Leak of refrigerant gas in a food factory

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Grimsby

United Kingdom

Chloro-fluoro-carbons
Domino effect
Pipes
Risk analysis
Safety management system
Organisation / procedures
Corrosion

THE FACILITIES INVOLVED

The site:

The company employs approximately 700 people in the production of fish ready meals which are then sold in supermarkets throughout the UK. Several different refrigeration and air conditioning systems are installed in the company's two factories. Raw materials and finished product are stored in large freezers which use ammonia as a refrigerant. Smaller air conditioning systems are installed in the factories to keep production areas at low temperature. The air conditioning systems use chloro difluoro methane as a refrigerant. A team of people had been given the responsibility for health and safety and this team included engineers, production managers and a full time health and safety officer.

The involved unit:

The air conditioning system from which the refrigerant gas leaked was installed in 1990 by a local specialist company. It was a common type of installation known as a vapour compression system. This means that a refrigerant is pumped into an evaporator where it changes state from a liquid at high pressure to a vapour at low pressure. This change of state produces a cooling effect in the evaporator and air drawn from the factory and through the evaporator is cooled before being returned into the factory.

The refrigerant in use in the air conditioning system was chloro difluoro methane which is also known as R22. It is one of the members of the general group of hydro chloro fluoro carbone or HCFCs which are known to be harmful to the ozone layer.

On contact with a naked flame, thermal decomposition occurs and irritant and toxic compounds such as phosgene, hydrogen chloride and hydrogen fluoride are released. These decomposition products can cause damage to the eye and respiratory tract.

The main motor in the air conditioning system was rated at 30kW and the system contained approximately 120 to 150 kg of R22. The air conditioning system from which the leak occurred was one of several similar systems in use in the factory.

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

The R22 had leaked from a small hole in the high pressure pipeline. The pipeline was made of copper and had a diameter of approximately 28 mm. The hole had developed because a water pipe located above the high pressure pipeline had also leaked. The water contained a corrosive biocide which, over the course of several months, caused the copper high pressure pipeline to corrode and eventually to split.

The R22 leaked from the pipeline over the course of two or three hours. Approximately 120kg of R22 had been released

R22 is heavier than air and so a cloud sank to floor level where air currents pushed it from the site of the leak and into a different part of the factory. Eventually, the cloud reached a part of the factory where a large industrial fish fryer was in use. The fryer was heated by gas burners. The R22 came into contact with the naked flame of the burners causing thermal decomposition as previously described.

Consequences of the accident:

13 employees were exposed to the thermal decomposition products which may have included phosgene. Fortunately, extraction ventilation was in use and so the employees were probably exposed to only low levels of irritant and toxic gases. These low levels were still sufficient to produce ill health effects. Some employees required several weeks of medical treatment although, fortunately, none appear to have suffered lasting damage to their health.

The European scale of industrial accidents

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the '*SEVESO II*' directive on handling hazardous substances, and in light of the information available, this accident can be characterised by the four following indices:

The parameters composing these indices and their corresponding rating protocol are available from the following Website: http://www.aria.developpement-durable.gouv.fr

The overall score of the "Hazardous materials released" index stands at "1", since the quantity of toxic substances released remains unknown (parameter Q1: quantity less than 0.1% of the SEVESO threshold).

The "Human and social consequences" index was rated a "2", given that 13 employees were intoxicated.

Due to a lack of information available, both the "Environmental consequences" and "Economic consequences" indices were not rated.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

The investigation revealed several weaknesses in the company's procedures for operating the air conditioning system. (refer to each point on overhead) :

- √ The procedures for ensuring that risk assessments were carried out and reviewed periodically were very weak:
  - o There were no risk assessments for the operation of refrigeration and air conditioning systems.
  - o The health and safety officer had carried out some risk assessments relating to food production activities but, generally speaking, these were only produced in response to accidents or other incidents. Risk assessment was reactive rather than pro-active.
  - o The health and safety officer lacked technical knowledge of air conditioning systems and she relied on the engineering department for advice in this area. Unfortunately, the engineering department tended to work in isolation and had not contributed or offered to contribute to the risk assessment process.
- √ There was no scheme of planned preventive maintenance.
- √ No one had been given the responsibility for checking lubricant levels, the level of refrigerant in the system or the condition of pipework. No one was ensuring that parts were being replaced before they became worn.
- √ The company which installed the system did send an engineer once a year but he merely cleaned the condenser filter and recharged the system with refrigerant.
- √ A senior member of this company told me that he could have provided a planned preventive maintenance scheme. It would have involved his engineers attending site twice a year during which they would make detailed checks on the compressor, the condenser and the electrical control panel. They would also carry out a leak test of the system.
- √ There were no arrangements for detecting leaks of refrigerant. A halide lamp was available but no training in its use had been provided. A halide lamp is a simple piece of equipment. It has a small naked flame which will turn green in the presence of small quantities of refrigerant and purple for larger quantities.

- √ The engineers who were responsible for the operation of the air conditioning system were keeping very poor records. There were no record of repairs carried out, of how much refrigerant had been used of running hours of the system and there were no diagram or plan showing the layout of the system.
- √ None of the engineers were trained in the maintenance of refrigeration and air conditioning systems.
- √ There was a lack of knowledge within the company about codes of practice such as the Institute of Refrigeration Code of Practice for the Minimisation of Refrigerant Emissions from Refrigerating Systems. This code gives advice on all aspects of design and construction of a system, operation and maintenance, leak detection and training for personnel. The code is recognised by the HSE as setting out good practice in the use and maintenance of refrigerating systems.

ACTIONS TAKEN

The HSE considers that the company had failed to take sufficient precautions to protect both its employees and the environment. By putting employees at risk, the company had failed to comply with section 2 of the Health and Safety at Work Act 1974.

By releasing an ozone depleting substance, the company had failed to comply with Regulation 6 of the Environmental Protection (Controls on Substances that Deplete the Ozone Layer) Regulations 1996. (the Ozone Regulations for short).

The decision was taken to prosecute the operator for failing to protect its employees and the environment. The company was fined £l5 000 for failing to comply with the Health and Safety at Work Act and £4000 for failing to comply with the Ozone Regulations. The HSE was also awarded costs of over £5 000. The company was given 21 days to pay the fines and costs. A number of employees are now pursuing compensation claims and it is therefore likely that the company will suffer further financial penalties.

In court, the prosecution stressed that this was an unusual case in which one incident had not only put employees at risk but had also put the wider public at risk by the potential for environmental damage. The magistrates followed the case closely and took some time to decide on appropriate penalties.

The case received quite widespread media interest. It made the front page of the local newspaper, it was reported on the television news and I was interviewed about on local radio.

LESSONS LEARNT

The operator has introduced many improvements to the management of refrigeration and air conditioning systems. They began by dismantling all refrigeration and air conditioning systems over a period of months and replacing or repairing parts as necessary. This work cost the company well over £20 000.

A planned preventive maintenance system has been introduced. A new computer programme has been installed and is used to record the number of running hours of each refrigeration and air conditioning system. The programme will automatically indicate when certain parts of a particular system are due for maintenance or replacement.

One of the company engineers has completed a college course on refrigeration engineering. He will be assisted by a specialist refrigeration company who have been contracted to provide expert guidance to the operator. All work carried out by the specialist contractor will be recorded on the company’s computer system.

New leak detection methods have been introduced. A fluorescent dye is mixed into the refrigerant. Each week, an engineer examines pipework using an ultra violet lamp. If there are any leaks then the dye will fluoress under the UV light. This has already been a success as several minor leaks have been detected over the course of the past 18 months. Electronic leak detectors have been trialled but have not been successful. It has been found that gases other than HCFCs will trigger the detectors. The company still has halide lamps which, together with the ultra violet light, can be used to detect leaks quite quickly. Extensive records of all leak tests, pressure readings, hours run and all maintenance work undertaken are kept.

The company learned a valuable lesson on the nature of risk and the crucial role that risk assessment plays in successful health and safety management. Any incident has the potential to give rise to secondary risks. In this case the leaking water pipe lead to a leak in the pipe containing refrigerant. The leaking refrigerant gas posed no immediate threat to employees. The leak occurred in a part of the factory which is normally unoccupied The risk to employees only arose once the refrigerant travelled through the factory and came into contact with the naked flame. The lesson to be learned is that some lateral thinking is necessary when assessing risk and the assessor must always look beyond the obvious.