

## A Big Bang

*Contents:* A decision-making activity based on a case-study of a fire and an explosion in a warehouse.

*Time:* 2 periods or more, depending on number of activities attempted. Homework time could be used.

*Intended use:* GCSE Chemistry and Science courses. Links with work on burning, fuels and oxidation.

*Aims:*

- To complement work on burning, fuels, the fire triangle, and oxidation reactions
- To develop awareness of the need for safety precautions when dangerous chemicals are being stored
- To provide opportunities to develop skills involved in analysing evidence, interpreting data and communicating technical information.

*Requirements:* Students' worksheets No.1003. Some students may want access to a book of data or a catalogue giving more information about the chemicals referred to in the unit.

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This unit is based on a real incident which happened in Salford on the 25th September 1982. The information is taken from the report by HM Factory Inspectorate. The essential details of the incident have been retained but the place and the characters' names in the students' worksheets are fictional.

### Suggested use

Before reading the information, students should be aware of the decisions they have to make. These are described on page 4. The decision-making tasks are best tackled in small groups.

### Background information on the incident

This information is based on the report of HM Factory Inspectorate.

1 For many years there had been a serious problem of vandalism in the area. Vandalism increased when older buildings near the site were cleared. There were many examples of fires being started deliberately in empty properties.

The inquiry held after the incident decided that the fire was started by vandals outside the warehouse. Previously the vandals may have damaged containers of flammable liquids, spilt them and mixed them with other chemicals.

There was probably a flammable atmosphere at low level in the warehouse. This allowed the fire to spread quickly to the sodium chlorate which exploded violently. Once the fire reached the east end of the building the evidence suggests that the sodium chlorate stacked on wooden pallets exploded in less than a minute.

There was not enough evidence to allow the investigators to decide on the cause of the explosions. They came up with three theories. All three theories involve the drums containing sodium chlorate. The drums were made of steel with an inner lining of polythene.

*Theory 1* The explosion happened very quickly. There was only time for the outside of the metal drums to get hot. The polythene liners melted and reacted violently with the sodium chlorate. Hot sodium chlorate released oxygen which then began to react with the steel of the drums.

*Theory 2* The heat of the fire burst the drums. Sodium chlorate scattered on the floor and mixed with the vapour of flammable liquids which had been spilt by the vandals.

*Theory 3* The vandals mixed the chemicals and contaminated the sodium chlorate with flammable carbon compounds, making a mixture of an oxidiser with a fuel. When the fire reached this mixture and heated it there was an explosion.

**2** The haulage firm was not aware of the the guidelines published by the Health and Safety Executive for the storage of both sodium chlorate and flammable liquids.

There were 35 tonnes of sodium chlorate stored in the warehouse. It was packed in steel drums lined with polythene. Stored near the sodium chlorate there were large amounts of various carbon compounds. These compounds were highly flammable. Most of them react violently with sodium chlorate.

These arrangements for storing chemicals were in breach of the regulations: Sodium chlorate should be stored away from sources of ignition either in the open air or in a fire-resistant building. It should not be stored with other chemicals, or near things which will burn such as wood. The guidelines about storing flammable liquids warn that closed containers can burst violently when heated if they contain liquids. Such liquids should also be stored either in the open air or in a separate fire-resistant storeroom.

The chemical company were happy with the service they were receiving. They assumed that the haulage company would have the necessary knowledge about the chemicals and take suitable precautions when storing them. When staff from the chemical company visited the warehouse they did not comment on the way the chemicals were stored.

Following police investigations five people were charged with burglary. Two of them were also charged with arson.

### **Further activities**

Useful follow-up work might include bringing in a local Fire Officer, or a Health and Safety Officer from the local authority.

One trial school used a computer to produce a 'front page' mock-up for the 200-word newspaper article.

## A BIG BANG

This unit is about a fire and explosion in a warehouse. The accident happened in a town in the north of England. We will call the town Norton. There were 2000 tonnes of chemicals in store at the time.

The fire and explosion was at a warehouse owned by the Norton Haulage Company. The map in Figure 1 shows you where the warehouse was. The haulage firm was storing and supplying chemicals for a company we will call HGB Chemicals.

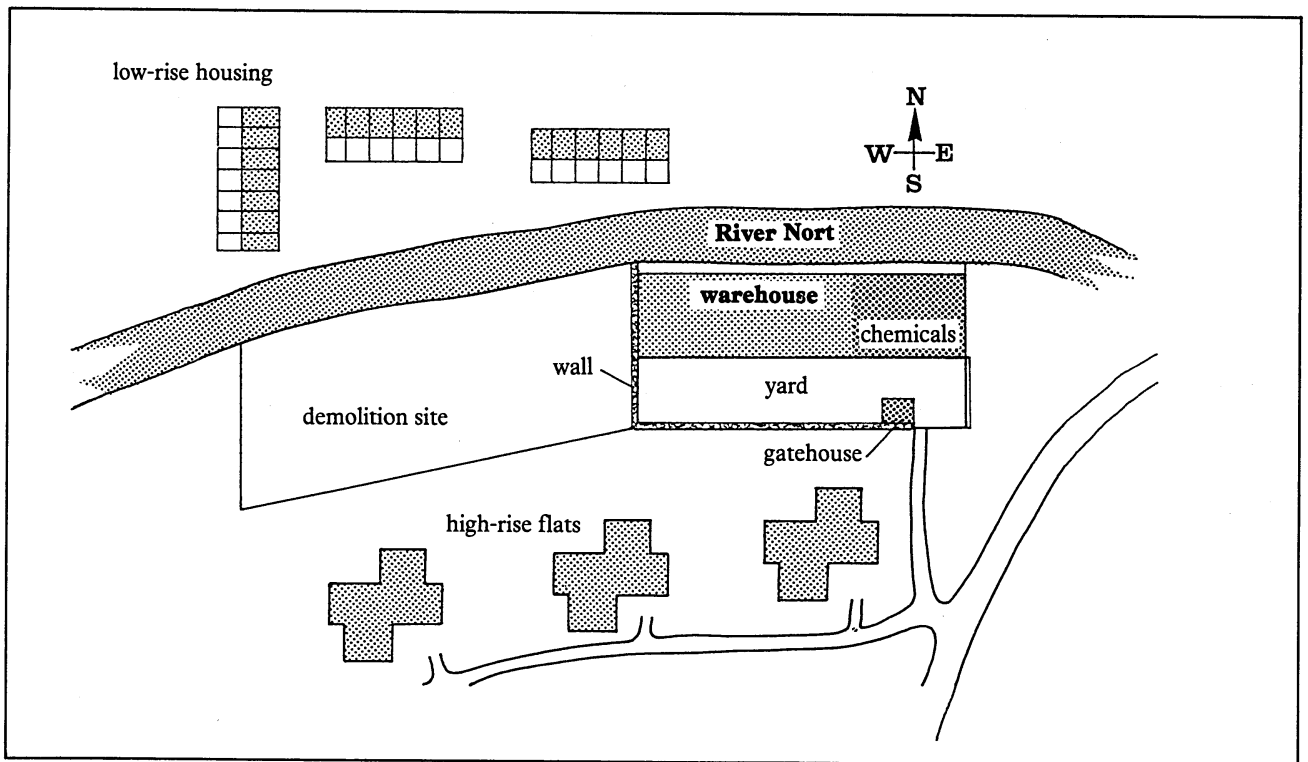


Figure 1

The explosion destroyed the warehouse. Many flats and houses nearby were damaged and several hundred people had to be evacuated from their homes.

About sixty local people went to hospital within three days of the incident. Most of them were suffering from the effects of breathing smoke and fumes. They were also suffering from shock. Nine people were treated for cuts, one for an eye injury and four for nausea and vomiting. Later about a hundred people went to the hospital complaining of chest ailments, sore throats, and the effects of fumes.

The explosion was so serious that there was an inquiry afterwards. In this unit you can read the stories from witnesses who were interviewed during the inquiry.

**Your job is to try to decide what caused the fire and explosion, and who was to blame.**

### Summary

Time:	23.30 hours
Place:	Norton
Situation:	A warehouse near the old docks.
Incident:	A fire and explosion



Figure 2 The warehouse after the explosion

## The evidence

### **Mr David Gray, Managing Director of Norton Haulage Company**

'At the time of the explosion we had large stocks of chemicals in the warehouse. All our records were destroyed in the fire but we have managed to produce a list of the chemicals which we think were in store at the time (see Information sheet).

'All the chemicals were in bags or drums. They were stacked on wooden pallets (trays). All the chemicals were together at the east end of the warehouse.

'HGB Chemicals were quite happy with the service we gave them. Their people visited us and never commented on the way we stored the chemicals.'

### **Mr Winston Carter, Security Guard**

'It was my job to patrol the warehouse and yard at night and weekends. We've had a lot of trouble with vandals at this warehouse. It's next to a demolition site, and the kids climb through a gap in the wall into the yard. Sometimes they manage to get into the warehouse.

'On the night of the explosion I arrived late in the afternoon as usual. In the early evening I saw some kids around the warehouse and I chased them away.

'When I'm on duty I walk round the yard at least once an hour. That night I went into the yard to look round at about 11.20. On my way back to the gatehouse I heard a noise like thunder followed by a very loud bang. I thought I was falling. I can remember turning and seeing flames shooting out of a hole in the roof of the warehouse.'

**Mr Gerald Wright, local Police Officer**

'We've had a lot of problems in this area since they started knocking down the old buildings. Children could get into the yard. A barrier was built to stop this but it was burnt down ten days before this incident.

'There were other fires between then and the day of the incident including one started using rubber tyres.'

**Mrs Ivy Green, resident in nearby flats**

'I live on the sixteenth floor. My bedroom window overlooks the warehouse. At about half past eleven I looked out of the window before going to bed. I saw smoke and flames coming from the end of the warehouse next to the demolition site — that's the west end. I went to phone the fire brigade at once.

'When I got back from the phone I saw the fire had got much bigger and I think I saw two people running away. The fire moved towards the other end of the warehouse — the east end. Suddenly there was an enormous explosion. It was followed by several more explosions.'

**Mr George Douglas, officer in local fire brigade**

'We received a 999 call at 11.30 pm. We were at the warehouse within three minutes. The warehouse was blazing and there were explosions from time to time. It took eight hours to get the fire under control.

'When the fire was out we inspected the warehouse. The damage was extensive. Most of the chemicals were destroyed or damaged by fire and water. We found two big holes in the floor at the east end of the warehouse. They must have been caused by explosions. We reckon the force of the biggest explosion was the equivalent of one tonne of TNT.

'The roofs and windows of nearby flats were damaged.'

**Mrs Susan Foster, officer of the Health and Safety Executive**

'I am a specialist on the safe storage of chemicals. The Health and Safety Executive have strict guidelines for chemical stores. Any company which keeps chemicals is obliged by law to follow our guidelines. Our rules are designed to protect workers and the public.

'Norton Haulage were not storing chemicals safely in the warehouse. They were not following our rules for safe storage.

'As far as fire risks are concerned, oxidizing agents and flammable liquids are particularly dangerous. They should always be stored apart from each other.'

## You decide

- 1 Work in a group to try to decide what caused the fire and explosion. Your explanations should be as detailed as possible.
- **How do you think the fire started?**  
Try to think of as many ways as possible.  
Remember the fire triangle (Figure 3).
- **How did the fire spread?**  
Why do you think the fire spread so quickly once it started?
- **What caused the explosions?**  
Why do you think there was an explosion when the fire reached the area where the chemicals were stored? Which of the chemicals do you think were involved?
- 2 When you have a theory to explain the fire and explosion, try to decide who you think was to blame. What responsibility — if any — do you think the following people had for the fire and explosion: vandals, the security man, the managers of the haulage firm, the managers of the chemical company using the chemicals?

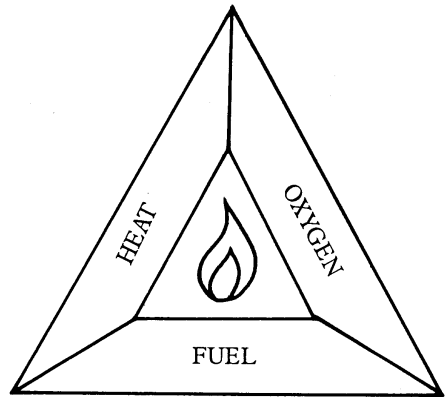


Figure 3 The Fire Triangle. The three things needed to make a fire.

## Further questions and activities

- 1 If you were the Managing Director of HGB Chemicals, what would you do to stop this type of accident happening again?
- 2 What could other bodies, like the police, the fire service and the Health and Safety Executive, do to stop this type of accident happening again?
- 3 Write a 200-word article for the local newspaper about the incident.

**List of chemicals stored in the warehouse of Norton Haulage at the time of the fire**

<i>Chemical</i>	<i>Packaging</i>	<i>Total quantity</i>	<i>Properties</i>
Titanium dioxide	Bags	950 tonnes	A white pigment which is used to make paint. It is not flammable.
Aluminium chloride	Steel drums 275 kg in each drum	450 tonnes	A solid which will react with water to release hydrogen chloride gas. Hydrogen chloride is a choking, acid gas. Aluminium chloride and hydrogen chloride are both non-flammable.
Paradichlorobenzene (1,4-dichlorobenzene)	Sacks 50 kg in each sack	300 tonnes	A flammable solid
Orthodichlorobenzene (1,2-dichlorobenzene)	Steel drums 250 kg in each drum. Some of the drums were badly damaged and had been leaking.	120 tonnes	A colourless, flammable liquid.
Lead chromate	Bags	90 tonnes	A yellow pigment which is often used for road marking. Highly poisonous. Not flammable.
Sodium chlorate	Steel drums lined with polythene. 50 kg in each drum.	35 tonnes	A powerful oxidizing agent. It gives off oxygen when heated above 265 °C.
Xylene (dimethylbenzene)	Steel drums 1.70kg in each drum	10 tonnes	A flammable liquid which evaporates easily.