaping gasoline stream.
2. The thrust bearing failed as the result of a lack of lubrication following the incorrect setting-up of the lubricator.

4633 06 July 1989

Source : LLOYDS LIST, 1989, 8 JUL.; HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1989, AUG.
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A fire in a fuel line at the site power station caused damage to an instrument cable which lead to total shutdown of the site. Lack of steam meant flaring was very smoky. Local residents complained.
Recommissioning of the cracker and downsteam plant took two weeks. Flaring (a necessary safety control during start-up and shutdown) was needed. The associated use of steam (to reduce the smoky appearance of the emissions) was also noisy.
[fire - consequence, damage to equipment, plant shutdown, flare system, cracking equipment, power plant, gas / vapour release, power supply failure]

Lessons

A 24 hour rota was set up to receive telephoned complaints, which were dealt with in a courteous manner and an apology and explanation give.
The company placed an advert in the local paper explaining the situation and apologising to the local community.

2310 1989

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

Location : ,

Injured : 0 **Dead :** 0

Abstract

Due to a short circuit in one of the switch cupboards (25 kV), a fire occurred involving 3/4 of the plant's electric station and 10 switch cupboards. This resulted in the automatic shutdown of the chlorine production plant (except of the chlorine destruction unit) and the hexachloro benzene (HCB) production due to lack of adequate cooling capacity. The chlorine production facility remained 10 days off stream while the HCB production was resumed with imported chlorine. Gradual carbon formation in the mineral oil is suspected to be the cause of the short circuit.
[electrical, power supply failure, design inadequate]

Lessons

1. Installation of an inert gas-filled switch-cupboard instead of the oil-filled type.
2. Installation of the new switch cupboard in separate compartments using a fire-resistant partition.

3964 15 August 1987

Source : LOSS PREVENTION BULLETIN, 099, 20; CHEMICAL WEEK, 1987, AUG.; LLOYDS LIST, 1987, 17 AUG.
Location : Ras Tanura; Juamyah, SAUDI ARABIA

Injured : 0   **Dead :** 0

Abstract

A series of power interruptions caused shutdowns of one or both gas fractionating plants. 1900 bbls were released from plant 1 over a half-hour period. The large vapour cloud was probably ignited by a security vehicle which had stalled and was being restarted. The probable source of the propane was a flange in a 4 inch relief valve line.
[vapour cloud explosion, power supply failure, processing]

Lessons

[None Reported]

2732 14 April 1987

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A partly modified control system shorted out and cut the electrical power supply to a whole series of control systems. The plant shut-down automatically.
[instrumentation failure, power supply failure, plant shutdown]

Lessons

The management system for liaison between project and operational staff needed to be improved.

3860 06 February 1987

Source : NEW ZEALAND HERALD, 1987, 12 FEB.
Location : Marsden Point, NEW ZEALAND

Injured : 0 **Dead :** 0

Abstract

A fire occurred in the bitumen plant of an oil refinery as a result of a power supply failure.
[fire - consequence, refining]

Lessons

[None Reported]

3227 11 February 1985

Source : INSTITUTE OF INSURERS
Location : Scotford; Alberta, CANADA

Injured : 0 **Dead :** 0

Abstract

A power failure and extensive freezing occurred while attempting to restart one of two hydrocrackers. A fire occurred in the hydrocracker unit causing extensive physical damage to the whole unit.
[fire - consequence, power supply failure, start-up, cold weather, damage to equipment, cracking]

Lessons

[None Reported]

3097 02 September 1984

Source : INSTITUTE OF INSURERS
Location : Sriracha, THAILAND

Injured : 0 **Dead :** 0

Abstract

A series of explosions occurred following a power failure causing damage to stabilizer and high vacuum furnace.
[power supply failure, damage to equipment]

Lessons

[None Reported]

2914 10 February 1984

Source : INSTITUTE OF INSURERS
Location : , SOUTH AFRICA

Injured : 0 **Dead :** 0

Abstract

Instrument air failure caused shock to 2 tubes in the oven.
[mechanical equipment failure, air system failure]

Lessons

[None Reported]

8033 09 December 1983

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A failure of a 200 volts power system resulted in a loss of instrument air and the primary column naphtha pumps.
Approximately 50 minutes after the initial power failure a fire occurred over an area of about 500 sq. ft. around the ground flare knock-out drum. The fire was fought with foam and was extinguished within one hour. Damage was caused to control equipment, a motor and cables. There were no injuries to personnel.
[power supply failure, air system failure, fire - consequence, damage to equipment]

Lessons

[None Reported]

4085 05 December 1983

Source : ICHEME
Location : , UK

Injured : 0   **Dead :** 0

Abstract

While attempts were being made to start-up a compressor, an electrical short circuit occurred across the copper risers to the busbar-mounted transformer fitted to the compressor. Power supply failure followed and, also, a small electrical fire. Electrical protection relays operated correctly, isolating the supply to the relevant sub-station and shutting down a significant amount of plant equipment.
[fire - consequence, power supply failure]

Lessons

There was a manufacturing circuit breaker, which gave rise to abnormally high voltage in the system. Repeated attempts to start the compressor resulted in failure of insulation. The main technical recommendation was to incorporate a timer in the compressor start circuit so that the "start pulse" is applied for a fixed time thus preventing the circuit breaker from leading to insulation damage.
There was also evidence of similar compressor start-up problems for several months prior to the incident. Thus, compressor start-up instructions to be reviewed.

5008 24 November 1983

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

A refinery experienced a total failure of the external electrical power supply. This initiated a series of events which resulted in total loss of refinery steam generation and processing capability including Fluid Catalytic Cracker Unit (FCCU) emergency shutdown. An explosion occurred in the CO burner combustion chamber during the FCCU shutdown, but no injuries were reported as a result.
The cost of the total refinery shutdown is estimated to be about £800,000 of which £600,000 (1983) is attributable to FCCU/alkylation plant shutdown and subsequent operation at reduced throughput.
[refining, power supply failure, plant shutdown]

Lessons

[None Reported]

2801 10 November 1983

Source : INSTITUTE OF INSURERS
Location : Haifa, ISRAEL

Injured : 0 **Dead :** 0

Abstract

Explosion in vacuum column of crude oil unit following start-up after power supply failure.

Lessons

[None Reported]

5258 20 April 1983

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

An explosion was reported in the vicinity of the Fluid Catalytic Cracker Unit (FCCU) substation. Power to the FCCU failed, as both sides of the main power supply board tripped out. The FCCU, however, continued to operate on internally generated emergency power, supplying instrument power and lighting and steam turbine drives. No injuries were reported to have resulted.

On inspection it was revealed that the substation was full of highly astringent fumes and smoke.

The north end of the power supply board had overheated and one of the pump starter cubicles burned to destruction.

Investigation revealed that a flash-over had occurred within this starter, the stabs having been welded to the bus-bar, and the surrounding bus-bars badly charred. The fault was cleared by overcurrent protective relays in the feeder substation. The faulty section of bus-bar was isolated and the healthy south section was re-energised to restore as much power to the FCCU as possible whilst repairs were carried out on the north section.

After cutting away damaged sections of the bus-bar, insulation testing revealed resistances generally below 50 K ohms. Closer inspection revealed that the internals were covered with a dirty aqueous slime which proved to be mostly hydrochloric acid with a pH of 1, i.e. highly acidic. A total stripdown of the north section of the board was carried out for cleaning and dry-out as there was a high probability of further damage if the slime was not effectively removed.

When the north section had been reassembled and re-energised the same exercise was carried out on the south section where more of the acidic slime was found. Both sections of the board were back in service nine days after the original incident.

Several power cables running from the sub-station to individual pump motors were found to have some damage with one being completely unserviceable.

Investigation revealed that about 30 cables were overheated and burned, some severely, part-way along the sand filled common cable trench. It is surmised that this overheating was due to a combination of factors:

1. The trench was too full, cables were laid five or six deep.
2. Locally available sand with low thermal conductivity was used to fill the trench.
3. A steam trap discharging into the ground warmed the sand around the cables up to 38 degrees C.

[power supply failure, overheating, damage to equipment]

Lessons

[None Reported]

2442 1983

Source : ICHEME
Location : , SPAIN

Injured : 0 **Dead :** 0

Abstract

Fire on a refinery Fluid Catalytic Cracker Unit (FCCU) plant involving a regenerator caused by insufficent inert gas.
[fire - consequence, refining, inert gas failure, fluid cracker]

Lessons

[None Reported]

4830 14 December 1982

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Two detonations occurred while relighting a three-celled CDU heater after a power failure. Each cell has two burners on both the south and north sides. On restoration of power the heater box was purged for 15 minutes using the forced draft fan. One pilot was lit on the south side of each cell followed by the corresponding main burner, firing fuel gas. While establishing pilots on the north side of the heater a detonation occurred. Although the detonation noise was very loud no damage could be seen and the furnace was again purged for 40 minutes using the forced draft fan. In neither case was a gas test taken after purging. On attempting to light the first pilot there was another detonation with refractory falling from the plenum roof.
Investigation showed that the forced draft fan louvre was stuck in the closed position and the audible function associated with the low pressure alarm had been disconnected.
[explosion, power supply failure]

Lessons

[None Reported]

2298 20 December 1981

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

Explosion at a utilities plant involving a boiler which was caused by power failure.
[power supply failure]

Lessons

[None Reported]

2128 03 January 1981

Source : ICHEME
Location : , CANADA

Injured : 0 **Dead :** 0

Abstract

Fire at a petrochemical plant cause power supply failure.
[fire - consequence]

Lessons

[None Reported]

122821981

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

An explosion occurred when a group of furnaces tripped due to power failure. The explosion occurred in the hydrodesulphurizer furnace when the hydrotreater furnace was restarted. Both furnaces shared common flue gas ducting.
An investigation into the incident found that the hydrodesulphurizer furnace had not been closed and was later established that the burner cocks were passing.
As a result, gas continued to enter the furnace and when the burner of the hydrotreater furnace was lit the flame ignited and built-up gas in the common flue gas ducting and exploded back into the hydrodesulphurizer furnace, which had not been gas tested.
[power supply failure, design or procedure error, safety procedures inadequate]

Lessons

This incident stresses the importance of regular checks on safeguarding systems and closing of all burner cocks after a trip.

2018 30 May 1980

Source : ICHEME
Location : , UK

Injured : 0   **Dead :** 0

Abstract

A section of pipeline burst from its connection in the 450 psig compressed air system. The investigation showed that there had been an oil vapour and air explosion in the pipework following ignition probably by incandescent carbon. This was caused by a combination of poor maintenance, design deficiencies in integrating four compressors and the use of an oil subsequently shown not to be the best suited to the operating conditions.
[air system failure, maintenance inadequate, design inadequate]

Lessons

Recommendations included:
1. The redesigning of the pipework system to the manufacturer's recommendations
2. The establishment of divisional piping standards
3. The return to scheduled maintenance of major plant items
4. A review of safety procedures
5. The use of an oil suited to the high air pressures involved.

10689October 1979

Source : COMPENDIUM OF SHIPPING INCIDENTS, 1967-1979, NO. 26.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. The main thrust bearing and shaft of a ship were extensively damaged whilst the ship was on sea trials following maintenance.
The damage was caused by lack of oil due to a drain valve being open. There were signs of oil shortage early in the trials (no oil in sight glass) but these were ignored on the advice of the engine maker's representative. Subsequently, severe damage was found and the drain valve from the bottom of the thrust housing, was found to be open. It has been wrongly assumed that this was shut but this was not checked.
[damage to equipment, testing, lubricating oil, lubrication failure, operation inadequate]

Lessons

The direct costs of this incident exceeded £50,000 (1979). The damage could have been avoided by better inspection.
Disciplinary action was taken.

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]

1850 19 April 1979

Source : MARINE ACCIDENT REPORT TANK VESSEL EXPLOSION AND FIRE, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON D.C, USA, REPORT NUMBER NTSB-MAR-80-12, 1980; 100 LARGEST LOSSES, 9TH EDITION, MARSH & MCLENNAN, 1986.

Location : Port Neches; Texas, USA

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. An oil marine tanker had offloaded its cargo of crude oil and was taking on ballast water when it was struck by lightning. Two explosions followed and the forward four crude tanks caught fire. High winds hampered fire-fighting efforts. Most of the damage was to the ship but the refinery dock was extensively damaged. The probable cause was the improper installation of the flame screen in the flame arrester aboard the tanker which resulted in the propagation of fire through the cargo tank vent system after lightning ignited flammable gases at the top of the vent mast; and a partially open butterfly valve in the cargo tank vent pipe system which created a path for the flame to penetrate the cargo tanks. Failure to use the available inert gas system to maintain a nonexplosive atmosphere in the cargo tanks contributed to the accident.
[fire - consequence, inert gas failure]

Lessons

[None Reported]

1745 27 September 1978

Source : THE TIMES, 1978, 28 SEP.
Location : Oviedo, SPAIN

Injured : 0 **Dead :** 7

Abstract

A rail transportation incident. An electric train pulling 13 gasoline rail tankers was stopped in tunnel by a power failure. Explosion occurred when diesel entered tunnel to push out electric train. Fatality.
[power supply failure]

Lessons

[None Reported]

1283 01 December 1976

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

Fire at a petrochemical polypropylene plant. Source of ignition was hot surface. Equipment involved: extruder. Cause: lubrication failure.
[fire - consequence, processing]

Lessons

[None Reported]

9492 13 May 1976

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A widespread failure of multiple utilities occurred on a major petrochemicals site. The initiating event was a boiler fan overspeed trip which caused a partial electrical power failure. Only one supergrid feeder was available, the other being out of service for modification. Emergency load shedding failed to retrieve the situation, and a domino effect resulted in a total site power failure. An emergency generator failed to start automatically.
The power failure led in turn to the failure of instrument air, steam, cooling water, fire water, maintenance air and telephones.
Acrylonitrile reactor systems and associated plant (e.g. flare systems) were also shut down.
When power was eventually restored, some motors restarted without warning.
Although no serious damage resulted, acrylonitrile production was lost for a period of 4½ days, and it was acknowledged that more serious consequences had been narrowly avoided.
[power supply failure, utility failure, steam failure, power plant, electrical, processing, plant shutdown, product loss]

Lessons

The incident resulted in comprehensive reviews of:
1. Interdependence of various parts of the site, and in particular the utilities systems.
2. Emergency shutdown procedures.
3. Initiation of the General Alarm.
4. Availability of fire-water in the event of power failure.
5. Electrical system protective devices.

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]

917   18 July 1974

Source : DAVENPORT J.A, A SURVEY OF VAPOUR CLOUD INCIDENTS, CHEMICAL ENGINEERING PROGRESS, 1977, 73, SEP., 54-63; SAIA S.A, VAPOUR CLOUDS AND FIRES IN A LIGHT

Location : Plaquemine; Louisiana, USA

Injured : 0   **Dead :** 0

Abstract

A 24 inch bellows joint at the suction of an interstage compressor failed and released 57 cum (cubic metres) of propylene due to a major electrical failure. Sprinklers were operated and the vapour cloud travelled 250 to 300 ft in a wind of 2 m per second to a furnace where it was ignited. The flash fire was followed by flange fires.

[processing, power supply failure, fire - consequence]

Lessons

[None Reported]

887 07 April 1974

Source : EUROPEAN CHEMICAL NEWS, 1974, 12 APR.
Location : Carrington, UK

Injured : 0 **Dead :** 0

Abstract

Loss of power from national grid. Shell's own generators overloaded causing small fires.
[fire - consequence, power supply failure]

Lessons

[None Reported]

783 07 July 1973

Source : LENOIR E.M & DAVENPORT J.A, A SURVEY OF VAPOUR CLOUD EXPLOSIONS SECOND UPDATE, PROCESS SAFETY PROGRESS, 1993, 12, (1), 12-33; REPORT ON INVESTIGATION OF AN ETHYLENE PLANT ACCIDENT, THE SAFETY INFORMATION CENTRE REPORT, THE INSTITUTION FOR SAFETY OF HIGH PRESSURE GAS ENGINEERING, 1976; DISASTER INVESTIGATION REPORT, PLASTICS INDUSTRY NEWS 1973, DEC., 185-187; LOSS PREVENTION BULLETIN, 000, 1.

Location : Tokuyama City, JAPAN

Injured : 0 **Dead :** 1

Abstract

This ethylene manufacturing plant was used for producing olefin hydrocarbons (ethylene, propylene and butylene) and aromatic ones (benzene, toluene and xylene) from naphtha. Acetylene at low concentration in ethylene was hydrogenated under mild conditions to ethylene, the heat of reaction being absorbed by a carrier gas and ultimately removed by cooling water. The instrument air supply to the plant was accidentally isolated stopping the acetylene/ethylene feed. The failure of air supply was not immediately recognisable because the low pressure alarm on the instrument air supply was installed before the isolation valve. The hydrogen supply to the plant was isolated manually. Unfortunately, the hydrogen isolation valve leaked and the exothermic reaction continued converting the residual acetylene to ethylene and raising the reactor temperature well in excess of the normal operating temperature.
When the operation of the plant was resumed, the plant operator attempted to reduce the reaction temperature by feeding extra ethylene as was the normal practice. Under mild conditions of temperature and pressure, only acetylene is hydrogenated. At the higher actual temperature in the reactor ethylene was also hydrogenated generating additional amounts of heat. The reactor temperature reached some 1000 degrees C when the flange developed a leak which caught fire and an explosion and fire followed. The plant was shut down but there was no way of preventing 500 tonnes of hydrocarbon leaking out and feeding the fire. Fatality. Human error.
[air sustem failure, flange leak, reactors and reaction equipment]

Lessons

There are three lessons to be learnt from this accident:
1. Low pressure alarm should be installed downstream of isolation valves.
2. When good isolation is important, it is essential to install double isolation valves with a bleed between.
3. Remotely operated isolation valves should be installed to isolate equipment which is liable to leak very large inventories of flammable materials.

719 1973

Source : FIRE AND EXPLOSION RISK CONTROL IN THE PETROCHEMICAL INDUSTRY, COMMERCIAL UNION RISK MANAGEMENT LTD. TECHNICAL REPORT NO. 2, 1976.

Location : Tokuyama, JAPAN

Injured : 0 **Dead :** 0

Abstract

The plant was shutdown at the time as the supply of compressed air to the gauges had inadvertently been switched off. This failure of the air supply was not immediately recognised because of the low pressure alarm was installed before the isolation valve. Shortly after the plant was restarted an unusually high temperature was observed in an acetylene hydrogenation column. Probably the hydrogen supply had not been turned off completely during the shutdown due to a leaking isolation valve and the continued passage of hydrogen through the column led to a gradual increase in temperature. The column thermometers were all located on the outside of the column and registered 120 degrees C when the interior temperature was probably about 400 degrees C. As the plant operator was unaware of this situation, he attempted to reduce the column temperature by passing in additional ethylene. At this high temperature the ethylene was hydrogenated to ethane and the column temperature rose further to about 950 degrees C as the hydrogenation reactions are exothermic. Also the ethylene decomposed into methane, carbon and hydrogen. The hydrogen supply was turned off and the temperature fell to 700 degrees C. The high temperature and pressure generated by the above reactions caused a leakage of flammable gases at a valve flange on a pipe close to the column. An explosion and fire followed.

Firefighters took over 5 hours to achieve a measure of control but the fire continued to burn for a further 80 hours because there was no way of preventing 500 tonnes of hydrocarbons leaking out of the plant and feeding the fire. The acetylene hydrogenation column and surrounding equipment were totally destroyed.

[air system failure, exothermic reaction, reactors and reaction equipment, high temperature]

Lessons

[None Reported]

1256129 September 1972

Source : ICHEME
Location : Yokkaichi City, JAPAN

Injured : 0 **Dead :** 0

Abstract

A fire occurred when a break occurred in the ethylene supply pipe connected to the upper part of a reactor in an ethylene alcohol plant; ethylene gas remaining in the pipe caught fire.
The fire was quickly extinguished.
The cause of the incident was due to power supply failure, which shut the plant down.
A heater was left incompletely suspended, and the temperature of ethylene gas present at the inlet of the reactor rose abnormally high, resulting in a collapse of the ethylene supply pipe.
No injuries occurred.
[fire - consequence, plant shutdown, high pressure]

Lessons

[None Reported]

614 1972

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Crude distillation unit.
[fuel supply failure]

Lessons

[None Reported]

553   26 May 1971

Source : CHEMICAL WEEK, 1971, 7 JUL, 33.
Location : Bayport; Texas, USA

Injured : 4   **Dead :** 0

Abstract

An explosion occurred in a steam reboiler and crude alcohol column tower in this plant which produced propylene oxide by direct oxidation. The plant was on start-up after a scheduled 11 day turnaround. The explosion disrupted incoming power to the plant, leaving it with no utilities and only one fire pump. Water pressure for fire fighting was further reduced by several deluge systems which tripped throughout the plant.
[power supply failure]

Lessons

[None Reported]

413 1971

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

Abstract

A power supply failure in the 440 volt supply stopped the electrically driven feed and product pumps of a Propane Deasphalting Unit at 04.00 hours. When the steam driven charge pump failed to cut-in, the asphalt mix from the base of the extraction column to the fired heater was reduced to 50% of normal flow with the outlet temperature on automatic control at 232 degrees C - 260 degrees C (450 - 500 degrees F).
Power was restored about 15 minutes later but the electrically driven charge pumps could not be successfully recommissioned and it was decided to inject a flow of liquid propane through the furnace tubes until the heater could be put on circulation.
The heater outlet temperature controller had been placed on manual following a temperature increase to 276 degrees C (530 degrees F). After dropping to about 171 degrees C (340 degrees F), the temperature increased rapidly to 316 degrees C (600 degrees F) when the furnace was put on circulation, burner firing was cut back until the temperature dropped again and appeared steady.
The flow reading to the tube side of the furnace fell to zero as circulation was commenced but the meter was disregarded by the operator because of the known poor performance of its magnetic flow element and also because the reciprocating pump was obviously operating. Unfortunately it is likely that this pump was labouring against a high back pressure and not in fact pumping material through to the furnace.
At 06.50 hours smoke was seen coming from the furnace and the condition of the firebox indicated a tube failure. The unit was taken offstream and the furnace inspected after it had cooled down.
One tube had holed at a U-bend adjacent to a weld due to external wastage.
Further investigation revealed a number of tubes with excessive wear on the outside resulting from dew point corrosion. It is believed that cold air entering the furnace around the inlet pipe produced temperatures below the dew point.
Internal examination of the tubes showed coke in some to a depth of inch and the tube hardness had increased confirming that overheating had occurred for a prolonged period. It is fairly certain that the furnace was fired without any tubeside flow and that the thermocouple on the outlet pipe showed a decrease in temperature because of this lack of flow.
[pump failure, power supply failure, tube failure]

Lessons

Block in the sources of air in-leakage around the tubes and improve the temperature indicating facilities within the heater.

9816 07 September 1967

Source : LOSS PREVENTION, VOL. 3.

Location : ,

Injured : 0 **Dead :** 0

Abstract

An explosion occurred in a 270 lb/sq. inch compressed air system destroying two pulsation air bottles and the 8 inch air line. The cause was probably over lubrication plus inadequate after cooling.
[lubrication failure, high temperature]

Lessons

[None Reported]

10338May 1966

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

Major failure of a gas turbine. Maintenance work was in progress. Too many welding machines were being used in the area, and the electrical circuit breaker tripped. Normally the gas turbine control system was powered from a DC source which consisted of a rectifier with a bank of nickel-cadmium batteries floating on the line. The unit emergency AC generator was also tied into the system. The batteries were sized to carry the load for 2 hours after loss of AC power. This normally gave sufficient time to either restore AC power or for operators to effect a planned shutdown. This time something went wrong. In the control room, pressure and flow charts indicated to the operators that they could not keep the gas turbine on the line, and it was apparently shutting down automatically. The exhaust annulus was turning red and smoke coming from the annulus area. The shift supervisor immediately pushed the emergency shutdown button. The time from AC power failure until actuation of the emergency shutdown system was between two and three minutes. In that time the turbine was very severely damaged by a fire. The resultant plant shutdown lasted 12 weeks.

Investigations determined that an unusual sequence probably occurred in the control system. When the main AC power source failed, the DC load was picked up by the batteries which immediately started to decline in voltage. At approximately 52 volts and 71/2 seconds following the power failure, the solenoid valve actuated the gas shutoff valve which started to close. Turbine speed immediately started to decline and, since no signal to shut down had been given to the other controls, the governor caused the fuel gas control valve to open wide. Power was restored to the system by the emergency generator before the voltage declined below 12 volts to de-energize the shutdown relay, so this relay did not operate. When the voltage rose to about 80 volts, the gas solenoid valve energized and opened the fuel gas shutoff valve, allowing full gas flow through the wide open control valve. This excessive gas flow continued until the turbine was manually shut down.

It is believed that complete flame-out did not occur, or an explosion would have occurred when the right gas mixture hit the hot expander turbine. For a very short time a blowtorch-type fire extended from the combustion chambers into the turbine blading. The time required for almost total destruction of the blading under these conditions can be measured in seconds.

[power generation, damage to equipment, power supply failure, fire - consequence]

Lessons

The reliability of the DC power source was the weak link in the system. The batteries, as installed, could not be completely discharged, checked and serviced without a shutdown. The revised DC system consists of two, parallel, heavy duty battery banks each with a current controlling battery charger. The switching arrangement is such that each unit can be completely serviced on a periodic schedule. The charging current to each bank of batteries is adjustable and shown on ammeters. Operators are alerted by an alarm should a fault occur in the AC power to the battery chargers.

Another important feature of corrective action was to install a lockout device on the fuel gas shutdown valve so that after it starts to close, it cannot reopen without manual resetting. This shutdown valve was duplicated in series to protect against jamming or mechanical failure.

This expensive failure in a high cost, highly critical piece of equipment was caused by failure of a relatively low cost, auxiliary item. Every effort should be made to assure maximum reliability of any auxiliary equipment or controls. Cost control should not be a primary factor. The primary objective is to obtain a system which is the most reliable and the least complex and which can be maintained while in operation.

342 06 February 1966

Source : VERVALIN C.H, HPI LOSS INCIDENT CASE HISTORIES, HYDROCARBON PROCESSING, 1978, 57, FEB., 183-201.
Location : Louisiana, USA

Injured : 2 **Dead :** 3

Abstract

A valve on a reactor bottom opened accidentally on air failure releasing butadiene. Ignition source 50 ft (15 m) from point of spill. Spill about 200 usg (8 cum) (cubic metre) prior to ignition. Overpressures of 0.5 to 1 psi (3.4 to 6.9 kPa) were estimated. Synthetic rubber plant. Fatality.
[processing, vapour cloud explosion, air system failure]

Lessons

[None Reported]

9994 13 December 1964

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

Abstract

An explosion occurred in the precipitator of a fluid catalytic cracking unit.
The unit consisted of two separate reactors with a common regenerator. The regenerator was equipped with ten single stage cyclones, a waste heat boiler and the precipitator. The air for regeneration was supplied by two motor driven blowers operating in parallel.
At the time of the incident the unit was being returned to operation, after having been essentially shut down in the morning due to a total electrical power supply failure. Gas oil circulation had begun, and spent catalyst was being added to the regenerator from the storage hopper to build the level to normal. The air heater had been lit to start increasing regenerator temperature which had fallen to about 500 degrees F. The reactors were bottled up.
The explosion was caused by oil vapour that was ignited by a spark in the precipitator. The oil leaked into one of the reactors during gas oil circulation after the electric power was restored, and leaked through the reactor spent catalyst slide valve into the air stream to the regenerator. There was insufficient heat in the regenerator lean phase to burn this oil, but enough heat to vaporize it.
The explosion ruptured the shell of the precipitator and caused severe damage to the internals. There was fire erupting from the ruptured vessel. One air blower was vented to the atmosphere and steam was opened to the regenerator risers. The fire was quickly snuffed out. The unit was out of service for a total of 53 days as a result of the accident.
[fluid cracker, damage to equipment, reactors and reaction equipment, power supply failure, fire - consequence, spark, vapour cloud explosion]

Lessons

The following conclusions were made:
The operators were putting the unit back on stream following a power failure. While this was not a direct cause of the explosion, the total failure of power and the length of time that the unit was without power were major contributory factors.
There were two separate feeders to the unit from an outdoor electrical substation, assuring power for the unit as long as either of two buses was in service at the substation. The first power interruption, at 10.23 a.m., was caused by the failure of a micarta bus support. This was probably due in part to the very foggy and humid weather that day. Failure of the second electrical feeder occurred at 10.49 a.m., and was most likely due to a loose connection caused by a faulty bolt head. The fact that the power failure to the unit was total and continued for 2 hours and 41 minutes was significant, in that the operators had no experience of returning the unit to operation after this long a period without the blowers in operation, and it allowed the temperature in the regenerator to drop to the point where burning would not take place.
The following recommendations were made:
· Replace all the bus supports at the electrical substation with a less hydroscopic material constructed from polyester and spun glass.
· Investigate the possibility of adding heaters to crossover bus housing to minimize the effect of humidity.
· Establish a procedure for regular routine inspection and maintenance of electrical substations.
· Prepare a detailed check-list of important critical items concerning the start-up and shutdown of the unit on both a regular and emergency basis, to be carefully reviewed with the operators.
· Issue instructions and sketches to all operators aimed at preventing oil from getting into reactors at any time that catalyst is not circulating. These instructions are to provide specifically that the reactors must be blocked off from the circulating gas oil system with a double valve and bleed arrangement.

289   25 October 1964

Source : ICHEME
Location : ,

Injured : 0   **Dead :** 0

Abstract

Ethylene oxide explosion in acetaldehyde column. Rupture of ethylene oxide compressor cylinder following power failure started fires which engulfed the acetaldehyde column.
[fire - consequence]

Lessons

[None Reported]

248 14 December 1962

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Explosion in oxygen nozzle. Air supply failure opened vent and partially closed quick shut valve allowing backup of hydrocarbon to mix nozzle.

Lessons

[None Reported]

6924 Date Unknown

Source : LOSS PREVENTION BULLETIN, 012, 12.
Location : ,

Injured : 33 **Dead :** 0

Abstract

An extremely violent explosion with subsequent fire occurred in a 4000 litre glass lined steel vessel situated on the top floor of a plant building. Four operators were seriously burned, one of them critically and nine others were seriously injured. A further 20 persons suffering from slight injuries or shock were treated without being detained in hospital.
The vessel contained a solution of 450 kg of anhydrous aluminium chloride in 1000 kg of nitrobenzene which was prepared for use in a Friedel-Craft synthesis to be carried out in another vessel. There was a breakdown in the steam supply prior to the explosion. The steam valve to the heating jacket was left open and when the steam supply was restored the temperature of the contents rose to an unknown level.
Following the explosion a very exhaustive investigation of the nitrobenzene - $AlCl_3$ system was undertaken and the mechanism of the decomposition and kinetic constants of the various reactions involved were determined. It has been concluded that the nitrobenzene $AlCl_3$ system is thermally unstable at any concentration. It can only be handled safely in equipment provided with adequate cooling facilities and an accurate temperature control for a relatively short period of time.
[steam failure, chemical causes, burns, injury]

Lessons

[None Reported]

5289 Date Unknown

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A hydrocracker reactor was being emptied whilst under a nitrogen blanket by contractors specialising in inert gas entry. Two of the contractors employees were working inside the reactor with their breathing air supplies being continuously monitored from outside. The breathing air flow to one of the persons inside the reactor was seen to increase significantly which was followed shortly afterwards by a similar increase in the second person's air supply. The men were immediately recovered from inside the reactor without suffering any adverse effect and an investigation revealed that the two breathing air hoses had come into contact with a hot steam line. This line had been cold at the start of the work, but somehow the steam had been turned back on and the reinforced rubber breathing air hoses (tested to 130 bars) were damaged by the heat and started to leak.
[reactors and reaction equipment, damage to equipment, breathing apparatus, hot surface, air system failure, entry into confined space, near miss]

Lessons

[None Reported]

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.

2802 Date Unknown

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

Abstract

Electrical power failure occurred at a refinery.
A false trip of the pilot wire control cables resulted in an interruption to the 35 kV power supply. Fluctuation in generator output, from accelerating/decelerating machinery, caused one too many false trips and system disabled to prevent recurrence. While in the process of cutting the old cable tray for removal, the pilot wire control cable was cut (serviced equipment in operation), which, further, prevented the system from being able to discriminate as to where the fault existed (made safety device inoperative).
Losses included; lost opportunity, additional maintenance.
The cause was the person performing the work was not aware of the location of the pilot wire control cable.
[power supply failure, operator error, refining]

Lessons

1. Work on or near to refinery electrical incoming feeders and segments of the distribution system needs to be rigorously planned and controlled.
2. Protective systems do not always work as expected/designed, they should be reviewed and, where justified, updated.

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]

11824Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A fluid catalytic cracking unit was being restarted after a 2.5 hour shut down due to an electrical fault. During the shutdown oil had leaked into the reactor and some of the oil soaked catalyst then leaked through the side valve into the regenerator. The catalyst there had fallen to a temperature which would vaporise but not ignite the oil. When air was fed to the regenerator a flammable mixture was formed and this was ignited by a spark in the electrostatic precipitator.
[gas oil, start-up, cracking, precipitator, catalytic cracker, explosion, power supply failure, spark, design fault, safety procedures inadequate]

Lessons

1. A double block and bleed valve system was fitted on the gas oil feed lines.
2. The operators were provided with more detailed procedures for these circumstances.

11423Date Unknown

Source : CHEMICAL HAZARDS, HEALTH & SAFETY, ISSUE 5, 1988.
Location : , JAPAN

Injured : 0 **Dead :** 0

Abstract

Three Cl drying towers made of PVC exploded suddenly and violently in a Hg amalgam cell Cl plant. Due to the failure of the electric power system, a current breaker tripped out, the Hg pumps stopped and the steel bottom plates in the cells became exposed. The alarm did not work, since both the a.c. power supply to the mercury pumps and that for the alarm system were taken from the same source. Meanwhile, the d.c. power and brine supply to the cells were not interrupted. Therefore, the H generated at the steep plate cathode ad O at the anode at a mole ratio of 4:1, forming an explosive gas mixture, passed to the Cldrying towers. H2SO4 is used to irrigate the towers for drying of the wet Cl gas. The most likely source of the ignition in the towers was the discharge spark from an electrostatic charge caused by H2SO4 drops.
The actual electrostatic charge of a PVC Cl drying tower was then measured. A static potential of minus 5 kV was constantly detected near the hole which was drilled in the side wall of the space below the ring layer. The main conclusion obtained from the studies is that the towers should be constructed of an acid proof and conductive metal in the future, so that the towers can be held at the earth potential, together with the H2SO4, to prevent electrostatically charging.
[explosion, processing, power supply failure, sulphuric acid, heating equipment]

Lessons

[None Reported]

12025Date Unknown

Source : ICHEME
Location : ,

Injured : 0 **Dead :** 0

Abstract

A refinery instrument air failure resulted in the shutdown of all processing plants and the refinery's three packaged boilers. Later the same morning, one boiler had been recommissioned and was firing on fuel oil and gas, and a second boiler was on gas only.
The weather was severe with a temperature of -8 degrees C, imposing heavy demands on the LP steam for tracing and heating. The pressures within the steam system had fallen considerably during the period when all the boilers were out of service, and only increased slowly when the two boilers were recommissioned. To maintain the fuel gas pressure, butane was regassed. After some 40 minutes both operating boilers tripped out due-to low levels in their upper water drums. An attempt was then made to start one of these boilers on gas, but this failed, and the automatic purging sequence for the boiler fire box started. This purging sequence restarts automatically after each unsuccessful previous attempt, and lasts for 5 minutes. When the purge was complete the automatic start up on gas was initiated again, but when the gas was opened to the burner an explosion occurred.
The fire box was badly damaged, refractory walls had to be renewed and convection tubes renewed or repaired. Damage was also sustained to flue gas ducting. There were no injuries to personnel.
The investigation held by the refinery came to the following conclusions:
1. That the operators had followed all relevant written instructions.
2. That the purging/ignition system had functioned correctly as designed.
3. Consideration of the atmospheric operating conditions within the refinery suggested that condensation of hydrocarbon from the fuel gas had occurred.
4. Studies of the manufacturers logic diagrams for the automatic purge/ignition system showed that these did not "fail safe" if liquid hydrocarbon condensed in the fuel gas system and was fed to the burner.
5. Calculations made by the refinery showed that the presence of under 5 litres of liquid butane in the boiler fire box would give an explosive mixture, and that this volume corresponded to less than 1 seconds injection during the ignition period.
[heating, boiler, air system failure, weather effects, explosion, boiler explosion]

Lessons

To prevent a recurrence of the incident the following two procedures were initiated:
1. Light up of the first burner on fuel oil.
2. Before lighting gas burners, the fuel gas system to be thoroughly drained of hydrocarbon condensate.
Originally there were no proper drainage facilities on the fuel gas system sited close to the boiler. This was rectified during a subsequent major overhaul, by the installation of drains from the fuel gas control valve for each boiler. In addition new temperature detection was installed on the common fuel gas supply line to the boilers, linked to both local panel alarm and main control room alarm for low fuel gas temperature.

12991Date Unknown

Source : LOSS PREVENTION BULLETIN 146, 22-23.
Location : ,

Injured : 0 **Dead :** 0

Abstract

An explosion occurred in a chemical unit at a chemical plant. The incident occurred when lightning caused a decrease in voltage to the chemical plant's power supply. In the normal course of events the power supply would switch over to the emergency power unit and then back to the normal power supply network after a time delay. However, on this occasion the emergency power unit failed to take over, resulting in the 220 volts and 24 volts tension delivered by the emergency power unit gradually decreasing and various items of equipment stopping. The double effect valves (including valves which allowed the decompression of the gas network for all reactors) opened leading to a release of flammable gas mixture through a chimney.
The explosion occurred a few minutes later, when lightning struck the plant and ignited the flammable release. A flame front propagated through the pipes and equipment and destroyed a cyclone, a tank and a reactor.
[leak, power supply failure, damage to equipment, reactors and reaction equipment]

Lessons

The following lessons were leaned:
1. Automatic safety devices or equipment are obviously not free from potential failures (for example, emergency power unit).
2. The operating range of important safety equipment should be defined, as far as possible, by tests.
3. Interactions between items of equipment, wherever possible, tests should be check the whole safety loop.

12995Date Unknown

Source : LOSS PREVENTION BULLETIN, 147, 15.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred on an offshore compressor station. On the day of the incident there were force 9 gales, subzero temperatures and snow blizzards. The installation was experiencing difficulties with instrument air supply and fuel gas because of the severe weather and, in the early morning, there was a total shutdown of generators, gas compressors, turbine enclosure cooling fans and compressor auxiliaries. The static generated by the snow ignited the purge gas going up the main stack. The operation staff inhibited the vent system and set about extinguishing the vent using the CO_2 bottles, this was successfully accomplished. On completion of the snuffing, a flame was observed in the power turbine exhaust of one of the compressor units. The hydraulics associated with the unit vent of the other compressor unit was isolated and the total vent system inhibit removed. The compressor unit, which was on fire, was vented down. While this was being vented a fire occurred on the generator hood and power turbine drive coupling of the other unit. The built-in continuous flow system was initiated manually (as the centre solenoid had jammed on the automatic system) along with the dry powder system protecting the lube oil room as a precaution. The inhibits were removed from the vent system and the unit was depressurised. All the fires were successfully extinguished.
The Investigation.
The shutdown of power and simultaneous shutdown of gas compression was thought to be due to the closure of the main fuel gas supply valve. This was caused by freezing of the air supply line to the actuator. The fires at the enclosure and coupling were caused by gas escaping through the drains and seals, which was ignited by static generated by the snowstorm. The gas escape from the seals and drains occurred due to the emergency run-down seal oil supply running out while the unit was still pressurised (vent inhabited). The main seal oil supply had failed when power was lost.
[fire - consequence, offshore, weather effects, power supply failure]

Lessons

The following recommendations were made:
1. Investigate the reliability of the fuel gas supply and implement any actions arising.
2. Improve reliability of instrument air supply by:
· Lagging vulnerable sections
· Installing pressure switches
· Relocating impulse line tapping points
· Changing to different dryers
3. Carry out a study of the reliability of unit vent valves (install upstream lock open block valve to allow them to be tested). Relocate solenoid valves. Change hydraulic fluid (existing fluid may freeze in subzero temperature conditions).
4. Investigate choice and reliability of existing actuators and location of all lines and systems with regard to winter conditions.
5. Take reasonable fire precautions such as:
· Construct a fire wall at lube oil skid
· Install a fixed fire-fighting system at lube oil skid
· Improve the trigger initiation system for the built-in continuous flow system and draw up a regular testing schedule
· Improve oil drainage removal beneath skids
· Review existing fire-fighting equipment for its suitability/effectiveness, reliability, position
· Review fire/gas philosophy.
6. Consider the following venting issues:
· Reposition auxiliary vents from turbine exhausts
· Check purge gas rates and fit appropriate restriction orifice plates. Relocate thermocouples for tip fire detection and improve snuffing systems
· Consider the installation of a fluidic tip with snuffing arrangements
· Study the wider implications of re-siting the vent stack
· Consider the installation of a timer in the vent inhibit system
7. For staffing issues: review the experience and training requirements for compressor station crews.

13035Date Unknown

Source : LOSS PREVENTION BULLETIN 151, 15.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A voltage regulator on a 24-volt power pack failed, raising the voltage on the local distribution system to 40 volts. Many instruments were damaged. There was no over-voltage protection.
The incident occurred during normal operations, the control room operator noticed that all the mimic panel lights for the plant had lit up but no other alarms had sounded. This meant that he was running blind and could not confirm the status of the valve positions. He had the valves checked by the plant operators and called the shift electrician. The shift electrician reported that it was a complex problem, which would require plant personnel to solve.
There was no other apparent loss of control of the plant and it was decided to carry on operating.
Two days later, the plant electricians began working to solve the problem. The mimic panel was fed from three high integrity 24 v power packs, each with battery backup. It was discovered that the DC main was running at an elevated voltage and had blown the fuses in 38 separate relays. Repairs were carried out and the plant returned to normal operation on three days later.
The faulty power pack was returned to the origin manufacturer for detailed examination. The manufacturer reported back to the electrical and instrumentation engineer three weeks later.
The root cause:
Over-voltage due to unforeseen mode of failure at equipment specification stage was the root cause of this incident.
[power supply failure, electrical equipment failure, damage to equipment]

Lessons

The following recommendations were made:
1. Review all similar installations on the plant with a view to replacing them with equipment, which provides the required level of integrity.
2. Publicise the incident within the company to raise awareness.
Lessons learned:
1. The fundamental cause of the problem was an original design fault, which failed to specify the requirement for over-voltage protection on the power pack outputs. When the voltage regulation circuit failed, full rectified voltage was delivered to the output circuit resulting in the damage to downstream instrumentation.
2. Technology needs to be reviewed atintervals.

6818 Date Unknown

Source : LOSS PREVENTION BULLETIN, 004, 8.
Location : ,

Injured : 0 **Dead :** 0

Abstract

Solids were separated from acidic liquors on batchwise operated filters. Solvent was added to filter cake and live low pressure steam was admitted to the filter below the fixed bed. The 6 inch normal bore steam line conveying steam to the battery of filters failed. The plant was shutdown for repairs incurring two days downtime and considerable production loss. On this occasion some 30 feet of mild steel line was destroyed. Fortunately, no-one was injured. Subsequent investigation revealed that this incident had occurred previously, but had not been fully reported and investigated.
[steam failure, plant shutdown]

Lessons

Corrective action involved the installation of double block and bleed valves in stainless steel in the steam line to each filter.

7334 Date Unknown

Source : LOSS PREVENTION BULLETIN, 054, 24.
Location : Washington, USA

Injured : 16 **Dead :** 0

Abstract

Approximately 10,000 cubic feet of chlorine gas leaked from a plant. The accident was alledgedly caused by a power supply failure which caused loss of control of seals in a gas line.
[gas / vapour release]

Lessons

[None Reported]

6928 Date Unknown

Source : LOSS PREVENTION BULLETIN, 012, 10.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A violent boilover occurred in a hot vacuum bottoms storage tank operating at 140 degrees C. The weak roof seam was ruptured over a large extent of the circumference and shell plates were also ruptured. An estimated 12,000 tonnes of oil erupted from the tank, most of which overflowed the dike into adjacent tank bunds and offsite areas. No injuries or fires occurred, but massive clean up problems were created as the spilled material cooled and solidified.
The cause of the boilover was determined to have been water routed into the tank through the vacuum pipestill rundown line. A few hours before the incident a refinery power supply failure had occurred and during the resulting shutdown of the vacuum pipeline the pressures in the shell and tube sides of the bottoms product cooler had reversed allowing cooling water to enter the oil side though a small existing tube leak. When the unit was restarted, the accumulated quantity of this water leakage was routed to the rundown tank with the product flow. During normal operation of the unit oil pressure is higher than cooling water pressure and tube leakage does not create a boilover hazard in the product tank.
[contamination]

Lessons

[None Reported]

6989 Date Unknown

Source : LOSS PREVENTION BULLETIN, 015, 20-21.
Location : ,

Injured : 0 **Dead :** 0

Abstract

During the commissioning of an overseas plant, it was necessary to bring in a rail tanker of chlorine as the local chlorine unit was not yet in operation. It was decided to blow the liquid chlorine out of the rail tanker with instrument air, as this was conveniently available.
While unloading was in progress, a power supply failure occurred and the instrument air compressor stopped. When it re-started only a few minutes later, three control rooms filled with chlorine and many instruments were damaged.
No non-return valve was fitted at the purge inlet point and in addition, the air line had been fitted to the bottom of the rail tanker instead of the top.
[gas / vapour release]

Lessons

Non-return valves should always be fitted at purge gas inlet points and no purge into a liquid space should be carried out where a purge into a vapour space is possible.

7138 Date Unknown

Source : LOSS PREVENTION BULLETIN, 043, 39-40.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A dry rise sprinkler system fitted into an unheated warehouse had the air connection fitted above the water clack or flap valve. It thus maintained the riser and distributor under air, but if a heat sensitive bulb burst and the air pressure was released, the flap valve, working on a differential pressure of 4:1, allowed water to flow through the system and to sprinkle from the burst head.
The plant air system was used to supply the necessary air. Due to a drop in air pressure, the flap valve opened and water rose above the air inlet pipe.
The water was at 10 bar. The air supply was 4 bar. Although the air supply was fitted with a non-return valve, it leaked. Water passed back slowly into the plant air system and rendered the whole plant air system useless.
[air system failure, warehousing]

Lessons

Fire protection system in general, but drier risers in particular, should be supplied from an independent air supply. This will minimise the consequential loss of the almost inevitable failure of any non-return valve.

7147 Date Unknown

Source : LOSS PREVENTION BULLETIN, 033, 31-33.
Location : ,

Injured : 0 **Dead :** 0

Abstract

The plant was a natural gas treatment plant to remove hydrogen sulphide and carbon dioxide to a pipeline gas specification. The process fluid was an inhibited alkaline salt solution. The absorber operated at 70 bar (1000 p.s.i.g.) and regeneration of the circulating fluid was at about atmospheric pressure and a temperature of 105 degrees C.
The plant had operated for over ten years with no significant problems. In addition, the plant had been designed to fail to a safe condition.
The plant was situated in a desert area and, on the night in question, the area was subject to a major electrical storm and indeed, the plant was struck by lightning. The transient surge in the system caused the plant power supply failure and the plant to shut down. In the control room, however, the multi-stage high pressure centrifugal pump was heard to overspeed (the pump pumping the process fluid from the low pressure absorber). Shortly after the pump motor disintegrated, a major process line was severed and almost immediately the escaping natural gas ignited.
After the investigation it was found that, the rotor of the electric motor had disintegrated and this probably occurred at a rotational speed when being driven in reserve by the centrifugal multi-stage pump which was being actuated as a turbine. The pump was driven initially by the column of fluid and then by the gas. The gas was relieving from the high pressure to the low pressure side of the pump.
Due to the corrosive tendency of the process fluid, the velocity of the fluid at the pump discharge was limited to a value specified by the process licensor. The discharge line size was 250 mm (10 inch) diameter. The pump was immediately followed by a conventional non-return valve in a horizontal section of the pipe run. As installed, a butterfly valve was in the line before the absorber to provide positive shut-off. The valve took about 15 seconds to close and was pneumatically operated. Over the years this valve was thought to have operated unsatisfactorily and its method of operation had been modified without success. Two years before the incident, the valve had been replaced by a second non-return valve. The pump was now protected by two identical non-return valves. Hand operated block valves were provided. The plant continued to function satisfactorily.
The non-return valves were in critical positions and had been specified in stainless steel. In addition the process fluid had been supplied with a corrosion inhibitor which provided a passive coating to plant metalwork.
Although centrifugal pumps do not produce fluctuations in pressure at the discharge of the same order of magnitude as positive displacement pumps, the pressure does oscillate about a mean value at high frequency. This fluctuation had been transmitted to the non-return valves. This, in turn, meant that there was continual relative movement between the flap-valve pivot and the bearings. This movement had been sufficient to prevent the corrosion inhibitor from successfully forming a passive coating. Although the stainless steel was resistant to corrosion over a period, the result was similar to stress corrosion and the pivots and bearings had worn away to a considerable extent. Both valves in series had been subject to the same forces and both had reacted similarly. On the day when they were required to operate, both failed simultaneously. On the stopping of the fluid flow the valves closed. Due to wear at the pivots, they were both displaced in the valve body and both had failed to seat correctly. No seal or shut-off was achieved and partial backflow could and did occur due to pressure difference in the vessels. This was of small consequence as the liquid was unloaded, but once gas was flowing disaster was inevitable.
[valve failure, fire - consequence, separation]

Lessons

[None Reported]

7172 Date Unknown

Source : LOSS PREVENTION BULLETIN, 047, 26-27.
Location : ,

Injured : 0 **Dead :** 0

Abstract

For environment reasons, all the vents on a chemical plant were collected in a vent main and passed to a furnace. To balance the vent flow and furnace requirement, the vents passed into the furnace fan and constituted about 30% of the furnace air flow requirement.
The vent main normally ran at 1% to 4% of lower explosive limit.
Following a power cut all the electric motors were tripped. One distillation unit in the chemical plant recovering solvent ran at atmospheric pressure. The condenser cooling water circulation was tripped with the power cut but the steam supply went down slowly.
The result was a heavy build up of un-condensed flammable solvent vapours in the vent manifold (by calculation, above the higher explosive level).
Soon after the furnace was returned on line, the ducting between the fan and the furnace exploded, blowing the ducting apart causing no damage.
It is believed that the explosion was caused by vapour from the vent to the furnace inlet ducting lowering the vapours to within the explosive range, which ignited from the furnace.
[power supply failure]

Lessons

[None Reported]

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.

7229 Date Unknown

Source : LOSS PREVENTION BULLETIN, 062, 24.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A polymerisation batch reactor was being controlled by a Programmable Logic Controller (PLC). Although it was provided with a back-up unit the power supply was interrupted for a short time. The PLC reset to the initial set which caused the bottom valve and vent valve on the reactor to open and resulted in product loss. Another programme was operated inadvertently also. Prompt operation by the operators prevented any loss or risk to people. The batch was terminated manually.

In an investigation several factors were taken into consideration:

1. There were a number of irregularities in the alarm system to indicate that the back-up unit was in operation. The system was not well understood by the operators.
2. The operators had not been sufficiently well trained in how to react to failure in the power supply. It would have been possible to by-pass the PLC and finish the batch manually.
3. The reset position on the PLC was not fail safe.
4. PLC's are often used for sequencing operation on batch reactors. Reverting to the initial state in the middle of a batch is usually not a fail safe position. The plant had recognised this to some extent by providing a back-up unit, but had not given sufficient attention to design and operation of the back-up unit to ensure an adequate overall reliability.

[reactors and reaction equipment, process control & instrumentation, design inadequate, power supply failure]

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.

10572Date Unknown

Source : INSTRUMENTATION TECHNOLOGY, 1972, 19 (10): 39.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A case history of inadequate instrumentation (major failure of a gas turbine, standby system not ready).
A DC relay, opened by various temperature and speed sensing devices in the turbine, initiated a programmed shutdown procedure, also DC operated. The relay also opened on loss of DC power.
DC power was supplied from a rectifier fed by the public utility, with a battery backup designed for two hours of operation. An emergency AC generator, engine driven, was also connected.
One of the actions triggered by the relay was operation of a solenoid valve that controlled the opening and closing of an emergency shutdown valve in the line supplying fuel gas to the turbine. Trouble occurred because means had not been provided whereby a thorough check on the battery system could be made except at major turnarounds. Investigation revealed:
1. The batteries were in such poor condition that when AC power to the rectifier was lost, battery voltage dropped from 128 to 12 volts in 20 seconds when under full load.
2. The solenoid actuating the emergency fuel shutdown valve de-energized when the voltage dropped to 52. Battery voltage dropped to this figure in 7.5 seconds after a simulated power failure.
3. The main relay de-energized at 12 volts, which was reached 18.5 seconds after the power failure.
4. The solenoid controlling the shutdown valve energized at 80 volts on an ascending voltage curve.
5. The fuel gas shutdown valve travelled from completely open to completely closed in 1 second and from closed to open in 2.5 seconds.
When power was lost, the emergency valve started to close 7.5 seconds later. Since the turbine was operating under load, the reduction in fuel supply caused an immediate slowdown. Sensing this slowdown, instrumentation opened the regular control valve wide while the emergency valve was closing.
Upon start-up of the emergency generator, the solenoid control on the emergency valve was re-energized and opened this emergency valve wide just before it would have closed tightly enough to extinguish the fire in the turbine combustor units. The combination of reduced air flow to the combustor (because of slower turbine speed) and maximum flow of gas (because both the emergency and regulating fuel valve were wide open) resulted in fire burning up the turbine blades.
[damage to equipment, instrumentation failure, power supply failure, fire - consequence, emergency shutdown valve, fuel gas]

Lessons

The following recommendations were made:
Redesign of the safety control system to provide better measurements of important variables and more reliable control through redundancy or by diversity of the systems.
There is still only one solenoid valve to close the emergency shutdown valve, but opening the valve is a manual operation. The battery installation is now set up for easy inspection.

7505 Date Unknown

Source : LOSS PREVENTION BULLETIN, 120, 3-4.
Location : ,

Injured : 0 **Dead :** 0

Abstract

On the morning of the incident, a stripping column was operating normally and since the fertiliser unit was washing out, the column bottoms stream was routed to the crystalliser.
The normal washout procedure involved hot water circulation of the crystalliser and associated equipment, with intermittent dumping to the open drain channels in the concrete floor of the fertiliser unit. The drain channel network led directly to an open sump and then to the factory drain system.
The fertiliser unit washout was in progress and, as was usual, a number of routine maintenance jobs were being carried out. One of these jobs was to repair metal steps on the stairway within the structure, and involved welding. The normal hot work procedures had been complied with, a permit to work issued, and the welding was proceeding normally. Later that morning there was a factory power and steam failure. The stripping column quickly dumped and, because there was no automatic shutoff valve, the bottoms, which were now rich in organics, continued to be routed to the crystalliser and hence to the open drain channel network.
Sparks from the welding operation caused ignition resulting in an extensive fire which spread throughout the drain channel network and to the open sump. Although there were no injuries, damage was caused to instrumentation and wiring in the area.
The following conclusions were made:
An accident is seldom, if ever, the result of one single event. In this case:
1. If there had been no steam failure there would have been no fire.
2. If there had been no washout in progress, there would have been no fire.
3. If there had been no hot work going on there would have been no fire.
It required the interaction of all three occurrences to produce the fire and this occurred.
[fire - consequence, power supply failure, separation equipment, damage to equipment]

Lessons

[None Reported]

7619 Date Unknown

Source : LOSS PREVENTION BULLETIN, 130, 21-22.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A large factory used its general purpose compressed air system as the normal supply to its instrument air supply, via a manual isolating valve and a non-return valve. A second smaller compressor was installed to provide backup for instrument air in the event of failure of the main factory air system. Both compressors were electrically driven. The second compressor was provided with automatic start, initiated by low pressure in the instrument air line.
The second compressor was tested each month by closing the manual valve in the line supplying the instrument air system from the general purpose supply, watching the pressure fall in the instrument air system, and checking that the second compressor started at the right pressure.
In due course, there was a failure in the general purpose air supply when a vehicle struck and ruptured the main air line. The pressure in the instrument air system fell, and the second compressor started. However the non-return valve, which had never been tested, failed to seat. Further, the cylinders in the second compressor had corroded over time, and quickly damaged the carbon rings. The reduced delivery rate from the damaged compressor was incapable of maintaining instrument air pressure in the face of loss of pressure through reverse flow to the general purpose air supply system. The loss of instrument air pressure caused a massive release of irritant and toxic fumes from one of the plants, giving rise to vigorous statutory and community response.
[air system failure, gas / vapour release, testing, toxic fumes]

Lessons

The following recommendations were made:
1. Testing of backup systems should be as realistic as possible. It is particularly important to test realistically the system for initiating the backup operation.
2. While installation of non-return valves in such situations as above is good practice, unless they are tested regularly they cannot be relied on. An alternative, instrument-based, back-flow prevention system may be preferable.
3. Backup systems need inspection and maintenance.
4. Although this was not a problem on this occasion, the sources of power to main and backup equipment should be independent and preferably of a diverse type.
5. The wisdom of supplying the instrument air supply from the general purpose air system can be queried, but that was not an issue in this instance, except that there is probably more potential for failure of some form in that system than in a dedicated instrument air system.

7620 Date Unknown

Source : LOSS PREVENTION BULLETIN, 130, 22.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A failure of external power supply caused lights to go out. From the basement of the building could be heard the standby diesel starting, but the lights did not come on. It was learnt the next day that, although the generator was tested each week by the venue staff, the startup was manually initiated (not automatically) and the automatic changeover from external to emergency power was not tested. All that was done was to run the generator up to speed, check that it was generating the correct voltage, and allow it to warm up.
[testing, power supply failure, testing inadequate]

Lessons

Testing of backup systems should be as realistic as possible. It is particularly important to test realistically the system for initiating the backup operation.

7743 Date Unknown

Source : BARTON J AND ROGERS R, CHEMICAL REACTION HAZARDS, 2ND EDITION, ICHEME, 1997, APPENDIX 1, 163.

Location : ,

Injured : 33 **Dead :** 0

Abstract

A 4 m3 reactor contained a solution of 450 kg of anhydrous aluminium chloride in 1000 kg of nitrobenzene which was prepared for use in a Friedel Crafts synthesis to be carried out in another vessel. There was a break down in the steam supply prior to the explosion, which injured 33 people and caused extensive damage.

The steam valve to the heating jacket was left open and when the steam supply was restored the temperature of the batch rose to an unknown level.

Following the explosion a very exhaustive investigation of the nitrobenzene/aluminium chlorine system was undertaken and the mechanism of the decomposition and kinetic constants of the various reactions involved were determined. It was concluded that the system is inherently thermally unstable at any concentration.

[steam failure, reactors and reaction equipment, damage to equipment, injury]

Lessons

[None Reported]

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]

7874 Date Unknown

Source : LOSS PREVENTION BULLETIN, 110, 1-3.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A large site was supplied from two independent Grid Supply Points via separate circuits. The routes of these circuits were totally different. On the site there were additional electrical supplies. These were from on-site steam and standby diesel engine driven generation. The process control system from the whole plant was provided with an alternative electrical supply from a separate stand alone Un-interruptible Power Supply.
During, a lightning storm, these events look place:
1. Each Grid infeed was struck by lightning in separate incidents, some 10 minutes apart. This resulted in total loss of external power supplies.
2. All auxiliary power supplies for the control of the on-site steam driven generation were lost when the external power supplies failed and this generation closed down.
3. The diesel powered generation auto-started and ran up to speed. It did not take up load because an auxiliary relay which controlled the final circuit breaker used to connect the load failed.
4. The UPS system maintained the process control.
5. There was considerable effluent overflow.

Subsequent investigations revealed the following:
1. The diesel powered generation was regularly tested but no connections were ever made to a DEAD electrical system so that the generators would carry load, i.e. the final links in the chain were never proved.
2. The site staff lacked adequate knowledge of the on-site power supply system and were unable to take appropriate corrective action.
3. There were no pre-arranged switching procedures available to cope with a total electrical power failure.
4. Electrical equipment was not properly identified i.e. clearly labelled.
5. There was a total loss of air supplies for plant control during the incident because of insufficient storage capacity on the air receivers to cater for a total failure of this kind.
6. The on-site communications proved to be incapable of coping with the information transfers necessary in a major incident of this kind.
7. There were no defined PRIORITY alarms. The control centre was overwhelmed with information and the priority alarms were lost in the mass of data received.
[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 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:
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.

7875 Date Unknown

Source : LOSS PREVENTION BULLETIN, 110, 3.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A large chemical complex supplied part of its electrical load from an on-site generator rated at 24 Megawatts. It was routine to bring the generator on-load, as the site electrical load increased, by manual operation. During this operation the final switch used to connect the generator to the system was closed when the generator and main supply were out of phase. The following sequence of events took place:

1. The main electrical protection used to protect the main incoming switchboard (the bus-zone protection) operated and disconnected all electrical supplies. This was because the electrical system became unstable on the through fault current flow when the final switch was closed out of phase.
2. The plant electrical system collapsed due to the loss of all infeeds.
3. All process steam supplies were lost.
4. Process material was flared off.

The subsequent investigations revealed that:

1. The generator steam turbine speed control was erratic. This was the result of corroded bearings in the sensor unit making it unpredictable.
2. The control centre was overwhelmed with data as there was no priority scheme for alarms.

[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 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:

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.

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.

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.
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.