

Gas Detection on Offshore Platforms

Background

Twenty years ago, fire swept through an oil rig in the Scottish sector of the North Sea. Panic and confusion were the order of the day as the doomed installation buckled into the frigid water. One of the findings in a public inquiry into the disaster, headed by Lord Cullen, who is one of Scotland's senior judges, was that the gas detection system alarmed before the explosion. The explosion cost the life of 167 men and insured loss of £ 1.7 billion (US \$ 3.4 billion).

The disaster began with a routine maintenance procedure. A backup propane condensate pump in the processing area needed to have its pressure safety valve checked. The work could not be completed by 18.00 so the worker asked, and received permission, to leave the rest of the work until the next day.

Later in the evening, during the following work shift, the primary condensate pump failed. None of those present were aware that a vital part of the machine had been removed and decided to start the backup pump. Gas product began to escape from the large hole left by the missing valve.

An automatic gas-detection system triggered an alarm in module C where the blind flanged was situated, and the location of the initial explosion. The alarm did not trigger safety actions to mitigate the hazard. The subsequent and more sustained re-pressurizing of the pump, which occurred shortly before the explosion, would have released condensate at a rate of 3 kg/s, producing a flammable mixture containing about 45 kg of condensate in module C. This led to second series of gas alarms, seconds before the explosion.

The gas ignited and exploded, blowing through the firewalls. The fire spread through the damaged firewalls, destroyed some oil lines and soon large quantities of stored oil were burning out of control. The automatic deluge system, which was designed to spray water on an ignition event of this magnitude in order to contain it or extinguish it, were never activated because it had been deactivated.

Of the 229 people on board of the platform, 62 men were forced to jump into the sea because access to life boats was blocked by smoke and flames. Most of the 167 who died suffocated on carbon

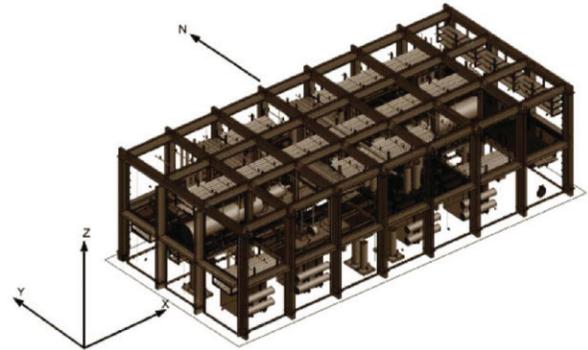


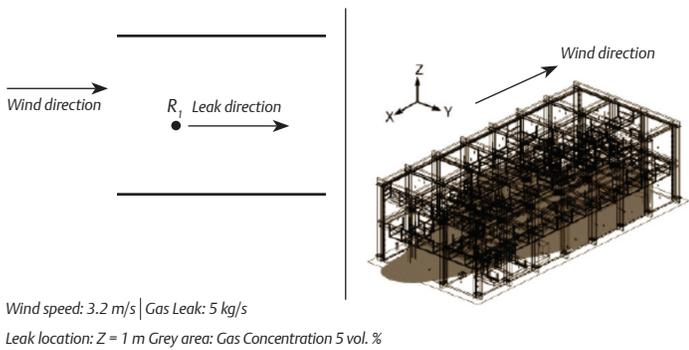
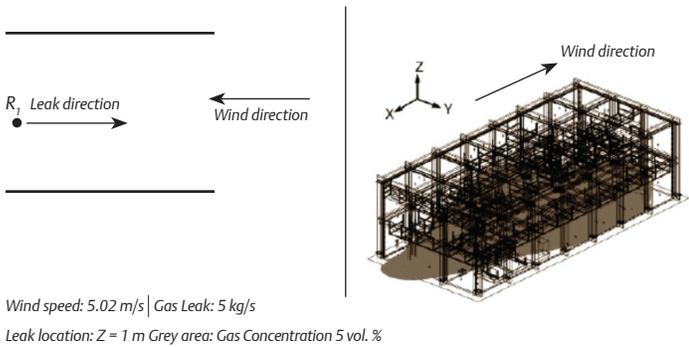
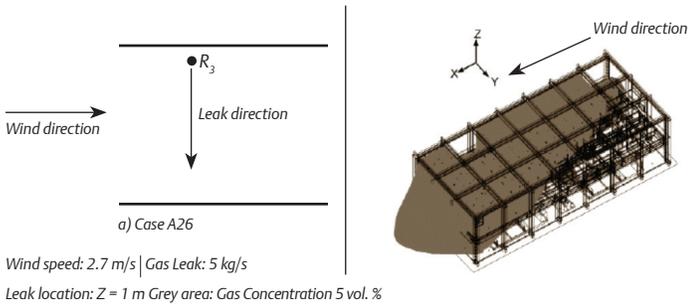
Illustration 1

monoxide and fumes. A potentially hazardous event can be harmless if it occurs in isolation. However, as with most man made disasters, it was a series of seemingly unlikely events that occurred in an escalating sequence. In the case of this incident, had the automatic gas-detection system triggered as designed, and brought the module into a safe state through emergency shut down processes then a major disaster could possibly have been averted.

In offshore structures, it is critical to understand: the degree of gas dispersion where interaction between the gas release; the wind field; and the complex, highly congested and partially confined geometry of the installation, in order to determine gas detector placement to achieve the adequate process safety time.

In 1998 a joint industry project was carried out to study the dispersion of high-pressure gas release in congested, partially confined geometry. The geometry represented a full-scale offshore process module with a high number of obstacles. The test module was constructed to be 28 m long in the x-direction, 12 m in the y-direction and 8 m in the z-direction (Illustration 1). The gas mixture used 20 % natural gas and 80 % nitrogen, with a molecular weight of 25.6. The lower- and upper flammability limit is set to be 5 vol. % or 100 % LEL defined by ANIS/ISA-TR.12.13.01 Flammability Characteristics of Combustible Gases and Vapors.

In each on the scenarios, with identical detector placement, the actual coverage was vastly different. Inadequate detector coverage due to improper or insufficient sensor placement would result in an unmitigated hazardous state.



Even with adequate detection coverage, the successful activation of the sensor(s), logic solver(s) and final elements safety functions is necessary to mitigate the hazard. Failure of any of the safety functions on demand will result in escalation of hazard. The availability of the gas detector depends heavily upon correct selection, installation, calibration and periodic maintenance of the detector.

Selection of the detector must identify the limitation of different sensor technologies. Two common sensing technologies are the catalytic sensor and infrared optical sensor. The catalytic sensor function is limited by the lack of oxygen presence. In the event on high combustible gas concentration, oxygen may be displaced which will negate the actual measurement. The catalytic sensor is also susceptible to poisoning agents such as silicones (e.g. waterproofing, adhesives, release agents, special oils and greases, hand lotion), sulphur compounds (e.g. sulphur dioxides, hydrogen hydrogen sulphide), halogenated compounds and organo-phosphorus compounds (e.g. herbicides, insecticides). The infrared sensor relies on the absorption of carbon-hydrogen bonds in the infrared spectrum; which will negate the actual infrared sensor incapable of detecting hydrogen gases. Some infrared sensors also utilize an internal mirror to reflect the infrared light source into a sensing receiver, possible optical contaminants (e.g. dust, oil film, salt deposits) could effect the detector accuracy.

Selection of gas detection technologies should also consider the process safety time. The process safety time is the time between detection of the hazard and the time to bring a process to a safety state. It is important to consider the potential release rate of flammable gas, response time of the sensor, delay time of data transmission, delay time of alarm device and time for executive action (e.g. emergency shut down valve, ventilation). In addition to detection coverage, factors such as ventilation, wind speed and direction, temperature effects, potential sources of ignition, protection from mechanical and water damage, and ease of maintenance and calibration should be considered.

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