



**HSE Investigation Summary of explosion
incident at 1-5 Bridge Street, Shrewsbury,
Shropshire, SY1 1QT
on 3rd January 2010**

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1) Executive Summary

At approximately 11.26am on Sunday 3rd January 2010 an explosion and subsequent fire destroyed 1-5 Bridge Street, Shrewsbury, Shropshire, SY1 1QT. Six people suffered major injuries, several others suffered minor injuries. A number of properties in the area were also significantly damaged and Shrewsbury Town Centre was partially closed for several days causing disruption for local residents and businesses.

1-5 Bridge Street was a part commercial, part residential premises. At the time of the explosion the ground floor and parts of the first and second floors were being converted for use as a restaurant. Part of the first floor was being used as residential accommodation.

West Mercia Police led the initial investigation into the incident. They concluded there was no evidence that any person had intentionally sought to cause a fire or explosion at the property. There was no evidence of the presence of an explosive device. The Police subsequently concluded their investigation and handed investigation primacy to HSE.

HSE undertook a detailed investigation into the circumstances that led to the explosion. The investigation focussed upon identifying possible fuel sources and likely ignition sources within the building and the local area.

Key Investigation Findings

The HSE investigation (supported by the Health and Safety Laboratory) revealed:-

- There was no evidence to indicate any person had acted intentionally to create a fire or explosion at 1-5 Bridge Street.
- There was no evidence of LPG or solid fuel sources within the debris of the building or incident area.
- There was no mains gas supply running into the premises.
- A low pressure cast iron gas main was located in the footway in front of 1-5 Bridge Street.
- The gas main was fractured at a point approximately 1.5 metres from 1-5 Bridge Street.
- A pathway that would have allowed gas leaking from the main to flow into 1-5 Bridge Street.
- A number of potential ignition sources within 1-5 Bridge Street.
- That, based upon debris analysis, the building damage was consistent with a natural gas explosion
- There had been no reports of the smell of gas either inside or outside of 1-5 Bridge St in the days or hours leading up to the explosion.

Key Investigation Conclusions

- Mains gas leaked from a fractured low pressure cast iron gas main located in the footway immediately in front of 1-5 Bridge Street.
- The gas accumulated within 1-5 Bridge Street.
- The gas was ignited by a source within the building leading to the explosion.

- The particular ground conditions, including the corrosive nature of the soil and the stresses imposed by structures near to the main may have contributed to the unpredicted failure of the main.
- There is no evidence of failures by the pipeline operator or any other company or individual to warrant prosecution.

2) The investigation team

HSE worked with West Mercia Police and the Health and Safety Laboratory to undertake a detailed examination of the incident scene. The HSE team included HM Inspectors of Health and Safety and specialists in metallurgy and fire and explosion. Representatives from National Grid Gas, British Telecom, Shropshire Council and Central Networks (the local electricity supplier) also contributed.

3) Description of Bridge Street area

Bridge Street is within Shrewsbury town centre and a busy traffic and pedestrian area. Bridge Street is a road allowing traffic to flow in both directions, with two lanes leading towards the Welsh Bridge and one road leading from Mardol Quay towards Hills' Lane/Barker Street.

There are a number of buildings neighbouring 1-5 Bridge Street, most are of a commercial nature or a commercial nature at ground floor level with some domestic accommodation at first/second floor level.

There were a number of below-ground utility infrastructure systems in the Bridge Street area. These included mains gas, water and electricity supply systems, telecoms and traffic light supplies running in part through Bridge Street and in particular within the footway immediately adjacent to the explosion site.

4) Description of 1-5 Bridge Street

1-5 Bridge Street was brick built and consisted of three storeys built on a concrete base with no cellar area. The commercial area of the building including the ground floor and half of the first and second floors of the building; were being refurbished for use as a restaurant. Part of the first floor contained a two bedroomed flat that was severely damaged in the explosion.

The commercial parts of Bridge Street were being refurbished for use as a restaurant. The work was internal only. There was no gas supply to the property. No construction work had been done in the property over the Christmas break and work had not recommenced. The contractors and property owner had visited the site the day before the explosion to discuss the project. As part of the discussions they visited all commercial parts of the property and noted no issues of concern.

The primary means of heating to the flat was electric wall heaters and an electrically heated hot water system. Neither the flat nor the commercial areas had any other fuel supplied and contained no portable equipment such as LPG powered appliances likely to leak any explosive gas.

The roadway immediately in front of the footpath area was a double yellow zone to prevent parking. There was no evidence to indicate significant traffic loading caused by vehicles parking on the footway outside 1-5 Bridge Street prior to the incident.

5) Circumstances leading up to the explosion

None of the occupants of 1-5 Bridge Street reported having smelt gas or noticed anything unusual in or around the flat in the days and weeks leading up to the explosion.

The occupants of the flat were awake until the early hours of the 3rd January and were in the lounge area of the flat until approximately 5am. They described a “funny” smell as they moved from the lounge to the bedroom at the rear of the flat. As one of them had a few minutes earlier turned on the electric wall heater in the bedroom, they had assumed that was the source, as the heater often gave off a musty smell when first switched on. There is no evidence to suggest a fault with the wall heater caused the explosion.

6) The explosion

On the morning of 3rd January there were four people occupying the flat at Bridge Street. None of them smelt gas or noticed anything unusual within the flat. Nobody left the flat during the morning. All four of the occupants were located around the landing and bedroom areas of the flat when the explosion occurred. There was no one present in the restaurant area of the property.

According to the time noted on the CCTV camera (owned by the local authority and located on Bridge Street) the explosion occurred at approximately 11.26am. This is consistent with the timings of the Police, Fire and gas emergency service response to the incident. The video evidence shows that the explosion occurred within 1-5 Bridge Street.

Immediately after the explosion, a fire was burning in the footway immediately in front of 1-5 Bridge Street. This fire became increasingly intense in the minutes after the explosion.

7) Injuries and damage

All four occupants of 1-5 Bridge Street suffered major injuries when they were either thrown from the building, or buried in the debris. The explosion damaged the north and west sides of the property. Debris was thrown some distance from the building into the neighbouring Shrewsbury Hotel car park and the surrounding areas.

There were a number of vehicles parked at the Shrewsbury Hotel. A family of six were near or within their car in the car park at the time of the explosion. Two of them suffered major injury from flying debris. Many of the neighbouring buildings suffered damage due to the debris; this was primarily damage to windows and facade areas rather than significant structural damage. The explosion damaged other utilities within the Bridge Street area e.g. telecommunications infrastructure and traffic light systems

8) The cause of the explosion

West Mercia Police and HSE interviewed key witnesses including some of those people who had been injured. HSL experts carried out a detailed analysis of the site. This enabled the police and HSE to eliminate quickly the possibility of any criminal or terrorist activity. It also revealed no evidence of fuel sources such as Liquefied Petroleum Gas (LPG). The focus of the investigation became the gas distribution system in Bridge Street.

a) The gas main at Bridge Street

A 9-inch low-pressure cast iron gas main was found at a depth of approximately 1 metre below the footway outside 1-5 Bridge Street. The main dated from the 1930's. Its exact installation date, its manufacturer, installer, design specification and installation standard cannot be identified. It is common for the records for a main of this age to be unavailable. Site excavation and pressure testing confirmed that the gas main did not have any service pipes connecting it to any property in or near Bridge Street.

The main had been laid in a trench containing a number of bricks and was partly laid on a brick wall. This may have given rise to stresses on the pipe. It is current installation practice to lay new mains on an aggregate bed to spread any stress load. Also, a telecom chamber, constructed around 20 years ago, was close to the main. This may have placed further stresses upon the main.

The ground was a sandy-gravel soil type which is categorised as very aggressive to moderately corrosive.

The mains replacement programme requires specific risk assessments of cast iron mains using detailed risk modelling techniques. These assessments consider specific local conditions, local gas network leakage and maintenance history. Surveys undertaken as part of the mains replacement programme and for on-going maintenance purposes include visual ground level assessments. In this case these below ground factors could not have been known to National Grid Gas.

b) Network gas operating pressure

HSE's analysis of National Grid Gas records confirms that the gas operating pressures in the low pressure system feeding Bridge Street were within normal pressure parameters for this type of main in the days prior to the explosion. There was no evidence to indicate over pressurisation of the low pressure main outside 1-5 Bridge Street.

c) Gas odour information

Records from odourant injection points within the Shrewsbury local network confirmed odourant levels were within acceptable parameters prior to the explosion. The injected odourant makes gas easy to smell, so aiding detection of any leaks. No reports of the smell of gas in the Bridge Street area were made to the gas emergency service in the weeks preceding the explosion.

d) Key findings

There was no evidence to indicate any person had acted intentionally to create a fire or explosion at 1-5 Bridge Street. There was no evidence of LPG or solid fuel sources within the debris of the building or incident area.

The investigation identified a low pressure cast iron gas main, located within the footway in front of 1-5 Bridge Street which had fractured at a point approximately 1.5 metres from the property. There was no mains gas supply to the property. There had been no reports of the smell of gas either inside or outside of 1-5 Bridge St in the days or hours leading up to the explosion.

A pathway was identified which would have allowed gas leaking from the main to flow into the property. A number of potential ignition sources were identified within the property. Based upon debris analysis, the building damage was consistent with a natural gas explosion.

9) UK gas mains maintenance and legal duties

The UK cast iron gas main infrastructure was mostly laid during the first half of the 20th century and its current physical condition is difficult to determine. The gas industry has approximately 275,000km of gas pipelines in Great Britain, of these, some 91,000 km are iron mains located within 30 metres of property and operating at pressure between 25mbar and 2 bar. Since 1977 the gas industry has managed a mains replacement policy designed to reduce the risk of fire or explosion incidents arising from the failure of iron mains.

The Pipelines Safety Regulations 1996 (Regulation 13) requires that a pipeline is maintained in an efficient state, in efficient working order and in good repair. Under Regulation 13A operators may prepare a programme to manage risk from their network. If this programme is suitable and sufficient HSE must approve it. Once approved, the programme becomes part of the Gas Safety (Management) Regulations 1996 (GSMR) safety case for the pipeline network. Consequently, failure to comply with the approved programme leaves the operator open to prosecution.

The model used to judge if a programme is suitable and sufficient requires the operator to identify the highest risk sections of pipework and decommission or replace them on a rolling basis. The ultimate aim of the programme is to ensure that in the 30 years from its beginning all iron gas mains within 30 metres of any domestic property will have been decommissioned or replaced with a new (usually polyethylene) pipe. This is often referred to as the 30:30 programme. It is estimated that in the lifetime of the 30:30 programme over 100,000 kms of pipework will be decommissioned or replaced. Low pressure mains do not carry an additional risk weighting in the model. The low pressure main outside 1-5 Bridge Street was assessed as low risk thus it would be subject to replacement when it formed part of a logical approach to mains replacement in the general area.

The gas industry undertake a range of actions to achieve a gas tight distribution network. Regarding low pressure mains this consists of four key areas:-

- (i) mains replacement following risk assessment;
- (ii) leakage surveys;
- (iii) condition replacement;
- (iv) repairs of reported leaks including those reported through the gas emergency response system.

10) Review of dutyholder actions

a) National Grid Gas's low pressure mains maintenance

National Grid Gas's maintenance strategy is consistent with that of the wider gas industry.

i) Mains replacement risk score for the gas main outside 1-5 Bridge Street

HSE has scrutinised National Grid Gas's records for the gas main located outside 1-5 Bridge Street. We are content that NGG had correctly classified this as a low risk rating for replacement using the latest mains replacement model parameters. A low score means this main was not allocated for replacement prior to the incident.

ii) Leakage surveys

National Grid Gas's policy is to undertake a leakage survey on any main in the West Midlands network that has been allocated a significant risk score. As this gas main had a low score, it was not the subject of a leakage survey. This meets accepted standards.

iii) Condition replacement

In addition, all mains that have required maintenance or have been the subject of leakage reports should be assessed to determine whether there is a need to replace the main. The main outside 1-5 Bridge Street had not been the subject of leakage reports or recent maintenance and so was not subject to additional assessment.

iv) Repairs of reported leaks

As confirmed by the records of public reported gas escapes, there had been no reported leaks from the main in recent years thus no need for reactive repairs. This is in line with accepted standards.

HSE's investigation has concluded that in relation to the main outside 1-5 Bridge Street National Grid Gas had correctly applied their maintenance procedures. No factors were identified that could have indicated that this main was particularly likely to be prone to failure.

b) Enforcement policy for iron gas mains

In 2001, HSE published an enforcement policy describing a programme of activity that it believed to be the most reasonable approach for the gas industry to implement to manage the risks arising from the failure of ageing iron mains.

The gas industry undertake detailed assessments of the cast iron mains using risk modelling techniques which allow them to prioritise the replacement of those mains which pose the greatest risk.

Given the vast amount of mains which require replacement a 30-year replacement programme was proposed by the gas industry and agreed by HSE and the gas industry economic regulator, OFGEM. HSE believes the programme represents an appropriate approach to the mitigation of risk.

HSE's enforcement policy was updated in 2006 and remains in force. It has been widely publicised and is available on the HSE website (see

<http://www.hse.gov.uk/gas/supply/mainsreplacement/irongasmain.htm>). The policy aims to ensure that the risks of leaks from an aging gas network are managed and that those parts of the network most likely to fail are targeted for early decommissioning or replacement, the gas industry cannot ensure that all risks are removed.

HSE's investigation has concluded that National Grid Gas have correctly applied their gas mains maintenance procedures in relation to the low pressure main located at 1-5 Bridge Street. The main had been appropriately risk assessed, was not subject to leakage reports thus not identified for proactive replacement prior to the incident.

The investigation identified no breaches of health and safety legislation, therefore, giving consideration to HSE's enforcement model and enforcement policies, enforcement action is not appropriate in relation to this incident.

Acknowledgements

HSE would like to thank all those who assisted with the investigation including West Mercia Police, Shropshire Fire & Rescue Service and Shropshire County Council. These agencies were key in co-ordinating the rescue effort and actions taken to make the area safe, allowing further investigation and infrastructure repair work to be completed.

In particular we would like to acknowledge the efforts of both off-duty and on-duty police officers who were at the scene of the explosion almost immediately. These officers were instrumental in rescuing the injured under dangerous conditions. Their prompt actions significantly reduced the likelihood of further injury to members of the public.

We would also like to thank the many injured people and their families for their co-operation in the investigation at such a difficult time for them.