1220515 February 2000

Source : CNN.COM, U.S. NEWS, FEBRUARY 16, 2000, (http://www.cnn.com).
Location : New York, USA

Injured : 0 **Dead :** 0

Abstract

A radioactive leak occurred at a power plant. The incident occurred when a small leak was detected in a steam generator at the plant's containment building, a sealed concrete building that holds the reactor a the nuclear power plant. Approximately 1 cubic foot of gas escaped.
The leak was immediately isolated and the plant shut down.
An investigation into the incident found that the leak occurred in a tube used to carry hot, radioactive, high-pressure water to a pool of cool, non-radioactive water. Steam produced when the hot water hits the cool water, turns a turbine and generates electricity.
The plant will remain closed fro maintenance.
[gas / vapour release, plant shutdown, processing]

Lessons

[None Reported]

1186620 September 1999

Source : CNN.COM, U.S. NEWS, SEPTEMBER 20, 1999, (http://www.cnn.com).
Location : , GULF OF MEXICO

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A fire occurred onboard a cruise ship which was carrying 1,700 passengers.
The fire started in the engine room, which was quickly put out, but had damaged the engines. The star-board motor was temporarily restarted, but failed again, stranding the ship 100 miles off the coast.
[fire - consequence, damage to equipment, passenger ship]

Lessons

[None Reported]

1250108 April 1999

Source : CNN.COM, U.S. NEWS, APRIL 8, 1999, (http://www.cnn.com).
Location : Florida, USA

Injured : 50 **Dead :** 2

Abstract

A generator exploded inside a coal-fired power plant killing two workers and injuring fifty others. At least three of the injured suffered serious burns.
An investigation into the incident found that a hydrogen gas leak may have caused the explosion.
The explosion occurred as the generator was being tested following routine maintenance.
The plant was shut down whilst investigations took place to make sure that none of the other generators were affected by the blast.
[testing, plant shutdown, fatality, injury]

Lessons

[None Reported]

1060608 April 1998

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A diesel fire occurred on a production platform as operators were filling the diesel tank for the essential generator. The operator noticed that it was taking too long to fill the diesel tank and began to check for a problem. He found that the float indicator on the diesel tank cover was reading three quarter full. He removed the level gauge to determine the exact fuel level which resulted in fuel spraying into the generator enclosure. The diesel oil contacted the generator exhaust which ignited the fuel.

The cause of this incident is related to the design of the fuel tank and filling system. The safe filling procedure relied entirely on the mechanical level gauge and the operators ability to judge when the tank was full. The design faults are as follows:

1. Inadequate level indication on the tank.
2. No high level alarm or switch.
3. No overfill protection to shut-off pump.
4. Gauge connection located inside enclosure.

[fire - consequence, material transfer, design inadequate, mechanical equipment failure]

Lessons

[None Reported]

1139510 November 1997

Source : LOSS CONTROL NEWSLETTER, 1997.
Location : , AUSTRALIA

Injured : 3 **Dead :** 0

Abstract

A fire caused damage to two electrical generators in the engine room of an offshore platform.
An initial investigation pointed to a mechanical problem in one of the five turbines in the generator. The vessel was taken to a shipyard for repair. 60 days interruption.
[fire - consequence, damage to equipment]

Lessons

[None Reported]

1291120 September 1997

Source : ICHEME

Location : ,

Injured : 5 **Dead :** 2

Abstract

Severe damage occurred to a steam turbine when a compressor on ammonia plant refrigeration failed killing two people and injuring five others.
The failure of the turbine rotor resulted in the steam, let down from 97 bar superheated at 496 degrees C, mixed with lubricating oil. The release enveloped five employees in the area of the turbine and compressor.
An investigation concluded that the incident was a result of a combination of errors, which occurred in a sequence which provided the opportunity for the turbine failure.
[damage to equipment, fatality, mechanical equipment failure, gas / vapour release, injury]

Lessons

[None Reported]

8948 1997

Source : CHEMICAL HAZARDS IN INDUSTRY, 1997, JUL.
Location : ,

Injured : 0 **Dead :** 2

Abstract

An accident occurred when repeated operation of a starter failed to start the engine. The driver lifted the drivers seat, activated the choke knob on the carburettor pressure regulator and when he again operated the started button, the gas air mixture in the engine compartment ignited and caused an explosion. The flash flame ignited his clothing, causing his death. The heat also melted the hosepipe at the gas bottle, causing a stream of butane-propane mixture, which also ignited and killed another person.
[mechanical equipment failure, fatality]

Lessons

[None Reported]

1107005 October 1996

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

Abstract

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

Lessons

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

3177 30 June 1995

Source : LLOYDS LIST, 1995, JUL, 1.
Location : Dunlin A, North Sea, UK

Injured : 0 **Dead :** 0

Abstract

A fire occurred in a generator room which was caused by a lubricating oil leak from a turbine gasket.
[fire - consequence, processing]

Lessons

[None Reported]

6752 03 November 1994

Source : LLOYDS LIST, 1994, 5 NOV., & 7 NOV.
Location : Claymore Platform; North Sea, UK

Injured : 0 **Dead :** 0

Abstract

Small fire on a gas turbine on an offshore platform forced closure of six platforms and the evacuation of 145 persons.
[fire - consequence]

Lessons

[None Reported]

6748 01 November 1994

Source : LLOYDS LIST, 1994, 3 NOV.
Location : Leipzig, GERMANY

Injured : 5 **Dead :** 4

Abstract

Explosion in gas turbine power station during testing. Several buildings nearby were damaged. Fatality.

Lessons

[None Reported]

8787 27 August 1994

Source : PROCESS SAFETY PROGRESS, VOLUME 16, NO.1, GLENN E MAHNKEN, MICHEAL T ROOK.
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A fire consumed the titanium tube bundle of a steam turbine condenser during demolition work in a decommissioned power plant. The titanium fire is believed to have initiated by contact with hot steel slag from torch cutting which was being conducted to remove sections of the steel condenser casing above the tube bundle. The approximately 25 ft long bundle was essentially consumed end-to-end, including the tube sheets.
A fire watch had stationed as part of the plant's Hot Work Permit System, but the initial phase of the fire was obscured from view. Workers reported a bright yellow low flame coming from inside the south end of the tube bundle. Water application on the fire by workers and the local fire department was followed by explosions within the tube bundle and discharge pipes. Fortunately, no injuries or property damages occurred from this incident.
[fire - consequence, hot work, hot surface]

Lessons

Conclusions and Recommendations:
1. Titanium is a known "combustible" metal, but fire experience is mainly with chips, fines and powders. Ignition of a self-propagating tube bundle fire during torch or arc cutting is a less frequent type of fire, but such fires can have severe consequences. Ignition appears to occur by development of a "hot spot", either directly by contact with the torch, or indirectly via heat transfer from accumulating hot steel slag particles. The hot spot develops into a self-sustaining fire due to the close spacing of the tubes in the bundle.
2. There is a risk of subsequent explosions if water is applied to extinguish heat exchanger fire.
3. Prevent, prevent, prevent. Before performing any hot work on a heat exchanger, the materials of construction must be verified, in addition to other standard hot work precautions. If titanium tubes are present, hot work must not be allowed unless the tubes are first removed mechanically.
4. Heat exchangers containing titanium tubing must be labelled to that effect, with a ht work fire hazard notice posted on the unit.
5. Hot work permits in use in plants where titanium could be present is to contain a specific check box to confirm that no "combustible metals" are present in the work area.
6. Persons involved in hot work and emergency organisation personnel to be trained to recognise metal fires and to use proper metal fire extinguishers (if safe to do so).
7. A co-operative, aggressive and co-ordinated effort by all parties involved in the incident and the loss investigation helped to expedite the determination of the cause and the necessary measures to prevent a recurrence.

6615 01 July 1994

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 3RD QUARTER, 1994.
Location : Daya Bay, CHINA

Injured : 0 **Dead :** 0

Abstract

Nuclear reactor shutdown due to leak in generator cooling circuit.
[cooling equipment, radioactive release]

Lessons

[None Reported]

8314 May 1994

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

Abstract

A release of crude oil causes shutdown of a crude distillation unit at a refinery. Spill.
The incident occurred when a loss of lubricating oil pressure caused the turbine driven desalted crude oil pump to shut down. Pressure build up and unsuccessful attempts to start/re-start pumps led to mechanical equipment failure of the relief valve's bellows and failure of adjoining piping. It was found that carbon steel tubing, which transmits the lubricating oil system pressure failed. The cause was found t be lack of preventive maintenance and inspection schedules for tubing. In addition pump modifications conflicted with its design and the pump was not tested before being returned to service.
Losses: production loss $1.7 million (1994), local claims $10,000 (1994), equipment damage $160,000 (1994).
[process causes, design or precedure error, maintenance inadequate, refining, mechanical equipment failure, maintenance inadequate]

Lessons

Start-up and change-over switching arrangements for parallel pumps need to be routinely tested and available to operators. Modification to switching arrangements need to be agreed by all concerned and documented.

8332 February 1994

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

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

Lessons

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

124171994

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

An incident occurred at a refinery when X-rays were taken of piping at a distance of approximately 3 metres from a gas turbine enclosure. This triggered the UV fire detectors inside the enclosure which resulted in a trip of the turbine and release of the extinguishing agent.
When the crew moved to piping next to another turbine installation the same reaction was observed.
[design or procedure error, plant / property / equipment, fire fighting equipment]

Lessons

[None Reported]

6234 22 September 1993

Source : CHEMICAL HAZARDS IN INDUSTRY, 1994, JAN.
Location : Sweeny; Texas, USA

Injured : 2 **Dead :** 1

Abstract

Preventative maintenance on steam turbine when there was an explosion. Fatality.

Lessons

[None Reported]

6156 17 July 1993

Source : EXECUTIVE NEWS, 1993, 18 JUL.
Location : Ninian South Platform, NORTH SEA

Injured : 0 **Dead :** 0

Abstract

Fire in turbine exhaust following routine maintenance on an offshore platform.
[fire - consequence]

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]

6011 01 April 1993

Source : LLOYDS LIST, 1993, 2 APR., & 16 APR.
Location : Narora, INDIA

Injured : 0 **Dead :** 0

Abstract

Leaking hydrogen gas in turbine generator caught fire in nuclear power plant.
[fire - consequence]

Lessons

[None Reported]

5980 10 March 1993

Source : HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1993, MAY.

Location : Beilungang, CHINA

Injured : 20 **Dead :** 20

Abstract

Massive explosion in generator at power plant. Fatality.

Lessons

[None Reported]

5668 25 May 1992

Source : THE CHEMICAL ENGINEER, 1992, 11 JUN.
Location : Ekofisk; North Sea, UK SECTOR

Injured : 0 **Dead :** 0

Abstract

Cleaning of gas turbine with high pressure water and chemicals had been completed and the gas alarm turned off as it was affected by the cleaning chemicals. On running up the gas turbine to full power a flameout occurred but because the gas alarm had not been reset the build-up of gas in the combustion chamber went undetected. On re-ignition there was an explosion which set fire to the inlet air filter.
[fire - consequence, operation inadequate]

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]

1081629 April 1991

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

Hydrogen fuelled fires in non-nuclear section was allowed to burn out. The main transformer buckled during a power surge spilling 20000 gallons of oil, 100 gallons of which spilled into the nearby waterway. The turbine generator and conductors were severely damaged. The plant was shut down after one month. There was no radioactive release.
[damage to equipment, plant shutdown, process causes]

Lessons

[None Reported]

5034 26 June 1990

Source : HAZARDOUS CARGO BULLETIN INCIDENT LOG, 1990, SEP.
Location : South Shields; Tyne And Wear, UK

Injured : 2 **Dead :** 0

Abstract

Two contractors overcome by fumes from chemical cleaner sprayed on generators of marine chemical tanker. Two Norwegian crew doned breathing apparatus and saved the men.
[marine tanker, asphyxiation, solvent, cleaning fluid]

Lessons

[None Reported]

4951 01 April 1990

Source : SEDGWICK LOSS CONTROL NEWSLETTER, 2ND QUARTER, 1990.
Location : Gulfaks A; North Sea, NORWAY

Injured : 0 **Dead :** 0

Abstract

Damage occurred in gas turbine generator on an offshore platform.
[damage to equipment]

Lessons

[None Reported]

4839 09 January 1990

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

Injured : 0 **Dead :** 0

Abstract

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

Lessons

[None Reported]

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

123931990

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 1

Abstract

A contractor was electrocuted while touching a lamp-stand that formed part of a temporary installation.
An investigation into the incident found that the cable to one of the lamp-fittings was damaged, the individual cores were interrupted and one of the cores was welded together with the earth-wire in the cable.
The earthing of the generator frame was not effective because of high resitance of the copper earth electrode. The earth leakage protection was not effective because of the unearthed winding arrangement and failed to trip the generator.
As a result of the above combination, circulation currents were flowing along various paths without being detected by the protection. When the victim touched one of the lamp-stands, he created another (parallel) path for the current and the contractors relatively low body impedance caused a large proportion of the current to flow through him.
[electric shock, fatality, generator, electrical equipment failure]

Lessons

[None Reported]

4750 19 October 1989

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

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

Lessons

[None Reported]

4546 16 April 1989

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred on an offshore production platform. Equipment involved: engine. Substance involve:, lube oil. Cause: leak.
[fire - consequence]

Lessons

[None Reported]

4539 11 April 1989

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Mechanical failure led to damage of a turbine at this refinery Fluid Catalytic Cracker Unit (FCCU) plant.
[damage to equipment, mechanical equipment failure, refining, fluid cracker]

Lessons

[None Reported]

1019528 June 1988

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred whilst an operator was carrying out routine engine starting in an engine testing room. The incident occurred when the engine backfired and a small fire started. The operator attempted to extinguish the fire with a hand extinguisher, but the room soon became smoke-logged and he had to withdraw. The works brigade responded, closed the doors and proceeded to deal with the fire. The local Fire Brigade arrived quickly and everything was under control by 8.15am.

There was damage to the cables and electronics associated with the engine testing facility. There were no personal injuries but two operators were affected by smoke. There was no damage beyond the close confines of the engine room.

[start-up, fire - consequence, engine, fire/explosion]

Lessons

[None Reported]

4206 24 June 1988

Source : EUROPEAN CHEMICAL NEWS, 1988, 4 JUL.
Location : Port Arthur; Texas, USA

Injured : 0 **Dead :** 0

Abstract

Incident at ethylene cracker plant. Explosion damaged steam turbine in a propylene compressor in compressor house from lube oil failure.
[cracking]

Lessons

[None Reported]

1072330 March 1988

Source : ICHEME
Location : , BELGIUM
Injured : 2 **Dead :** 0

Abstract

An accident involving 2 employees occurred in asbestos removal in an ethylene oxide unit. In order to remove the asbestos insulation around the system generator safely, the removal company was told to build a plastic tent with a lock round the steam generator.
A form was drawn up for this purpose which stated that flanges and valves could not be built in the tent and 'without roof'. An oxygen test was carried out on the tent in four different places on man's height and each time, normal values were measured. Based on this, the foreman gave permission to continue working.
Almost immediately of mounting the ladder in the tent, the two workers started to feel sick, became dizzy and everything turned black before their eyes. They managed to stumble outside and report the incident to the foreman.
Within 10 minutes of the accident, the oxygen test by the operator was done again which gave normal values. The general foreman carried out another test with another meter and normal values were noticed again. Later inspection showed that the tent was built with a closed roof and a bypass line on the nitrogen line was built in the tent with two locked block valves. Several used spray cans of glue and other substances were found in the tent and it was stated on the cans that they should only be used in ventilation rooms.
The actual cause of the accident is unknown and although nitrogen leaks in the tent cannot be excluded, there is reason to assume that other gases may have caused the symptoms of the 2 workers of feeling sick, throat irritation and breathing difficulties.
[gas / vapour release, maintenance, additional chemical present, testing, injury]

Lessons

1. It is now required to enter the tent and carry out the job with two people.
2. In the specific case of tents around ethylene oxide reactors in which nitrogen leaks can never be excluded, the tent must be built with windows of translucent plastic on each wall and entering the tent and execution of works in the tent is exclusively reserved for people carrying fresh air masks.
3. A safety guard will watch the tent for the whole period of the activities equipped with air apparatus and a knife to cut open the tent if necessary. The guard must be trained in using compressed sir apparatuses. A guard must also be provided for each work level.
4. Oxygen tests must be carried out every two hours on different heights.
5. The use of spray cans of glue or polyurethane in closed tents is prohibited unless the roof is open.
6. Asbestos removal personnel will be formally re-instructed about the procedure and that the conditions on the form must be observed.

3929 16 June 1987

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred on a generator at a power station which was caused by an electrical equipment failure.
[fire - consequence]

Lessons

[None Reported]

3599 26 April 1986

Source : LLOYDS LIST, 1986, 6 MAY.
Location : Chernobyl, USSR
Injured : 30,00(**Dead :** 31+

Abstract

On 26 April 1986 a nuclear reactor at Unit 4 of a Power Station exploded.
The turbine manufacturers working on the commissioning of Unit 4, during late 1983 anticipated that the unit might offer emergency power for some seconds during shutdown as the turbines spin to a halt. A test of this system was proposed but postponed to allow the plant to be commissioned before the end of 1983. On 27 March 1984, Unit 4 commenced commercial operation.
In April 1986, Unit 4 was to be shut-down for maintenance. A series of tests was scheduled, including the delayed emergency-power test. It was still unknown whether the declining momentum of the turbines could generate enough power to run the water pumps for 40 seconds. The test had to be conducted by the generator's manufacturers. Their plan was agreed after a 15-minute discussion with the deputy chief engineer for Units 3 and 4. The safety inspector was not consulted and the nuclear deputy chief engineer was not present. Formal approval was given by the director without consultation with nuclear specialists.
At 13:00 the reactor was switched to half power and one of the two generators was switched off. The emergency core cooling system was disconnected to prevent it from tripping. Before the test started there was a request for power until 23:00. The test was restarted at 23:00. Autocontrol of the control rods was disconnected. The power reduced, which under standard procedure would require the test to be abandoned. There was disagreement on what to do next. Further control rods were removed and by 01:00 the power had stabilised below the recommended minimum power level.
Soon after 01:00 an additional cooling pump was added to the system, requiring more control rods to be withdrawn. The extra water passing through the reactor caused a drop in steam pressure, and to prevent shutdown due to low steam pressure the operators overrode the trip signals. At 01:22, just as the experiment was beginning, the computer printout showed a reactivity reserve margin of half the minimum. At 01:23 the emergency regulating valves to the turbo-generator were turned off and the steam was shut off from the turbine. The computer logged a rapid rise in reactor power. The shift controller pressed the emergency shutdown button to lower all the control rods into the core, but the rods failed to descend completely. An explosion occurred blasting off the 1000 tonne shield and leaving the reactor open to the atmosphere.
[testing, reactors and reaction equipment, radioactive release, testing inadequate, design or procedure error, fatality, injury]

Lessons

Root causes of the incident included:
1. Inadequate commissioning of plant.
2. System was not tolerant of faults.
3. Large core which required a complex control system.
4. Complex piping with inherent difficulties in providing emergency cooling to each channel.
5. Absence of engineered safeguard features to counteract operator error.
6. Test was inadequately planned.
7. Regulations were violated.
8. Inadequate safety training, unclear assignment of safety responsibilities.
9. Inadequate handling of emergency.
10. Engineers in charge of the test knew little about nuclear reactors.
11. Deviation from specified operating procedure and neglect of safety procedures.

3348 07 July 1985

Source : LLOYDS LIST, 1985, 11 JUL.
Location : Ping-tung, TAIWAN

Injured : 0 **Dead :** 0

Abstract

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

Lessons

[None Reported]

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

1200106 July 1985

Source : LOSS PREVENTION BULLETIN, 078, 11-13.

Location : ,

Injured : 1 **Dead :** 2

Abstract

An explosion occurred in an ammonia plant resulting in two fatalities and serious injuries to another worker. Part of the gas purification plant was damaged.
The incident occurred during a water feed pump change over. Pump A with turbine was to be put into operation and pump B taken out. Three operators performed the change. However, the suction valve for the pump which was put into operation (pump A) was not opened and the plant subsequently shut down due to the failure of the water supply when pump B was stopped (low level trip on the absorption tower). As this fault was not discovered, the shift supervisor and the operators decided to start the plant again with water pump A. The water pump A was started, and the block valve (6mm) on the line to the absorption tower on the discharge side of the pump was opened after 10 seconds in accordance to the written instructions.
The operator in the control room noticed that the water flow was varying between 400 and 1700 m3/h (normal 2600 m3/h) and reported this via radio to the operators in the pump hall.
The operators then discovered that the suction valve was closed and reported this. They tried to open the valve but could not due to the high differential pressure against the gate valve. A small 50 mm bypass valve was already open, and this gave the reported flow on the flow indicator upstream from the valves.
Due to the suction valve being closed, the pump started cavitating/boiling and the axial thrust force balancing system lost its water flow. Consequently, the thrust collar of the bearing came in contact with the bearing cover which then turned red hot.
The temperature was thought to have been at least 750 degrees C.
The pump was stopped by the operator and normally the interlock system should have closed the block valve to the absorption tower.
However, the block valve stuck in a 40% open position and the check valve which was in series did not operate because the differential pressure was too small. The backflow rate had been limited by the capacity of the 50 mm bypass on the suction valve of the pump and later by the additional leakage to the pump hall.
This resulted in continuous flow of water from the absorption tower, followed by hydrogen gas which eventually entered the water main and the pump hall via the leaking flange. The operators, realising the situation, tried to depressurise the absorption tower by manual blowoff valves situated on the gangway on the pump hall roof. Whilst doing so, the pumphall exploded under them.
The following causes were found:
1. The check valve needed a major reverse flow of the water stream to provide the necessary force to close the valve.
2. The water pump suction side was designed for only 10 bar pressure and not fpr a discharge pressure of 40 bar.
3. The pump system was placed inside a building for frost protection, this made the confinement of hydrogen leakages possible.
[normal operations, design inadequate, fatality, injury]

Lessons

[None Reported]

9127 25 June 1985

Source : LLOYDS LIST, 1985, JUN, 25.
Location : California, USA

Injured : 0 **Dead :** 0

Abstract

Radioactive water leaked from a pipe connected to a steam generator inside a nuclear power plant. Fortunately this was contained inside the reactor building. [reactors and reaction equipment, near miss]

Lessons

[None Reported]

9114 13 August 1984

Source : LLOYDS LIST.
Location : California, USA

Injured : 0 **Dead :** 0

Abstract

An explosion and small hydrogen fire occurred in part of a generator in the non-nuclear section of a nuclear power plant. No release of radioactivity was reported.
The fire started on a turbine deck were the facilities generators are kept, this area is separate from the contaminant building where nuclear reaction takes place, so there was no danger of radioactive release.
[fire - consequence]

Lessons

[None Reported]

9118 13 April 1984

Source : NEW SCIENTIST.
Location : Bugey, FRANCE

Injured : 0 **Dead :** 0

Abstract

A 900 megawatt reactor was shutdown. This occurred after a series of electrical failures in the control panel, following a pump which sent cooling water to be removed with coolant. One back-up electric system failed, however, because current to the control panel had failed. The second, a diesel generator, did not work. The third back-up system, another generator, started.
[reactors and reaction equipment, electrical equipment failure]

Lessons

[None Reported]

2934 March 1984

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

Abstract

Damage to generator on a refinery utilities plant.
[damage to equipment, refining]

Lessons

[None Reported]

9115 March 1984

Source : LLOYDS LIST.
Location : Ohio, USA

Injured : 0 **Dead :** 0

Abstract

A valve failed knocking out one of the two steam generators that are the primary means for preventing the reactor from overheating.
The steam generator valve stuck in an open position after the reactor, which was operating at 99% power tripped due to another malfunction. The steam generator was emptied of water normally circulated through the reactor to keep it at safe temperatures. But the excess heat was being removed through an identical sister steam generator.
[mechanical equipment failure, reactors and reaction equipment, valve failure]

Lessons

[None Reported]

2916 16 February 1984

Source : DAILY TELEGRAPH, 1984, 17 FEB.
Location : , ENGLISH CHANNEL

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A fire broke out in the engine room of an LPG carrier cargo (1500 tonnes ethylene) which resulted in loss of power and a request for emergency assistance. However, the fire was extinguished by the vessels 17 man crew, and the ship was subsequently taken under tow to a place of safety.The cause of the fire is not reported. The cargo of ethylene was not involved in the incident.
[fire - consequence]

Lessons

[None Reported]

9247 08 February 1984

Source : LLOYDS LIST, 1984, FEB, 22.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A fire broke out inside the main engine scavenging manifold on a LPG marine tanker, damaging the main engine.
[fire - consequence, damage to equipment]

Lessons

[None Reported]

2855 1984

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

Abstract

An explosion occurred at a fertiliser plant involving a gas engine.

Lessons

[None Reported]

8421 28 June 1983

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred on a diesel test engine in a laboratory. The fire caused substantial damage to the laboratory. No personnel were injured. The investigation into the incident revealed that the machine has experienced a crankcase failure with severe crankshaft and piston damage. However the investigation failed to establish whether the fire resulted from mechanical failure of the machine, or from ignition of a fuel leak from the machine exhaust.
[laboratory work, testing, fire - consequence, mechanical equipment failure]

Lessons

1. All flexible rubber hoses on machine were replaced with metal braided hoses.
2. A revised procedure check list for machine start up was introduced.
3. Updated equipment inspection procedures were introduced regarding cleanliness.
4.Rroutine planned equipment inspections introduced with formal follow-up action plans.

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]

2528 10 March 1983

Source : INSTITUTE OF INSURERS
Location : , SYRIA

Injured : 0 **Dead :** 0

Abstract

Explosion in gas turbine.

Lessons

[None Reported]

2514 24 February 1983

Source : INSTITUTE OF INSURERS
Location : Marino Point, IRELAND

Injured : 0 **Dead :** 0

Abstract

A pump feeding lubricating oil to a turbine failed and escaping oil ignited. Spill.
[fire - consequence]

Lessons

[None Reported]

2422 07 December 1982

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

Abstract

Fire at a power station involving a generator, caused by shaft missalignment.
[fire - consequence, equipment misalignment]

Lessons

[None Reported]

1061023 December 1981

Source : HAZARDOUS CARGO BULLETIN, JUNE 1982.
Location : , WALES

Injured : 6 **Dead :** 1

Abstract

A marine transportation incident. A 2700 tonne coastal tanker was loading a cargo of gasoline at a refinery jetty when an explosion occurred in her engine room. Seven crewmembers were injured, one of whom later died.
Before the explosion the crew had discovered the presence of gasoline vapours in the engine room and had tried to shut down a diesel generator which was overrevving as a result of the gasoline vapours in the inlet air. At the time of the explosion they were attempting to disperse the flammable vapours from the area.
The engine room housed the drivers for pumps located in the adjacent pumproom. Glands were fitted to the pump motor shafts where they passed through the bulkhead separating the two rooms. It was later discovered that the pumproom was flooded with gasoline as a result of a serious leak. The most likely source of the flammable vapours in the engine room was through faulty glands. The ignition source could have been the overheated diesel engine or a spark from the generator.
The fire spread into the aft accommodation spaces.
Local fire brigades and fire-fighting tugs were called in. During the fire-fighting operation thermal updrafts made foam monitors ineffective. It was decided to flood the engine room to achieve maximum cooling.
[marine tanker, gas / vapour release, mechanical equipment failure, fatality, inadequate alarm system, fire - consequence, injury]

Lessons

The owners of the tanker made the following changes to other vessels of their fleet:
1. Level alarms in the pumproom.
2. Gas detectors on the engine room side of the pumproom bulkhead.
Adoption of ventilation systems suitable for heavy vapours could also be an important item, though this is not covered in the reports.
As regards fire-fighting, the local authorities, while satisfied with the response to the accident, recommended that:
1. Fire brigades to be called out immediately, rather than just alerted.
2. People in the area to be encouraged to call the police for information to minimise alarm.

1144521 November 1981

Source : ICHEME
Location : , WEST AFRICA
Injured : 0 **Dead :** 4

Abstract

An emergency generator at a petroleum terminal was brought on line. When the diesel generator was running satisfactorily, the 4 staff left the room and entered the adjacent switch house, it is believed with the intention of bringing the generator on line. An explosion occurred and all four were killed.The LPG system consisted of 4 inch jetty line to two large spheres. The entry line passed close to the emergency generator before entering a bunded pipe trench. As a heavy vehicle was to be used for pile driving in the area it had been decided to depressurise and degas the line between the spheres and the first valve, the spheres themselves, the bulk loading line and the bottle filling line. This venting took place without supervision and no readings were taken to monitor gas concentrations. This work was done without a permit to work, as was normal when work was carried out by the company#s own staff. The accident took place 8 hours after the venting.
After the accident investigations showed evidence of physical damage, but no evidence of secondary fires. It was concluded that the fire involved LPG only. No other work was taking place, nor were there any other people in the area, suggesting that the ignition source came from the generator itself. The most likely cause was spark from the non-flameproof switch when it was moved from mains to emergency power. The gas was stenched so it is unclear why the staff did not notice the smell in the area. Several possible mechanisms were identified for gas to escape from the open end of the gas line, but none can be definitely confirmed as the cause of the accident.
[fatality]

Lessons

The following areas were identified to prevent reoccurrence of such an event:
1. Better control of hazardous work.
2. Improved training and knowledge of the hazards of working with LP gas.

9430 19 November 1981

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A lagging fire occurred on a19.4 bar G steam turbine exhaust pipework. Flames were seen to be coming from lagging immediately below the steam turbine adjacent to the pipe support. The lagging was also smouldering locally in this area. The fire brigade were called and a dry powder extinguisher was used, the smouldering lagging was removed.
It is thought that a flammable solvent was being used by contractors, this had contaminated the lagging, did not have sufficient time to evaporate out and ignited causing the fire.
[contamination]

Lessons

[None Reported]

2271 21 October 1981

Source : ICHEME

Location : , SAUDI ARABIA

Injured : 0 **Dead :** 0

Abstract

An explosion on a refinery plant involving a turbine, caused by overspeed.
[refining]

Lessons

[None Reported]

2137 16 January 1981

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

Abstract

Fire and explosion at a refinery plant involving a gas turbine generator, caused by instrument failure.
[fire - consequence, refining, instrumentation failure]

Lessons

[None Reported]

1977 02 February 1980

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

Abstract

Mechanical equipment failure involving a gas turbine generator. Refinery utilities plant.
[refining]

Lessons

[None Reported]

9133 December 1979

Source : HAZARDOUS INCIDENT FILE, 1981.
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A minor malfunction occurred in the system which feeds water to the steam generators at a nuclear generating station.
[mechanical equipment failure]

Lessons

[None Reported]

1898 30 August 1979

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

Abstract

Mechanical equipment failure caused damage to a gas turbine generator at a utilities plant.
[damage to equipment]

Lessons

[None Reported]

9386 25 January 1979

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Failure of orifice plate. A steam generator was being raised to pressure using the high pressure steam main (650 psig) after a new joint had been injected into the bell end and prior to normal operation.

Later on that day a senior operator heard a steam leak, went to investigate and sound steam blowing from the orifice plate flanges. With the assistance of an operator he was closing the main valve and when the valve was almost shut, there was a loud bang followed by steam escaping from all sides of the orifice plate when the incident occurred.

Two fitters were sent to re-joint the orifice plate and found the plate had completely disintegrated and no trace of the gasket material was found.

The following conclusions were made:

1. The orifice plate failed due to cracks which appeared in the material.
2. These cracks were initiated by stress corrosion caused by concentrated chlorine attack.
3. The chloride irons were derived from the acidit gasket.
4. Cracks were propagated by a combination of stress corrosion and fatigue.

[equipment causes, material of construction failure]

Lessons

[None Reported]

9886 1979

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

On a large rotary hydraulic oil pump vibration and/or misalignment caused the coupling to fail. The overspeed trip on the turbine driver did not operate because of a bent valve spindle. The turbine disintegrated.
[pump, turbine, damage to equipment, maintenance inadequate, inspection inadequate, flexible coupling failure, safety equipment failure]

Lessons

Regular monitoring of pump vibration was instituted so that so that an increase could be detected and corrected before it caused an incident.
Overspeed trips require regular testing to ensure they remain in working condition.

9879 1978

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 0

Abstract

A pair of large team turbine driven hot oil pumps suffered from the severe vibration when changing operation from one to the other. In the end it loosened a flange on the small discharge valve bypass line and leak ignited. The cause was improper setting of the turbine governors. The difference of speed was on occasions sufficient that the faster pump reduced the flow on the other below the minimum safe level while both were on line during a changeover. This caused the pump vibrations. Until the incident no-one though to get expert advice on the reason for the vibration.
[hydrocarbon, start-up, pump, turbine, flange, blowout, fire - consequence, inspection inadequate, excessive vibration, flange leak, safety procedures inadequate]

Lessons

Centrifugal pumps and compressors should not be allowed to operate in parallel unless they are of the same design and driven at the same speed. Turbine driven pump governors need to be checked regularly where parallel operation is necessary.
Operations should report and supervision should investigate the cause of any severe vibration on a plant even if it only occurs for short periods.

1469 21 September 1977

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Fire at a production stabiliser plant. Source of ignition was hot surface. Equipment involved: gas turbine generator. Substance involved: lube oil. Cause: weld failure.
[fire - consequence]

Lessons

[None Reported]

1460 03 September 1977

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

Fire at a production oil stabilisation plant. Source of ignition was hot surface. Equipment involved: gas turbine generator. Substance: lube oil. Cause: weld failure.

Lessons

[None Reported]

1405 25 June 1977

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A fire occurred on a utilities plant. The source of ignition came from a hot surface in the area. Equipment involved: gas turbine generator. Substance involved: lube oil. Cause: seal failure.
[fire - consequence]

Lessons

[None Reported]

9368 05 January 1977

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

Abstract

Lifting gear incident. A crane engine ran out of control when an incorrectly fitted hydraulic oil line burst and sprayed oil into the engine air intake. The air filter, had it been fitted, would have prevented this.
[loss of control]

Lessons

[None Reported]

9961 25 September 1976

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A fire occurred in a catalytic cracking unit when the thrust bearing on the overhead fractionator gasoline transfer pump failed, allowing the pump seal to leak gasoline to atmosphere. The source of ignition is believed to have been from frictional heat in the area of thrust bearing failure. There were no injuries and fire damage was minimal. However, the fire initiated a chain of events which resulted in liquid entry into the wet gas compressor, causing severe damage to the compressor and drive turbine. Damage amounted to about $750,000 (1976). Unit down time was four weeks.
[fire - consequence, bearing failure, gas / vapour release, damage to equipment]

Lessons

The following conclusions were made:
Although the failure of the gasoline transfer pump bearing was the initiating element in the chain of events, extensive damage to the gas compression system could have been avoided if the automatic shutdown system on the turbine had been functioning properly or, when that system failed, if a manual trip out had been implemented.
The following recommendations were made:
1. Provide the required features to permit onstream testing of all critical elements in the turbine governor systems.
2. Establish a test schedule of sufficient frequency to ensure fouling of components due to lube oil deterioration will not occur between test cycles. For example, if lube oil on a dead-ended system is exposed to temperatures above 22 degree F, a monthly schedule might be warranted. Also, test facilities should included provisions to permit thorough flushing of dead-ended lines each time checkout is performed.
3. Especially avoid high temperature dead-ended oil systems where oil is in contact with copper or other metals which may promote oxidation and degradation.
4. Establish routine procedures to prevent deterioration of lube oil from water contamination, such as:
a) Maintain reservoir oil temperature to promote water separation (120 degrees F - 130 degrees F).
b) Check reservoir drain for presence of water.
c) When turbine labyrinths abnormal steam leakage, consider introduction of dry air or nitrogen at seal to minimise leakage.
d) If oil has hazy or darkened appearance, have analysed to determine extent and source of contamination.
5. Provide and maintain effective operation of eductors on the compressor labyrinth seals and/or purge compressor bearing housing labyrinths to minimise contamination of oil with process gas.
6. Maintain operator awareness of the consequences of liquid entry into compressors and of the importance of executing a manual shutdown of equipment promptly when automatic safety systems show evidence of malfunction.

9726 09 July 1976

Source : ICHEME
Location : , UK

Injured : 1 **Dead :** 0

Abstract

A multiple fracture occurred in the pipes leading to safety valves on a turbine interstage of a No.4 ethylene plant cracked gas compressor. At the time of the incident the plant had been running steadily. One man received minor injuries.
Minor damage was caused to equipment in the vicinity of the safety valves. As a result of the incident the plant shutdown immediately and remained shutdown for 10 days.
[damage to equipment, injury]

Lessons

1. Provided additional means of removing condensate.
2. Introduce checks to ensure that the condensate drainage systems are maintained in working order.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

1001 26 February 1975

Source : FINANCIAL TIMES, 1975, 27 FEB.
Location : Hunterston; Scotland, UK

Injured : 0 **Dead :** 0

Abstract

Fire damaged turbine and roof of building. Caused by hot oil.
[fire - consequence]

Lessons

[None Reported]

116691975

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A serious fire developed in the turbine house of this refinery which generated both its own steam and electricity.
The rupture of a diaphragm in a control valve allowed lubricating oil to spray into a basement area of the power station. The oil contacted an uninsulated section of a 900 psig steam line and ignited.
Briefly, loss of oil pressure to the turbogenerator also takes pressure off the steam control valve diaphragm allowing the steam driven auxiliary pump to cut in and re-establish oil pressure. The steam control valve was of an open body design and failure of the diaphragm allowed oil to spray into the atmosphere. The oil spray continued until the 500 gallon oil reservoir emptied, feeding the fire. Two turbogenerators were involved in the fire area, and loss of their electrical generation capacity was accompanied by the loss of pass out steam. Electrical load shedding according to a pre-scribed electrical emergency procedure was in hand, transferring from electrical to steam usage. This created a greater than normal demand on the 190 psig steam system. This would normally have been taken up by pass out from the 900 psig supply through the 400 psig let down stations, in turn to the 190 psig system. Unfortunately the 900 psig to 400 psig station failed to open on automatic, and further failed to respond when switched to manual control by the operator. The 400 psig boilers could have picked up the load to maintain the 400 psig system, but their load was not increased as false indication in the boiler house gave a normal pressure of 412 psig whereas the true pressure was only 325 psig. Eventually these false readings were recognised and the 400 psig boiler steaming rate increased and the 900 to 400 psig let down station manually jacked open.
Recognition of the problems and prompt action by the operating personnel in opening the let-down stations mitigated most of the effects of the steam loss to the refinery. The initial period after the fire demonstrated the inter-relationship between the various parts of the refinery, and the existence of good emergency action plans, tested by 'dry runs' did much to limit the effects of the emergency. The value of two way radio communication was also proved during the incident. In running up a standby turbine it was found that wiring for the external governor control had been damaged in the fire, preventing the control centre operator from synchronising the speed of the turbogenerator with the system. This difficulty was overcome by using two-way radios and manually adjusting the turbine throttle until the speed was synchronised.
[refining, power plant, turbine, valve, mechanical equipment failure, fire - consequence, leak]

Lessons

The modifications made by the refinery to correct the situation included the following:
1. The open type valve bodies were replaced with a closed type, with the breather vent piped back to the lube oil reservoir.
2. The above valves were removed from proximity to high pressure steam lines.
3. Critical pressure gauges, and let down valves are to be tested on a routine basis to ensure operational integrity.
4. A stand-by group of four to six two-way radios were made available solely to meet emergency situations
It is also recommend that refineries should include simulated total service failures as part of their emergency exercises The failure of ancillary equipment (pressure gauges, let down valves) during the emergency, illustrates the need to test such equipment on a routine basis.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

1050012 November 1974

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A fire occurred in the turbogenerator room of a powerhouse on an oil refinery plant. The fire was caused by oil leaking from a ruptured diaphragm on a pump that supplied oil to a turbogenerator. The oil sprayed into the surrounding area onto a bare section of 900psig steam line which caused the oil to ignite. The fire was extinguished by the on-site fire crew in about 15-20 minutes but, during the ensuing two hours, there was a consequence of significant stretching of the refinery's steam, and electrical supply systems.
[fire - consequence, refining]

Lessons

Description of the process:
An interlinked system utilised turbogenerators to:
1. Generate refinery electricity via 900 psig steam.
2. Extract refinery steam requirements from turbine drivers (400, 190 and 35 psig supplies).
3. Minimise electrical generation from 400 psig steam.
The fire caused the failure of one of the turbogenerator used to produce 900 psig and the apparent failure of a second. Both were shut down, this was followed by a failure of a system designed to automatically bring in supplies of steam at 400 psig. Also, since the steam from these two generators was part of the process for production of electricity, supplies of the latter were also affected. Prompt operator action mitigated the effects on both steam and electricity supplies.
Actions to prevent recurrence:
1. Modifications to the valve. Which allowed the oil to escape.
2. Improve lubricating oil pressure sensors.
3. Re-locate oil pump away from bare steam lines.
4. Improve scheduled testing systems for oil pumps and gauges, to check continued integrity.
5. Install back-up communication system for emergency usage only.

803 19 September 1973

Source : CHEMICAL MARKETING REPORTER, 1973, 15 OCT.
Location : Houston; Texas, USA

Injured : 0 **Dead :** 0

Abstract

Two unrelated fires. One caused by electrical failure which shutdown major units of oil distillation. Second was at the catalytic feed hydrotreater. The fire originated at the inboard end of a hydraulic turbine and spread quickly to the overhead piperack when the the hydraulic turbine bypass pipeline failed at a weld. The probable cause of the fire was hot oil from the hydraulic turbine being released from the case through a mechanical seal opening when the turbine connecting couplings and clutch experience a massive failure. The fire started due to hot oil spraying from the damaged turbine seal and quickly spread as it was fed with oil from the fuelled turbine bypass line. The source of ignition was probably sparks from the turbine shaft.
[fire - consequence, mechanical equipment failure, processing, weld failure]

Lessons

The following recommendations were made:
1. Couplings with sealed grease-type lubrication should be inspected on a maximum two-year cycle, flushed, and re-lubricated with a heavy duty grease.
2. Clutch housings should be designed to enable the housing to accept external loads.
3. Disengaging clutches should be anchored to the base plate and grouted to provide sufficient support for the clutch to remain in place in the event of coupling failure.
4. Provide secondary isolation valves on critical lines of the primary isolation valves could become inaccessible during an emergency.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

336 07 December 1972

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

On 7th December, 1972, the turbine drive of a cooling water pump was being started up when the upper casing disintegrated. The internals were scattered over a considerable area, one of the rotor wheels reaching a distance of 540 feet from the turbine and damaging pipelines and the side of a crude oil storage tank before coming to rest. There were no injuries to personnel but the turbine was a complete loss.

The turbine had been shut down in November for an overhaul which included work on the overspeed trip mechanism. Prior to putting the machine back on duty it was necessary to run it, uncoupled from its gearbox, in order to test the governor and overspeed trip. On starting up, the speed of the turbine increased rapidly accompanied with vibration, whereupon the machine was shut down; no reading was noted on the vibrating reed rev-counter attached to the case of the turbine. The same start-up procedure was repeated and although the rev-counter gave no reading, a high pitched noise quickly developed from the machine running at high speed and before any action could be taken, the top of the casing disintegrated.

[damage to equipment, mechanical equipment failure]

Lessons

Subsequent inspection of the turbine revealed that overspeeding resulted from the failure of the trip pin assembly. The correct operation of the latter is dependent upon the clearance between the plunger and the trip pin and this is adjusted by a jack-screw, which was missing from the overspeed trip lever.

10676December 1972

Source : COMPENDIUM OF SHIPPING INCIDENTS, 1967-1979, NO. 13.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. Serious damage occurred on a ship's main engine thrust due to inadequate oil lubricator whilst on power.
Shortly after leaving port, it was noted that the main engine lubricating oil (L.O.) temperature was abnormally high. An oil cover outlet valve was found to be barely open. This was opened and L.O. temperatures brought back to normal by the end of the watch. No comment on all this was made to the oncoming watch. Three and a half hours later the L.O. pressure to the main engine gear, had risen from 18-47 psi. The engine was slowed and discharge filters changed over. The pressure did not fall. The filters were opened and they were seen to contain traces of metal. They were cleaned and the engine pace increased. The L.O. temperature rose again. The ship proceeded to port for further investigation.
[damage to equipment, human causes, lubricating oil]

Lessons

The main turbine gearing was examined and:
1. The L.P. thrust collar pads were damaged beyond repair.
2. H.P. and L.P. primary thrust seriously damaged.
3. Main thrust ahead face serious damage.
4. Main shaft needed some re-machining.

The damage was, without doubt, worsened by continued running with insufficient lubrication. This could have been reduced, or possibly avoided if comprehensive handover information, between the two watches, had taken place.
Running at reduced speed, in confined waters and in poor weather, posed a hazard to the ship.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

4835 1972

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

Abstract

A propane pump turbine failed on a refinery. The plant operator of a propane deasphalting (PDA) and furfural units heard an alarm sound in the former unit indicating low propane feed flow.
He went from the furfural unit to the PDA pump house and found the propane feed pump turbine tripped out. He lifted the governor trip lever rod to re-start the turbine, allowing full steam pressure to the turbine and the turbine started to turn. Almost immediately sparks were seen emerging from the end of the governor housing and the operator dropped the trip lever rod, as he did so the governor and turbine bearing disintegrated.
The man was extremely lucky in only sustaining superficial small cuts on his face as the spread of debris was considerable within the pump house, this room rapidly filled with steam and it is to the credit of the operator and his crew that they were able to rectify the situation and maintain the plant on stream without further damage.
[damage to equipment, pump failure, refining]

Lessons

1. The operator in attempting to restart the pump turbine was unwise in the manner used since he re-admitted full steam pressure to the turbine casing.
2. Re-train operating staff in the handling of steam and other pump drivers.
3. Install safety valves in the turbine casings.

4834 1972

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A cooling water pump failed. This near miss occurred when the steam turbine driver of a cooling water pump broke up at high speed. A sheared coupling and failure of the emergency butterfly valve to arrest the overspeeding caused extensive damage to the turbine. Plant personnel were lucky not to be struck by flying pieces of metal. The fault lay in the mechanical inoperation of the overspeed valve.
[pump failure, valve failure, damage to equipment, mechanical equipment failure]

Lessons

Personnel are not always aware of the potentially destructive force of steam and require reminding of its dangers from time to time.

6785 1972

Source : ICHEME
Location : , UK

Injured : 0 **Dead :** 1

Abstract

Road transport. A fitter lost his life when the tilt cab of a vehicle was being returned to the normal position after maintenance work. The engine of the vehicle was running at the time, and, by some mischance, third gear became engaged, causing the vehicle to move forward. The man was caught between one of the wheels and the rear of the cab and dragged along with the vehicle.
[fatality, human causes]

Lessons

The immediate lesson to be learnt from this tragedy was that during the operation of tilting the cab, vehicle engines must not be left running. Engines should not be left running at any time during maintenance except when absolutely necessary for the job in hand. The hand brake must always be set and as an additional safety measure, consideration may be given to the use of chocks. However, it must be borne in mind that chocks will delay, or even prevent, moving the vehicle in an emergency, for example, a fire.

543 1972

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

Abstract

A road transportation incident. At a service station in Southern Turkey a road tanker arrived late at night to deliver product. The driver awoke the night attendant who lit a kerosene lamp and then started the generator. The driver connected the hose to the underground tank and then went to sleep. After a while the night attendant climbed onto the tanker with the lantern in his hand to check the product level in the compartment. To illuminate the liquid level better he lowered the lantern through the manhole into the compartment. The tanker exploded and caught fire, the flames enveloping the forecourt and the office building. The attendant was fatally injured and died on his way to hospital. The fire was extinguished after 1.5 hours but not before the road tanker was completely burned out and extensive damage was done to the service station.
[fire - consequence, fatality, damage to equipment, human causes]

Lessons

Train service station staff.

1305 1972

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

Abstract

A company reported a series of accidents concerning the breaking up at speed of steam turbines, as a result of over-pressuring and overspeeding. Following extensive investigations a number of recommendations were made.
[overpressurisation]

Lessons

1. Reed/vibration type tachometers are not an acceptable type of rotational speed indicating instrument for overspeed trip setting/testing.
2. Overspeed trip mechanisms should be checked, as far as practicable, for mechanical operation prior to running the turbine at or near its overspeed trip setting.
3. Where turbine casings are not protected by full capacity relief valves positive steps must be taken to ensure that the appropriate operators are trained to appreciate that the turbine casings must not be subjected to the full inlet steam pressure, by way of training and/or by mounting warning notices at the turbine steam inlet and exhaust valves.

1073126 February 1971

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 4

Abstract

A drain fitting on the piping between a booster and 40,000 psig high pressure compressor broke allowing ethylene to accumulate. Automatic equipment promptly detected the hazardous vapour and operated the automatic high density water spray system designed to wash ethylene from the atmosphere. Apparently the leak was too large for the spray system to handle. Ethylene entered the exhaust system of an engine which was driving one of the compressors causing the muffler to detonate, thus igniting the rest of the vapours. The explosions, which were felt six miles away, destroyed buildings and caused lesser damage throughout the polyethylene plant and to the surrounding properties.
[mechanical equipment failure, gas / vapour release, vapour cloud explosion, damage to equipment, fatality]

Lessons

[None Reported]

10668June 1970

Source : COMPENDIUM OF SHIPPING INCIDENTS, 1967-1979, NO. 6.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A ship's main engine was started on air while the vessel was in port. Visual evidence of a fault was observed but not fully communicated to the chief engineer.
Thus, the ship sailed without full rectification of the fault. Although further repairs were carried out at the next port, it was necessary to complete the passage on reduced power. Only at the next port, was it discovered that the main engine crankshaft journal had shrunk, causing incorrect settings and inability to maintain fun power.
[mechanical equipment failure]

Lessons

The engine start-up procedure had not bee strictly followed and a fault of non-communication to the appropriate authority.
This resulted in delays and extra costs.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

1050109 December 1967

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

Vibration of a steam turbine in a thermal cracking plant, led to a fire initiating at a pump gland oil leak. Operators saw a ball of fire at the inboard (inlet) end of the pump. The oil lines to this pump could not be shutoff immediately because the isolation valve was 10 feet above ground level and access to it was hampered by flames. The cracking plant was shutdown. However, the fire spread rapidly and caused several other oil lines in the oven to rupture. The plant fire crew finally extinguished the fire after about two and a half hours.
[fire - consequence, plant shutdown, excessive vibration]

Lessons

The severe vibration of the turbine, which led to the fire, was probably due to the nut which holds the over speed trip pin in place, coming loose. This resulted in severe vibration, transmitted to the gas oil furnace charge pump on which the fire started.
The following recommendations to avoid recurrence:
1. Re-route various oil pipelines to reduce possibility of adding extra fuel to a fire.
2. Relocate suction isolation valves to a level at which they can be reached from ground level.
3. Install water spray headers above critical equipment.
4. Investigate (a) possible use of sparger rings round hot oil pump packing glands, (b) possible change of blowdown valve type.
5. Install turret type water supplies.
6. Make valves that have to be at height chain operated.

9815 07 September 1967

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

Injured : 0 **Dead :** 0

Abstract

Fuel for jet engine starter cartridges was being compounded in a 10 gallon stainless steel mixer of special design and close tolerances. Near the completion of the mixing, the mixer was shut off, the mixture inspected and the mixer started remotely. The restarting caused a violent explosion.

Lessons

[None Reported]

9804 24 January 1967

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

Injured : 0 **Dead :** 0

Abstract

An electrical surge from a freak thunderstorm caused fire in the circuit breaker cubicle for a steam turbine driven electrical generator.
[weather effects, fire - consequence]

Lessons

[None Reported]

1014415 July 1966

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

Explosions occurred during start-up of a gas turbine.
An unsuccessful attempt was made to fire the gas turbine driver for the fluid catalytic cracking unit gas compressor. Gas was permitted to flow into the machine longer than normal because at first it appeared that combustion within the burner chamber had begun. The machine was tripped, brought back up to firing speed and the specified three-minute purge of the exhaust system performed. The second attempt to fire the machine also failed. It was then realized that the spark plugs were in the retracted or run position. The spark plugs were placed in the fire position and, following the specified three-minute purge, a third attempt was made to fire the turbine. Soon after the fuel gas was introduced, two explosions occurred in rapid succession, causing the exhaust system ducts to rupture.
The primary causes of the accident were excessive fuel gas rates for fire-off (due to the fuel gas ratio control valve opening too wide), faulty operation of the ignitors and a 'dead-end' in the duct system which the normal purging procedure did not sweep clear of the unusually rich mixture from the first two firing attempts.
[fuel gas, start-up, turbine, explosion, flow rate too high]

Lessons

The following recommendations were made:
1. Prior to each attempt to fire the gas turbine, open the vent downstream of the ratio control valve to check the operability of the valve at low flow rates. This does not assure 100% reliability but does vastly reduce the chances of malfunction.
2. Station an operator at the fuel gas flow recorder in the control room, to trip the machine if the fuel gas rate during fire-off reaches the quantity required to create a mixture of 50% of the lower explosive limit based on total air from the axial flow compressor.
3. Change the maximum ignition time from one minute to 25 seconds.
4. Install a flame detection device for start-up to shut down the machine automatically if flame is not sensed within 25 seconds after the ignitor is energized.
5. Install stainless steel spark plug assemblies to prevent the ignitors from remaining in the retracted or run position when the machine is shut down.
6. Increase the purge from three to ten minutes. After an unsuccessful attempt to start the machine (fuel gas introduced), a ten-minute purge is followed by gas tests to assure that all branches of the duct have been satisfactorily purged.
Eliminate the 'dead space' by installing a blanking plate to expedite temporary repairs. Move the valve at the waste heat boiler inlet to the location of the blanking plate.

9793 20 May 1966

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

Injured : 0 **Dead :** 0

Abstract

The blades of a gas turbine were damaged by an internal fire when a modulating valve opened wide after a flame out and raw fuel ignited off the hot blades in the turbine section.
[damage to equipment, hot surface, fire - consequence]

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.

9535 20 July 1965

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

Abstract

A fire occurred when ammonia escaped from an ice manufacturing plant and was ignited by the exhaust of a diesel engine.
[fire - consequence, gas / vapour release, hot surface]

Lessons

[None Reported]

9778 22 February 1965

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

Injured : 0 **Dead :** 0

Abstract

A cast iron vent condenser on a boiler feed water deaerator ruptured violently when an internal tube failed. Water shorted out a generator exciter, the AC generator failed, the boiler fuel control system went to vent and gas escaping from goose necks caught fire and ignited the boiler house roof.
[fire - consequence]

Lessons

[None Reported]

9774 05 January 1965

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

Injured : 0 **Dead :** 0

Abstract

A steam turbine driven coke oven gas compressor failed from vibration when a governor struck. Gas filled the building and a gas air explosion wrecked it. [mechanical equipment failure, gas / vapour release]

Lessons

[None Reported]

9773 28 December 1964

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

Injured : 0 **Dead :** 0

Abstract

The first time a new solid propellant rocket engine was being moved into a test building its unusual height caused it to catch the manual release on a deluge sprinkler system. About 100 rocket motors, in various stages, were damaged by moisture.
[damage to equipment, sprinklers, human causes]

Lessons

[None Reported]

9772 04 August 1964

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

Injured : 0 **Dead :** 0

Abstract

Oil sprayed from a broken lubrication line to a steam turbine driven electric generator and caught fire.
[mechanical equipment failure, fire - consequence]

Lessons

[None Reported]

5356 16 April 1947

Source : HAZARDOUS CARGO BULLETIN, FEB 1981.
Location : Texas City, USA
Injured : 3000 **Dead :** 468

Abstract

While sacks of ammonium nitrate were being loaded onto a ship, a small fire was discovered approximately 10 feet below the top of the cargo. The only water available was 2 jugs of drinking water and a 2 gallon fire extinguisher. A water hose was introduced into the hold but the master refused to allow its use because of the risk of damaging the cargo. The local fire department responded to an emergency call but on arrival found that they lacked suitable breathing equipment so a vehicle had to be dispatched to collect the equipment. Tugs failed to arrive to tow the ship away and the presence of a few cases of munitions in a hold adjacent to that where the fire was in progress deterred longshoremen from giving aid. The crowd of spectators was so thick that emergency vehicles had difficulty in trying to get through.

At 0912 a huge explosion occurred and the ship was torn apart. Two small aircraft circling overhead were destroyed and fell to the ground and bodies were seen falling through the air. Some 600 feet away, there was a vessel also carrying ammonium nitrate as well as sulphur and the crew had placed covers over the cargo hatches when the alarm siren first sounded. The force of the explosion blew the hatch covers off and suffocating fumes soon showed that the sulphur was on fire. A decision was made that the the vessel should be moved but tug boat crews had no heart for the task knowing that explosives were on board.

Later in the day, technical advice was received stating that ammonium nitrate would not explode unless a detonator was used. Therefore, cutting equipment was used to sever the anchor chain and tugs were able to move the ship but she then held fast probably wedged against another ship. At 0100 hours, huge balls of orange and red flames were seen coming from the vessel and an explosion occurred disintegrating the ship with flames rising to heights of 4,000 feet. Among the missiles hurled by the blast was a turbine weighing a ton and thrown over a distance of three-quarters of a mile. Casualties comprised 468 dead, approximately, 100 missing assumed dead and 3,000 injured. 2,000 were made homeless by the explosions.

[loading, fire - consequence, marine transport, damage to equipment, fatality, safety procedures inadequate, cigarette, labelling incorrect, injury]

Lessons

After the event, an inquiry concluded that the probable cause was a carelessly discarded cigarette or other smoking material. Incorrect labeling and the absence of the yellow 'oxidising substance' label resulted in the dock workers having no idea of any possible hazard and thought the risk was comparable to that of cement. As the yellow label was not present, smoking was not prohibited.

The lack of effort to remove the second ship or to keep it in a mobile state led to considerable additional destruction. Large quantities of water are required to stop an ammonium nitrate fire; the steam extinguishing methods used by the ship only exacerbated the risk. There was also an absence of legal controls in the port area.

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.

11847Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A hydraulic turbine using hot high pressure oil was connected through a clutch to a motor driven hydrodesulphuriser charge pump, which provided part of the power to drive the pump. The coupling between the clutch and pump failed. The failing of the lose coupling end then tore the clutch free from its pedestal. This in turn destroyed the turbine bearing and seal releasing hot oil which auto ignited. Finally the turbine bypass line failed increasing the severity of the fire. [hydrocarbons, turbine, coupling, rupture, fire - consequence, flexible coupling failure, bearing failure, inspection inadequate, design inadequate]

Lessons

1. Coupling with sealed grease lubrication should be inspected flushed and relubricated on a regular basis say two yearly.
2. Disengaging clutches should have adequate support so that they remain in place in event of a coupling failure. The same should apply to all elements of a drive train.
3. Where risks are high there should be isolating valves which will remain accessible during an emergency.
4. Routine vibration monitoring can detect deterioration before failure occurs.

11833Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

On a fluid catalytic cracking unit both fractionator overhead transfer pumps failed. Despite cutting back then cutting out the feed to the unit the level in the overhead receiver continued to rise. After 20 minutes the wet gas compressor operation because erratic and after 30 the internals failed due to liquid carry over. The coupling an seals then failed and the turbine driver overspeed and disintegrated. In investigation revealed that the operator had ignored the high level alarm. The high level shutdown had failed due to rapid lube oil deterioration making the hydraulic cylinder on the turbine steam valve stick open. [gasoline, hydrocarbon, cracking, continuous reaction, catalytic cracker, compressor, turbine, seal, damage to equipment, blowout, safety equipment failure, inspection inadequate, maintenance inadequate]

Lessons

1. Safety equipment needs routine checking to ensure it remains serviceable.
2. Lube oil should be checked for deterioration if this is rapid the cause should be sought and corrected.
3. Operators must be aware of the serious consequences of liquid carry over to a compressor. There was ample time for a manual compressor shutdown in this case.

11893Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A boiler fuel oil feed pump lost suction, probably due to light ends in the fuel. When the turbine driver sped up neither the governor nor the overspeed trip cut off the steam supply. The governor tore loose but the operator closed the manual steam valve before further damage was done. The overspeed trip was found to be stuck open and the governor valve stem badly fouled, probably by solids from the superheater spray water.
[fuel oil, steam, normal operations, turbine, protective safety equipment, near miss, damage to equipment, inspection inadequate, safety procedures inadequate]

Lessons

1. Though the incident was triggered by changing the fuel oil supply tank this was not the cause of the problem.
2. Safety devices such as overspeed trips must be checked on a routine basis. This can easily be done when shutting the unit down for maintenance.

11894Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

On a 500KW steam turbine which had been reconditioned, the governor and overspeed trip were being tested. Adjustments were made to correct erratic governor operation. These included shortening the overspeed trip loading spring. At the next overspeed trip test the turbine ran away and its casing shattered. The loading spring was found in a location where it could not have been if it had been refitted.
[steam, start-up, testing, turbine, rupture, maintenance procedure error, operator error]

Lessons

1. During overspeed trip tests the steam supply should be increased slowly under manual control while monitoring the speed with a tachometer. If the trip does not work the turbine will not then runaway and the steam supply can be cut off manually.
2. Operators may get careless in following the overspeed test procedures when overspeed trips almost always work correctly. They must be warned of the serious consequences.
3. An independent check that safety related maintenance work has been carried out correctly can be valuable.

11815Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

A 9500 kW gas turbine driver had failed to start twice. On the third attempt the burners did light but an explosion ruptured the exhaust ducting. The two failures to fire proved to be due to the spark plugs being in the retracted or runs position rather than the start position. The gas turbine had been given the standard 3 minute air purge between each attempt to start it. Investigations showed that due to instrument problems the fuel gas flow during start-up had been much higher than design. This together with a dead end exhaust duct to the waste heat boiler made the 3 minute air purge inadequate to eliminate flammable mixtures.
[methane , start-up, turbine, explosion, rupture, design inadequate, safety procedures inadequate, operator error]

Lessons

The use of a start-up check list could have reminded the operator to check the position of the spark plugs and he flow of fuel gas on the reloader chart.

11895Date Unknown

Source : ICHEME
Location : , USA

Injured : 0 **Dead :** 0

Abstract

Two machinists were carrying out an overspeed test on a steam turbine. The spacer type coupling had been unbolted at te pump end and pulled back away from the pump. While running at below trip speed vibration caused the coupling to move back towards the pump and re-engage. The shaft bent and the coupling was thrown free. Fortunately no one was injured.
[steam, start-up, testing, turbine, damage to equipment, near miss, maintenance procedure error]

Lessons

1. The spacer coupling should have been:
a) Removed or
b) clamped against movement or
c) disconnected at the turbine end

12759Date Unknown

Source : CHEMICAL HAZARDS IN INDUSTRY, JUNE 2000,; SAFETY REVIEW, MAR 2000, (67), 21.

Location : ,

Injured : 0 **Dead :** 1

Abstract

An explosion occurred at a power station killing a worker. The incident occurred due to a generator transformer-winding fault causing the transformer tank to split.
An inspection of the tank was being carried out when an explosion occurred as the oil drained out of the vertical split.
The worker killed was standing in direct line of the fireball.
The fault is believed to have caused local heating within the transformer, which created a source of ignition.
The falling oil level allowed an explosive gas/air mixture to be formed. This ignited when the oil level exposed the ignition source.
[electrical equipment failure, fatality]

Lessons

The report stated the following recommendations:
1. The incident highlights the risk of explosion continues for some time after a fault occurs.
2. Personnel should be aware of the dangers of a loss of transformer oil and intake of air.
3. The transformer must not be approached until sufficient time has elapsed for internal heat to dissipate.

12910Date Unknown

Source : ICHEME
Location : ,

Injured : 1 **Dead :** 1

Abstract

A sudden imbalance of a turbine rotor as a result of excessive speed caused the steam turbine to disintegrate during an overspeed trip test. An operator was killed and another injured in the incident.
An investigation into the incident found that the governor valve was open and stem corrosion indicated that it had not been controlling the turbine speed during the trip test.
[overspeed, fatality, testing, injury]

Lessons

[None Reported]

13026Date Unknown

Source : LOSS PREVENTION BULLETIN 150, 16.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A ship's engine was turned over with compressed air while the vessel was in port, water issued from a cylinder cock. The facts were not fully reported to the Chief Engineer and the ship set sail with the cylinder concerned cut out. Repairs were carried out at the next port, but still the original facts were not fully reported.

After re-sailing and applying full power, the relief valve on the cylinder lifted continuously and power had to be reduced for the rest of the passage. At the next port, further checks were made on engine timing, fuel pump settings and shrinkage marks on one of the engine journals, but all appeared to be in order. Still, full power on the cylinder could not be maintained and finally, at the next port, serious shrinkage damage occurred to the other journal of the main engine crankshaft was observed. The delays incurred were described as expensive in both time and cost, though not actually quantified. They could have been avoided or at least minimised if the original faults had been reported to the ship's authorities in a timelier manner.

[damage to equipment, human causes

Lessons

[None Reported]

9636 Date Unknown

Source : MANUFACTURING CHEMISTS ASSOCIATION 1966 VOL. 2, CASE HISTORY 884.; LOSS PREVENTION IN THE PROCESS INDUSTRIES, F. LEES.

Location : ,

Injured : 0 **Dead :** 0

Abstract

An inert gas generator was found to have produced a flammable oxygen mixture. The fail safe flame failure device had failed. The trip system on the oxygen content of the gas generated had caused shutdown when the oxygen content in some of the equipment reached 5 %, but did not prevent creation of a flammable mixture in the holding tank.
[control failure, plant shutdown]

Lessons

[None Reported]

6937 Date Unknown

Source : LOSS PREVENTION BULLETIN, 011, 14-15.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A six inch diameter, 35 bar steam main which included an isolation valve in a horizontal section, was followed by a 25 metre rise to a turbine shut off valve. The main was trapped 30 feet downstream of the isolating valve and the trap discharged into a 12 bar steam main.

The 35 bar system had been shut-down for a fortnight while maintenance was carried out in the turbine. The turbine shut off valve was already open. When the boiler man eased open the isolating valve, pressure rose normally to 27 bar, at which a loud bang was heard and downstream pressure fell. The bonnet of the turbine shut off valve had failed, as had several gasketted joints. The two mechanics standing by the turbine were able to retreat from the steam release and broke windows to obtain air.

The cause of failure was attributes to water hammer, caused by incorrect trapping design. Circumstances were abnormal in that the 12 bar system had remained pressurised for a long time with the 35 bar system isolated. During this period the 35 bar system would have filled with condensate, which would cool, providing ideal conditions for water hammer.

[gas / vapour release]

Lessons

After the incident the trap arrangement was altered. A new manual drain valve was fitted to the 35 bar main and both its discharge and that from the trap were led to atmosphere.

6994 Date Unknown

Source : LOSS PREVENTION BULLETIN, 015,16.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A leak of light oil occurred in a pump house and was ignited by a diesel engine.
[fire - consequence, spill]

Lessons

[None Reported]

7012 Date Unknown

Source : LOSS PREVENTION BULLETIN, 017, 11.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A high pressure air separation plant had a turbine close to the lagging box. An oil leak from the gear box associated with the turbine contaminated this lagging. When a liquid oxygen leak developed on the oxygen pump inside the lagging box there was an explosion and fire leading to the deaths of some men. Fatality. [contamination, fire - consequence]

Lessons

[None Reported]

7317 Date Unknown

Source : LOSS PREVENTION BULLETIN, 062, 27-31.
Location : ,

Injured : 0 **Dead :** 0

Abstract

During the preparation for maintenance work to be carried out, a compressor turbine oversped and self destructed. No fire occurred, and four persons present at the scene escaped without injury, in spite of the large amount of flying debris.
The turbine speed was controlled by an electronic governor. The governor set point could be adjusted locally or by a signal sent from the control house. The latter mode of operation was the normal mode.
In order to allow for repairs to the electronic governor without causing a process upset or shutting down the steam turbine, provision was made for switching the turbine speed control to either manual or direct computer control. In these two cases the signal would directly control governing valve position rather than turbine speed. Switching was normally performed at a panel located next to the steam turbine. The panel consisted of 3 indicating receiver gauges, a 3 way air selector switch and a manual loading station.
The steam turbine went into overspeed because of operator error. The manual loading station was adjusted to match control house output rather than the electronic governor output.
The problem was aggravated because the switch was made near maximum speed. There was no room left for error. When the selector switch was thrown into manual the governing valve went from about 15-20% open to nearly full open. The turbine was only lightly loaded and accelerated rapidly.
The overspeed trip failed to function. This was due to the following factors:
1. The trip throttle valve (TTV) did not properly close. This valve had exhibited the same problem several times before.
2. The mechanical bolt was damaged during the later stages of the failure, and it is not known if it operated properly.
3. The electronic overspeed trip signal leads were not connected to the trip circuit.
The governing valve, which was much slower acting then the TTV, did not close during the overspeed because the governor had just been bypassed.
The written procedure did not address the problem of taking the turbine from governor control to manual.
The layout and labelling of the control panel were unclear. The information presented by the right hand gauge was, at the time, useless, and helped confuse the operator.
The basic cause of the accident was improper operation of the equipment aggravated by failure of the overspeed trip system.
[overspeed, instrumentation failure, damage to equipment, operation inadequate]

Lessons

The following recommendations were made by the company:
Develop a comprehensive written procedure for slow speed turbine operation during unit shutdown.
Include in all operating procedures for the particular compressor, a step to bring the turbine to minimum governor speed by decreasing the governor set to minimum, done from the control house, before switching to local manual control.
1. Improve the reliability of the trip throttle valve.
2. Simplify the layout and labelling of the control panel.
3. Eliminate the right hand gauge, control house output.
4. Retrain post technicians in the operation of the electronic governor and the switchover system.
5. Connect the electronic overspeed trip to the trip system.
6. Modify the trip system so as to close the governing valve in case of trip, even if the governor is bypassed. Take steps to minimise valve closure time.
7. Re-evaluate the design and operating instructions of the electronic governor in the light of this accident.

Search results from IChemE's Accident Database. Information from she@icheme.org.uk

7511 Date Unknown

Source : LOSS PREVENTION BULLETIN, 121, 4.
Location : ,

Injured : 0 **Dead :** 0

Abstract

Incident on a nitric acid plant. Some years after start-up an expansion turbine shed a blade with no prior warning or any process upset. The temperature of the gas entering the turbine had never fallen below 150 degrees C, yet two weeks prior to the incident a random vibration trace did show evidence of excitation of the turbine disc natural frequencies. The turbine was a single stage impulse unit from a toroidal admission path which had a septum closing off the cross section at the 1 o'clock position.

On inspection the turbine blades showed slight surface marks on the non-active face. In addition the admission blades near to the septum showed some damage on the non-active face.

At the inlet to the turbine the centrifugal acceleration on the gas was between 5,000 and 10,000 m/sec2 which would centrifuge any water in the inlet gas outwards to enter as a single coherent jet at the septum. All evidence before and after the incident was consistent with water passing through the turbine - but any steam tables will show that water boils at 138 degrees C, at 2.3 bar.

The explanation of this "defiance of science" was that the evaporation process is heat transfer limited such that, in the one or two seconds velocity time lag between the outlet of the interchange and the inlet to the turbine, full vaporisation of any water was incomplete. The root cause of the problem was the late commissioning of the absorbent flow and a thin film jet flooding on the top tray.

Lessons

[None Reported]

10755Date Unknown

Source : CHEMICAL HAZARDS IN INDUSTRY, FEBRUARY 1998.
Location : , TRINIDAD

Injured : 3 **Dead :** 2

Abstract

Five workers were sprayed with vapour at a temperature of 400 degrees C while carrying out maintenance on a turbine for a cooling compressor at an ammonia plant. Two of the workers died an the three others were seriously injured.
[gas / vapour release, fatality, burns, leak, injury]

Lessons

[None Reported]

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.

7645 Date Unknown

Source : LOSS PREVENTION BULLETIN, 134, 21-22.

Location : ,

Injured : 0 **Dead :** 0

Abstract

A power recovery turbine was fitted with a start up bypass. During start-up the pressure differential across the turbine was very low, but piping vibration was excessive and clearly defined as a pure frequency. As the bypass entered an atmospheric stack the resultant noise was unacceptable. The installation of a 'piccolo' in the line only served to change the frequency.
[excessive vibration]

Lessons

[None Reported]

7647 Date Unknown

Source : LOSS PREVENTION BULLETIN, 134, 22.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A near miss incident. The entrance to a steam turbine was made up of 8 entry paths, one from each poppet valve of the regulator. The final section as it entered the turbine body was rectangular with internal cylindrical bracing rods. After a number of years the cylinder to plate weld cracked, and was replaced by a flat plate with rounded profiles at the front and rear. The dimensions were identical, with only the void between the rods having been filled in. The gas flow swirled round a bend, such that the angle of incidence on the bracing plate would be finite. At one particular valve position the whole turbine resonated. The frequency was proportional to the square root of the steam absolute temperatures, therefore it was clearly acoustic. When the rods of a slightly larger size were fitted the vibration disappeared.
[excessive vibration, near miss]

Lessons

[None Reported]

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.

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.

10426Date Unknown

Source : LOSS PREVENTION BULLETIN, 135, 9-10.
Location : ,

Injured : 0 **Dead :** 0

Abstract

A steam turbine driving a propylene compressor on an olefins complex, had been indicating high vibration on the vibration monitors. It was decided to shut down the complex to investigate the problem. The plant was shut down, and the turbine opened and examined. It was found that the turbine had shed three free-standing blades, caused by the chloride induced stresses at the roots of the blades. The blades were replaced and the plant made ready for start-up. Four cracked gas furnaces were put on-line and cracked gas flowed forward to flare. The cracked gas compressor was then run-up to idling speed with the small 3.8 cm bypass valve, around the recycle valve, open, the recycle valve was opened from the control room, and the machine was run up through the critical speed. The machine immediately went into a violent surge. The machine continued surging, making the 90 cm suction main move 0.6-0.9 m, and the steam relief valves lift. All this vibration resulted in metal sheets on the sides of the compressor house becoming dislodged and falling some 9-12 m to the ground, just missing personnel. Meanwhile the recycle valve was being frantically stroked in the control room and checks were being carried out in the field to determine the position of the valve.
All indications were that the valve was operating correctly, with its stem moving to the corresponding signals from the control room.
After five minutes the machine was manually tripped in the compressor house and the plant shut down because of the dangerous situation developing.
The recycle valve was isolated and taken out of line. When it was opened it was found that the stem had sheared internally, such, that it would indicate correct operation when stroked.
It had been assumed that because the cracked gas machine had been operating normally before the shut down that the recycle valve was also functioning correctly. This assumption meant that the machine was left surging for longer than was necessary.
[shutdown, mechanical equipment failure, material of construction failure]

Lessons

[None Reported]

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.

7887 Date Unknown

Source : LOSS PREVENTION BULLETIN, 066, 4.
Location : ,

Injured : 1 **Dead :** 0

Abstract

A man was drilling a hole in the hollow piston of a steam engine, when the drill penetrated the shell, a 3 ft flame shot out and injured him. The gas inside the piston was analysed and found to be hydrogen.
[maintenance, injury]

Lessons

[None Reported]

9231 Date Unknown

Source : PETROLEUM REVIEW, 1985, JULY.
Location : , EUROPE

Injured : 0 **Dead :** 1

Abstract

A contract driver prepared to unload about 10 tones of propane from his road tanker into storage. The road tanker hose was connected to the works pipeline which was lined up to propane storage. The driver commenced unloading using the road tanker pump which was driven by the vehicles diesel engine. After about 30 per cent of the contents had been discharged, aloud noise was heard and a heavy propane mist produced. The refinery operator promptly closed the quick action emergency valves and started the water deluge system. The road tanker driver ran to the cab of his vehicle to stop the motor. At this point the propane cloud ignited forming a fire ball which seriously injured the driver who died after a few days in hospital.
[vapour cloud explosion, spark, fatality]

Lessons

[None Reported]

9445 Date Unknown

Source : ICHEME

Location : ,

Injured : 0 **Dead :** 0

Abstract

A marine transportation incident. A fire occurred in the engine room of a 1819 dead-weight tonnes oil tanker, whilst discharging oil cargo. Smoke and flames were emitting from the starboard main engine shaft driven generator.
Following activation's of the ships emergency procedures, the fire was eventually extinguished and the engine stopped by two crew members wearing compressed air breathing apparatus.
The cause of the fire was attributed to the failure of a commutator component.
The emergency response teams were hampered by illumination resulting from the dense smoke.
[fire - consequence, unloading, equipment causes]

Lessons

The fitting of retro-reflective material on protective clothing, compressed air breathing apparatus would enhance detection significantly in dense smoke.