A guide to understanding

Ground Gas Explosions

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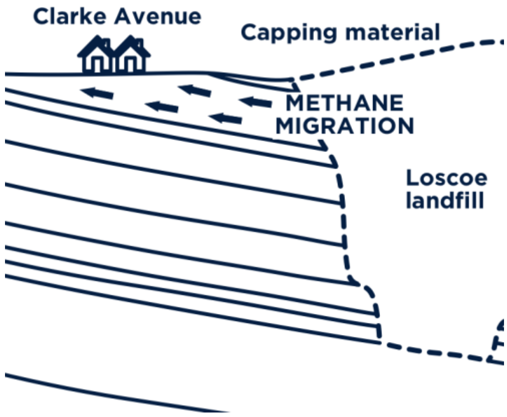

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A History of Ground Gas Explosions

The waste management industry has learnt the risks imposed by the potentially dangerous generation of landfill gas the hard way! Similar experiences to landfill gas explosions were evident many years earlier from the mining industry but despite this, it took several explosions and consequential deaths and injury before operators and regulators took action.

Figure 1: 1913 Senghenydd Colliery Disaster

On the 14th October 1913, 439 miners died at the Senghenydd colliery from what is believed to have been a methane (firedamp) explosion, caused by an electrical spark. The force of the explosion disturbed coal dust from the floor, which then ignited and raced through the mine.

On Wednesday 23 May 1984, a group of 44 people was assembled in a valve house set into a hillside at the outfall end of the Lune/Wyre Transfer Scheme at Abbeystead. The visitors were attending a presentation to allay anxieties on the effects of the installation on the winter flooding of the lower Wyre Valley.

As part of this presentation, water was to be pumped over the weir regulating the flow of water into the Wyre.

Shortly after pumping commenced there was an intense flash, followed immediately by an explosion causing severe damage to the valve house. Sixteen people were killed; no one escaped without injury from the valve house.

The explosion was caused by the ignition of a mixture of methane and air, which had accumulated in the valve house. The methane had been displaced from a void, which had formed in the end of the Wyresdale Tunnel during a period of 17 days before the explosion when no water was pumped through the system.

No source of ignition for the explosion was positively identified. Thorough examination and testing of the electrical equipment did not revealed any faults likely to have caused ignition and there was insufficient evidence to confirm any of the other explanations which had been considered. Smoking in the Valve House was not prohibited because the likelihood of a flammable atmosphere arising there had not been envisaged.

AN HSE investigation [1] cited several failings in technical measures, which otherwise may have prevented the explosion. The possibility of a methane rich environment had not been recognised. The fact that large quantities of methane might be dissolved in water, which subsequently leaked into the system, was not considered by those involved with the design/operation of the system. A system designed for discharging water open to the atmosphere would have prevented an explosion. The operation of the plant was not in accordance with the operating manual provided by the designers of the systems. Changes in the operating procedures had taken place without proper consultation as to their impact. Operators were not fully aware of the significance of special features of the pumping installation.

Figure 3: Loscoe, Derbyshire

At 6.30 a.m. on 24th March 1986, the bungalow at 51 Clarke Avenue, Loscoe, Derbyshire, was completely destroyed by a methane gas explosion. Three occupants of the house were badly injured (Figure 3).

Although natural gas was supplied to the bungalow, gas samples were taken during the resulting investigation from the wreckage soon after the explosion were found to be generally similar to landfill gas. Two more houses within the vicinity were found to be unfit for habitation for the preceding nine months, and others for short periods. Attention was directed, therefore, to a historical landfill site situated approximately 70m from the bungalow and the consideration of a possible pathway linking the two. In addition, atmospheric conditions were checked and a large fall in barometric pressure was found to have occurred immediately before the explosion where total pressure fell by 29mb in seven hours, with hourly drops in pressure ranging between 3.3mb and 4.8mb.

This was identified to have directly caused migration of landfill gas through a permeable sandstone horizon that 'sucked' methane along it (Figure 4). A central heating pilot light ignited the methane.

After the explosion, Derbyshire County Council monitored methane levels in the remaining houses immediately around the destroyed bungalow at regular intervals and attempts were made to draw the gas out of the tip by horizontal and vertical methane extraction wells. Flow rates of landfill gas generated from the site measurements subsequently were 150–200 m^3 of gas per hour with a 30–35% methane content and 3–4% oxygen: or approximately 45- 70 m^3 of methane per hour.

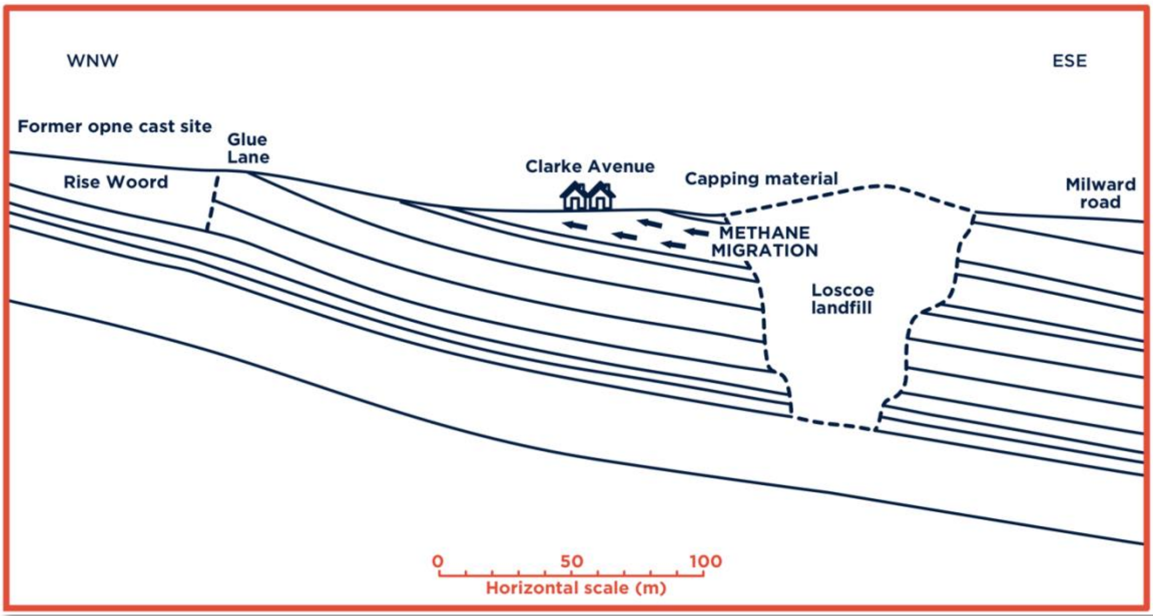

Figure 4: Based on geological cross-section at Loscoe, Derbyshire

NHBC guidance [2] would now recommend that such a cross section, also known as an initial conceptual site model, would form part of a preliminary risk assessment prior to any development work in the vicinity of landfill.

US Explosions

Atlanta, Georgia, USA

In December, 1967 a single storey building was destroyed, two people killed and two injured by a methane gas explosion. The building had a basement which was bricked up sealing it except for a pipe which connected the basement to the rest of the building. Landfill gas escaping from the pipe was ignited possibly by a cigarette and an explosion occurred.

Winston-Salem, North Carolina, USA

In 1969 a gas explosion occurred in an armoury built close to a landfill site. The building was erected seven years earlier when the site was operational, but about a week before the explosion extra material was deposited over the site and it is thought this caused the gas migration into the building. The explosion killed three people, and twenty five were injured.

In these accidents the landfill gas explosions were caused by alterations to the pathways for gas migration after the closure of the site. These alterations or blockages caused the landfill gas to accumulate in an enclosed area and reach an explosive limit.

Conclusion

Thankfully, with current greatly improved landfill practices, landfill gas explosion accidents of the type described, have become a thing of the past. To a large extent they shaped the UK Environment Agency's landfill development requirements and gas migration prevention guidance, until the advent of the EU Landfill Directive in the late 1990s, as now embodied in the EU ATEX Directive and UK's DSEAR [3] regulations. There are many other references sources from bodies such as the NHBC [2] and CIRIA[4] as well as British Standards [5,6] plus, there are portable and fixed bore-hole monitoring solutions for long term studies.

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References

1. The Abbeystead explosion : a report of the investigation by the Health and Safety Executive into the explosion on 23 May 1984 at the valve house of the Lune/Wyre Water Transfer Scheme at Abbeystead',
2. NHBC Guidance on methane and carbon monoxide, March 2007
3. The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
4. CIRIA C716 Remediating and mitigating risks from volatile organic compound (VOC) vapours from land affected by contamination
5. BS8576:2013 Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)
6. BS8485:2015 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

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