Explosion of a truck carrying explosives

22 March 1989

Peterborough
United Kingdom

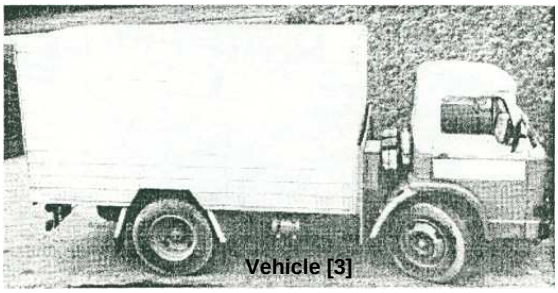
Pyrotechnics/ Explosives
Urban environment
Explosion
Organisation / evacuation
Risk assessment
Safety distances

FACILITIES, INFRASTRUCTURES AND ELEMENTS INVOLVED

Transport vehicle concerned :

The vehicle was a Ford D Series II.5 tonne box van, specially modified to carry up to 5 tonnes of explosives. The sheet aluminium box load compartment was fitted with a roller shutter door at the rear, and was separated from the cab of the vehicle by a fire resistant screen. The vehicle was crewed by a driver and an attendant who had been employed for 13 months and 11 years respectively.

The load included two consignments of blasting explosives to be delivered on route to Peterborough, fuseheads for a pyrotechnic factory on the Industrial zone, and a further consignment of high explosives for a destination beyond Peterborough.

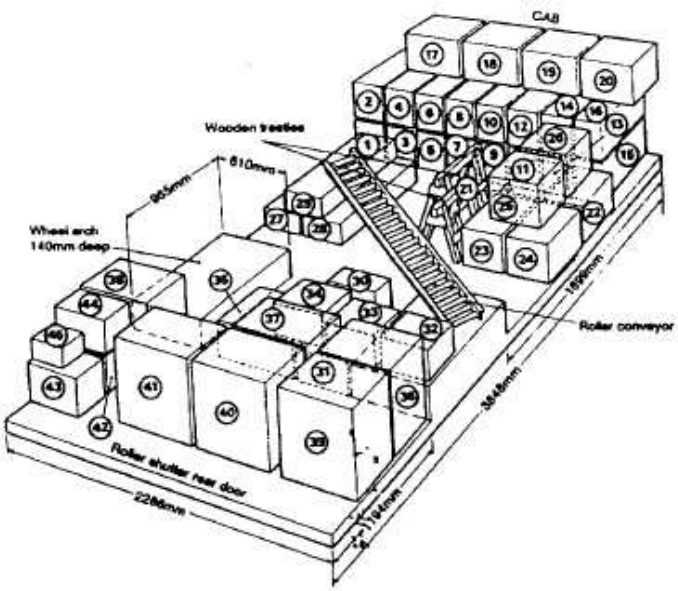


Vehicle [3]

At the time of the incident the vehicle contained [2]:

High explosives	Powergel 800 Powergel E800 Magma primers Ammon Gelit Wire (non explosive)	150 kg (6 x 25kg cases) 500 kg (20 x 25 kg cases) 56 kg (5 x 12.5 kg) 75 kg (3 x 25 kg) 5kg	Box 21 to 26 (draft below) Box 1- 20 (draft below) Box 27 - 29 (draft below) Box 30-34 (draft below) Box 35 (draft below)
Detonators	detonator boxes Detonator boxes	Empty 3 x 5 kg (500 No 8 star in number / 250 Magnadet in number)	Box 36- 38 (draft below) Box 39-41 (draft below)
Fuseheads	Vulcan Cerium	10,000 in 1 box 2,400 in 3 boxes	Box 45 (draft below) Box 42- 44 (draft below)

The high explosives and detonators were typical of those used in quarrying and other blasting work. The fuseheads were to be used at a fireworks factory as electrical igniters in pyrotechnic devices. The Cerium fuseheads were supplied uncut on combs with 20 fuseheads per comb. The Vulcan fuseheads were supplied already cut into single devices.

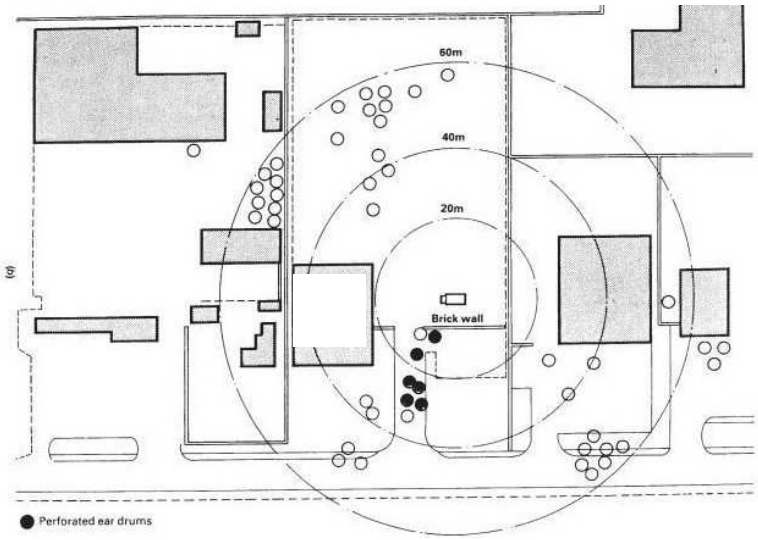


Distribution of load inside the vehicle [2]

The involved unit:

The yard where the explosion occurred is on the edge of an industrial estate mainly comprising small to medium size commercial and industrial properties, consisting principally of large steel and pre-cast concrete framed buildings.

The entrance to the yard is set back and separated from the road by a pavement and grass verge some 24m wide: the yard is about 90 by 60 m, bounded on the south side by a 2 m high, 9" brick wall, and on the other sides by a chain link fence. The surface of the yard was asphalt over hard core. There was a 'sleeping policeman' speed ramp just inside the main gate.



Site plan [1, 4]

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

The vehicle had travelled 140 km from the loading depot to Peterborough, making to deliveries en route at 07:15 and 08:00. The load had been rearranged after the second delivery. It was heading for the pyrotechnic Factory on the Industrial zone, but missed a turning. The driver decided to continue along the road and turned right into one company's yard to turn around.

As the vehicle entered the yard, it passed over the concrete speed ramp whereupon there was a minor explosion inside the load compartment which blew the rear roller shutter door outwards. As the driver continued in a clockwise circle around the yard he noticed in his rear mirror, blue smoke behind the lorry. He stopped the vehicle near the middle of the yard facing the exit.

Both the driver and mate went to the rear of the vehicle to investigate and subsequently to arrange contact with the emergency services.

The roller shutter door was hanging out of its guides on the passenger side and only partially in the guides on the drivers side. The door was secure both top and bottom. Through the gaps at the sides of the door could be seen smoke and flames inside the compartment.

Initially the fire produced only a small amount of black smoke. As it progressed however, minor "pops" and bangs were heard with increasing frequency. As the fire progressed further, thick yellow smoke was observed and immediately before the explosion the sides of the vehicle were seen to bulge.

The vehicle exploded at approximately 09.45, 12 minutes after the start of the fire. [1]

Consequences of the accident:

One fireman was killed by a fragment as he was approximately 15 metres away from the burning vehicle., just beyond the edge of the wall on the south side and at the entrance to the yard and stood ready to receive water. A second fireman was badly injured (burns).

The other badly injured person was outdoors approx. 40 metres away, and was hit by a fragment and suffered from a punctured lung.

The number of persons injured in this explosion exceeded 100. Of these, 80 were admitted to hospital; with 2 in intensive care, 12 as inpatients with other blast related injuries (head, spine, eardrums), and the remainder with superficial injuries (cuts, shock).

Persons outdoors and close to the explosion sustained perforated eardrums, cuts and bruises from flying debris, and were thrown to the ground. Persons indoors sustained the greatest numbers of injuries from flying glass. Other injuries indoors were due to collapsed ceilings.

The explosion created a crater of 3.5 m radius by 46 cm depth in the tarmac surface of the yard. The floor of the explosives vehicle was approximately 1 meter off the floor.

Blast damage to the two buildings on either side of the explosion was considerable. The closest building had to be demolished. Damage to buildings further afield consists of large doors blown in, metal cladding removed, asbestos roofs collapsed, metal cladding damaged, window frames blown in, extensive window damage etc. About 150 buildings were significantly damaged. Window damage was extensive reaching as far out as some 1 200 m away.

Approximately 13O cars were damaged to varying degrees, that is about 60 beyond viable repair, 13 badly damaged, 51 slightly damaged, and the remainder superficially damaged.

Fragments were thrown over a wide area. Within a licensed fireworks site some 380-400 m away, a number of small items in the weight range 100-3000 gram were found.

Overall, the blast damage appears to be consistent with a high order detonation of a quantity of explosives equivalent to 800kg of TNT [1, 3].

Aerial view of the disaster [3]

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

Two parameters come into play in determining the "dangerous materials released" index: Q1 and Q2.

- 800 kg of explosives of class 1.1 representing less than 0.1% of the corresponding Seveso threshold (50 tonnes – explosive substances not classified in division 1.4 according to the ADR agreement (United Nations), whish is the equivalent of level 1 of the "dangerous materials released" index according to the Q1 parameter.
- the explosion was equivalent to 800 kg of TNT, thus the Q2 parameter was rated at 2.

Consequently, the overall rating for the "dangerous materials released" index reached 2.

Two parameters come into play in determining the "human and social consequences" index: H3 and H5.

- The H3 parameter reached level 3: 1 fire-fighter died.
- The H5 parameter reached level 4: 100 people were injured.

The overall rating for the "human and social consequences" index consequently stood at 4.

Due to a lack of information, both the "environmental consequences" and "economic consequences" indexes were not rated.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

A comprehensive series of experiments was done to investigate various aspects of the accident [2].

Subsequent tests on samples of both high explosives and detonators involved in this incident showed normal behaviour. Their packaging fully met the requirements laid down. Examination of production records revealed no anomalies. All were found to be safe to transport.

The Vulcan fuseheads were found to be in a satisfactory condition and properly packed.

The Cerium fusehead combs however were found to be packed in unauthorised and unsafe packaging. The transport package consisted of an outer wooden box containing 2 metal boxes of 400 combs (each with 20 heads) placed lid to lid and surrounded by sawdust. The type of packaging used was both illegal and dangerous in that there were excessive numbers of fuseheads per box, the packaging was loose resulting in presence of loose composition inside metal boxes, and presence of rust.

Fusehead composition was examined and found to be extremely sensitive both to impact and friction. Mixtures with rust (1 %) had a 10 fold increase in impact sensitivity. Boxes of combs dropped from a height of 1.2 metres exploded in some tests but not others. Ignition trials on one box of cerium combs produced a fireball approximately 2.5 m in diameter, and lasting 0.3 second. [2]

The initial minor explosion was probably caused by ignition of the Cerium fusehead combs when the vehicle jolted over the speed ramp control. The likely mechanism for ignition being impact or friction of the fusehead debris or loose composition against the metal box packaging. The fusehead composition was probably sensitised by the presence of rust. The fireball which followed threw burning debris around the load compartment, starting a number of fires.

The mechanism for detonation of the whole cargo cannot be firmly established. One possibility is the presence of detonators which were scattered about during the fire and landing on or near heated and perhaps sensitised explosives. Another possible mechanism is the burning to detonation of the Pentolite boosters or the Ammon-Gelit. [1]

LESSONS LEARNT

Importance of a safe and adapted packaging for the transport of dangerous goods (TDG)

The packaging of the Cerium fuseheads revealed illegal and unsafe, making the release of loose composition possible during normal transportation. It was then a “matter of time” (in that case, probably chock when falling) before it reacted. A safe and adapted packaging is essential for the transportation of explosives. The explosive company operating the truck was fined £250,000 for breaching Section 3 of the Health and Safety at Work Act 1974.

Importance of an adequate evacuation

The fire should have been considered as a pre-warning sign and should have led to a large evacuation of the area. Instead, numbers of people congregated both in the open in close proximity to the van and inside buildings adjacent to glazing. This resulted in many injuries : persons outdoors were blown off their feet, sustained hearing damage, and for some injured by fragments ; persons indoors sustained serious cuts from flying glass and/or fragments and injuries from falling ceilings/debris.

If the start of a fire on a truck carrying explosives cannot be quickly mastered, e.g. by the use of the vehicle’s fire-extinguishers, good practice in such a case is to use the time between the onset of fire and the explosion to evacuate the area. That is also a reason why 2 experimented (i.e. aware of the dangers and of emergency procedures) drivers are necessary.

Destroyed car at about 40 m from the explosion [3]

REFERENCES (INCLUDING PICTURES)

- [1] HSE Report on the Peterborough explosion, blast damage and Injuries. Available via the EIDAS database.
- [2] Technical investigation of the explosion on 22 March 1989 at Peterborough, England. *Propellants, Explosives, Pyrotechnics nb 17 p 139-145 (1992).*
- [3] Ministry of Defense, Explosives Storage and Transport Committee "A comparative assessment of the recorded damage resulting from the accidental explosion of an explosives vehicle and the predicted damage to industrial structures". [not publicly available]
- [4] LEES's Loss prevention in the process industries; Vol 1. Sam Mannan Editor. Part on the case histories.