Lecture PA2

Accidents in Use of Explosives in Europe

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1. INTRODUCTION

This paper reports statistics and information from accidents, at the end user side, in some of the European Countries. The information have been collected in order to give an idea of what frequencies and types of accidents, with explosives involved, we see in Europe today.

Some of the sources mentioned in the paper do not differentiate on accident at the construction work site, the mine or at the manufacturer site. Some of the sources are missing either accidents at the mine sites or the construction site in their statistics - but still the material have been used in order to give the reader a glimpse of what we type and frequencies of accidents we can see among the users today.

Reports have been achieved from the following countries;

- Sweden
- Finland
- Ireland
- Germany
- Norway
- Denmark and Greenland
- France
- UK. (This material was extensive but the achieved material was at such a level that it was not possible to see the details of the accidents that were caused by explosion, without an extra effort of some days to penetrate the various databases and get the details out from them. The material has therefore been left outside this report.)

2. STATISTICS FROM SOME EUROPEAN NATIONS

2.1. Sweden

Data has been received from the National Board of Occupational Safety and Health at Stockholm and covers the years of 1992 to 2001.

Statistics are collected in the ten geographical regions of Sweden. The Stockholm region does not get all information regarding accidents/incidents.

Statistics cover manufacturing as well as mining and civil engineering operations.

An accident is defined as an event where a person has more than one day of absence from work. Property damage without personal injuries is not defined as an accident. (From 2001, within EU, it has been agreed upon that a reported accident should be one where a person has more than three days of absence.)

Destruction of explosives (demilitarisation operations);

- ○ Five reported incidents/accidents
  - • One fatality
  - • Three injured persons
  - • One property damage

Other incidents/accidents-i.e. wrong cutting of detonating cord, wrong use of linear shaped charges used in rescue operation etc.

- ○ Four incidents/accidents
  - • 2 injuries

Drilling into a misfired charge;

- ○ Six accidents
- • 4 fatalities
- • 2 severe injuries

Flyrock;

- ○ Eighteen reported incidents/accidents
  - • Three injured persons
  - • Fifteen property damages

A representative from the National Board of Occupational Safety and Health, Stockholm says the following regarding incidents/accidents due to Flyrock:

" It is believed that we have at least the same number of unrecorded cases."

2.2. Finland

From Finland statistics concerning fatalities has been received from 1930 to 1999 in the categories Blasting, Manufacturing, Storage, Children's play and other. See Figure 1.

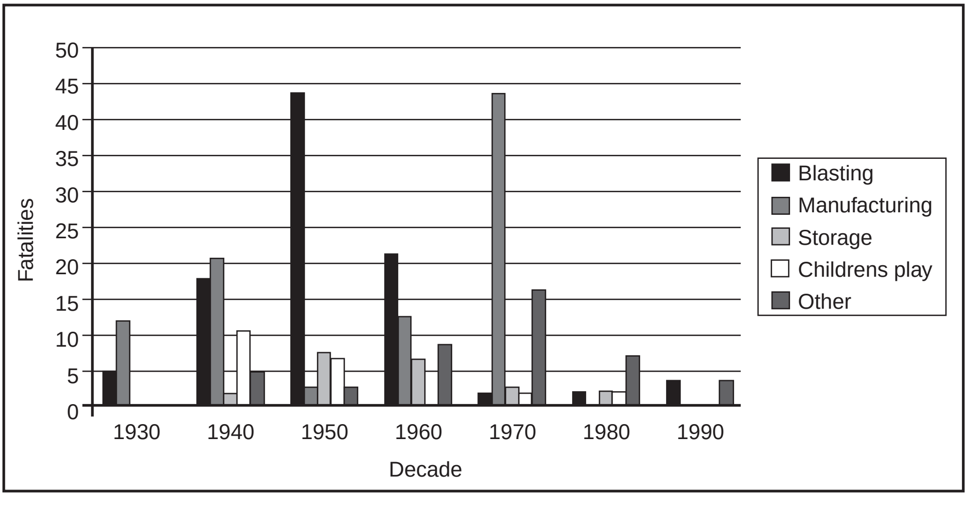

Figure 1. Number of fatalities related to explosives in Finland 1930-1999.

It was possible to break down the statistics to only reflect the end user side (construction and mining) and the result is shown in Table 1 below.

Transportation of explosives at the work site	1
Careless handling of explosives	2
Trench blasting	6
Charging	1
Flyrocks	6
Other	4
Total	20

Table 1. Fatalities at mining and construction sites related to the use of explosives during the years 1973-99.

2.3. Ireland

The material from Ireland is reflecting the situation during the recent 5 years. Examples reproduced below concern accidents in Mining and Quarrying but two are from Civil engineering work sites.

Flyrock (N.B. It is not compulsory to report flyrock unless it injures someone requiring them to have hospital treatment).

- Windscreen blown out of an excavator 500m away due to flyrock when blasting using pumped emulsions (not reported and not investigated).
- Bedroom window and doorframe of house damaged 300metres away (investigated) and due to poor blast design.
- 24 cars and 2 workshops damaged due to flyrock caused from, failure to have a free face, overloading of the hole, insufficient stemming and lack of training. Resulted in prosecution.
- New factory unit severely damaged +*E*3.000.000 as a result of flyrock (+6 rocks x 2 metres x 2 metres) a distance of 500 Metres away due to numerous failures by the shotfirer relating to design, face profiling, failure to check hole diameter or inclination, no drill log information and poor management controls. Prosecution pending.

Storage (N.B. Ireland is unique in that due to the unavailability of storage facilities surplus explosives must be destroyed on site [because of the terrorist threat].)

- 16 kilograms of explosives were destructed by burning. Established guidelines were not followed, electric detonators were accidentally placed on the fire. Due for prosecution March 14, 2002. (Civil Eng. Work).
- 64 kilograms of explosives were destructed by burning at the same site. Established guidelines were not followed, explosives self initiated during burning. Due for prosecution March 14, 2002. (Civil Eng. Work).
- A similar incident occurred when Galmoy Mine was under development and the explosives were initiated by burning primaflex detonating cord with the nitro-glycerin explosive.

Misfires

- In the mines there are numerous misfires involving pentaflex failing to initiate in the perimeter holes of tunnel blasts. There are a number of possible reasons for this including hole spacing, delay sequence, poor shotfiring procedures, failure to confine the explosives in the hole or a combination of these.

- Misfires are not reportable in the quarry industry and therefore no details are given.

Poor management control

- An incident occurred at one mine where the round was fired as someone was driving by and he was fortunate to avoid serious injury as the drivers door of the vehicle was severely damaged. The property damage was due to poor management controls and the failure by the shot firer to prevent access to that area.

Lightning

- There have been reports of a few instances of initiation or part initiation of a quarry round by lightning but in both of these cases the quarry had been cleared.

Extraneous current source/Static electricity

- A shotfirer was fortunate to only receive minor injuries when two electric detonators initiated in his trouser pocket when he placed a radio in there as well - the battery terminals coming into contact with the lead wires.
- Another incident involving a young worker, who should not have had a detonator in his hand, was injured during the loading of a quarry when the detonator in his hand initiated blowing off two of his fingers. Despite intensive efforts the cause of this cannot be pinpointed, the lead wires were not damaged, the detonator did not appear to have been previously damaged, extraneous current sources were not detected; static electricity is still probably the most likely source.

2.4. Germany

The Steinbruchs-Berufsgenossenshaft, (StBG) trade association is the carrier of statutory accident insurance for companies of the mineral extraction industry in Germany.

StBG has 6300 member companies with 195.996 employees.

Member companies are representing the following industries;

- Natural stone industry
- Ready-mix concrete
- Gravel and sand industry
- Prefabricated cement products
- Natural oil and gas industry
- Asphalt mixing industry
- Cement industry
- Recycling industry- Limestone and gypsum

Since 1962 StBG has in co-operation with other industrial trade associations and the local-insurance carriers kept statistics on accidents caused by work with explosives. Underground Mining is, however, not represented in the statistics from StBG.

From 1962 to 1966, the first five-year period, a total of 106 at-work explosives accidents were recorded, injuring 118 people - 5 of them fatally. Increased efforts in the following years resulted in a decrease in the number of accidents.

1992 to -96, the last completed five-year period, a total of 9 at-work explosives accidents were recorded, injuring 14 people - 4 of them fatally.

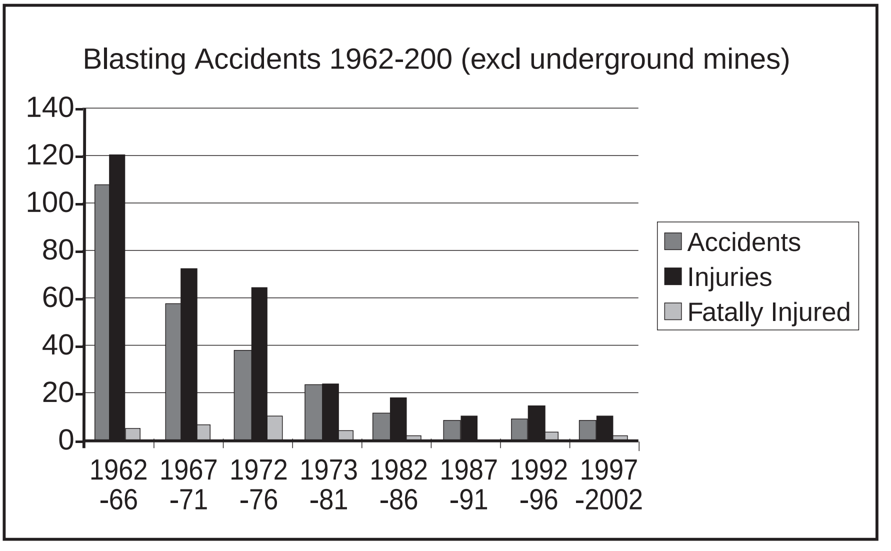

Figure 2. Blasting accidents 1962 to 2000 (excl underground mines).

Table 2 gives more detailed information about what accidents and their causes Germany has had during the years of 1997-2000.

Year	Injured	Fatally	Type of explosives	Type of blasting	Type of Accident	Cause of Accident
1997	1	0	Gelatinous	Area Blasting	Insufficient cover	Projectiles while removing dud. Failure to clear blasting area
1997	1	1	Emulsion expl	2nd series blasting	Insufficient Cover	Failure to clear blasting area
1998	1	0	Gelatinous	Large borehole	Premature detonation	Burning paper only 10m away
1998	1	0	Gelatinous ANC Explosives	Large borehole	Dud	Detonation during boulder comminution
1998	3	0	Gelatinous	Tunnel profile blasting	Dud	Improper manufacturing of the priming cartridge
2000	1	0	Emulsion expl	Boulder blasting	Insufficient cover	Failure to clear blasting area (within 94m)
2000	1	0	Gelatinous	Large borehole	Dud	Residual explosive in the debris heap, no redundant ignition
2000	1	0	Emulsion expl	Large borehole	Insufficient cover	Wheel loader remained with open door in blasting area (180m)

Table 2. Accidents during the period 1997-2000.

2.5. Norway

Norway has good long-term statistics of accidents caused at the end user side.

The definition of accident is very wide and it was noted that the definition of accident covered everything more severe than a Near Miss.

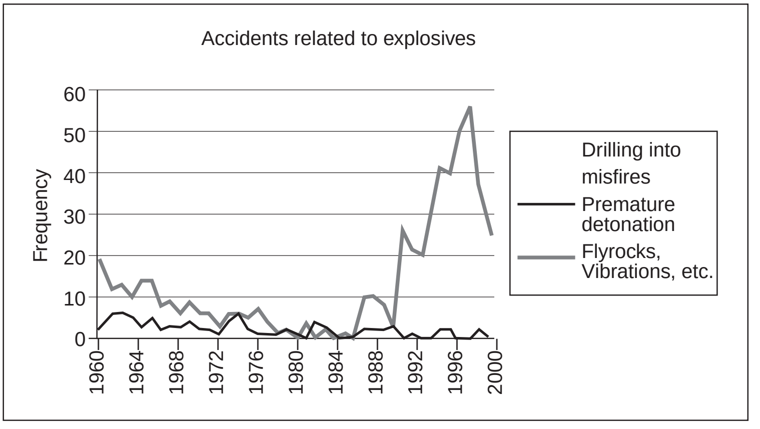

Figure 3. Recorded accidents in Norway during the period 1960 to 2000.

Observe that in the period of 1990 a very strong increase of accidents due to flyrock took place. Figure 4 below shows the period 1990 - 2000. The numbers of accidents, fatalities and injuries from this period has been summarized in Table 3 below.

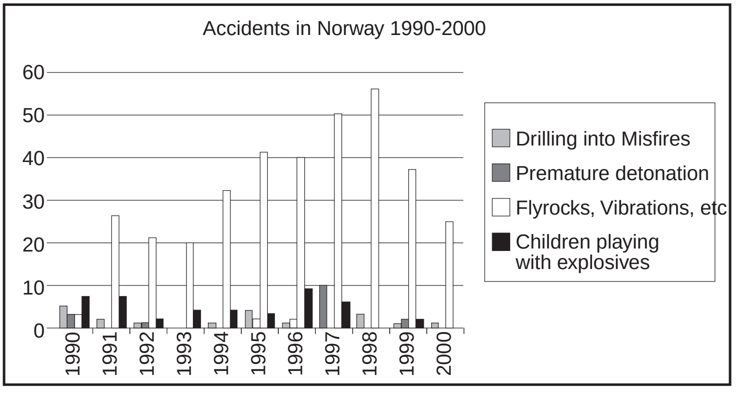

Figure 4. Recorded accidents in Norway during the period 1990 to 2000.

	Accidents	Fatalities	Injuries
Drilling into misfires	28	1	15
Premature detonation	8	2	10
Flyrocks, Vibrations, etc	***314***	5	45
Children playing with explosives	42	3	42

Table 3. Accidents, fatalities and injuries in Norway reported during the period 1990-2000.

DBE in Norway who keep records of the accidents gives the following remarks when the question is asked why such a large increase of accidents due to flyrock was reported after 1990;

a) Reporting is compulsory but all do not send in reports! In 1990 a campaign started to get all reports.
b) The average hole diameter increased from 51 mm to 64 -76 mm.
c) There was a shift from cartridged explosives to bulk explosives (ANFO and emulsions.)
d) Exclusion zones; These are general of right size at start-up, but they have a tendency to decrease as long as the blasting work is successful.

2.6. Denmark and Greenland

Reported accidents in Table 4 are those that have been found from news in media and not from any systematic reporting/monitoring schedule.

Year	Injured	Fatally	Type of explosives	Type of blasting	Type of Accident	Cause of Accident
1995	2	0	Dynamite	Trench blasting	Misfire	Drilled and hit a previous shot hole filled with undetonated dynamite
1997	1	0	?l	Quarry blasting	Flyrocks	Shot firer was not positioned in safe area (under truck)
1997	1	0	?	Demolition	Misfire	Detonation occured when an operator removed the chimney foundation
1998	10	0	?	Demolition	Debris	Failure to clear blasting area Misjudgement of height of chimney
1999	2	0	?	Demolition	Flyrocks	Failure to clear blasting area (100m)
2001	1	1	Dynamite	Bench blasting	Violation of rules	Drilled into an already charged hole
2001	1	1	?	Underground mining	Dud	? A miner was burning waste outside the mine

Table 4. Accidents reported by newspapers in Denmark and Greenland 1995-2001.

2.6. France

Accidents reported from France have occurred in civil engineering works. - i.e. no mining and no quarrying data are given. These are monitored by the Ministry of Industry.

The statistics represents explosives accidents on building construction sites since 1980. Out of 12.000 building construction accidents there are 22 accidents with explosives involved representing 9 death and 22 injured persons.

An accident is defined as an event where a person has more than three days absence from work. Property damage without personal injuries is not defined as an accident.

Figure 5 shows the accident development since 1980 in civil engineering works. Table 5 is more detailed and shows the numbers of fatalities and injuries during these years. Misfires and flyrock have been the prevailing causes of fatalities and injuries.

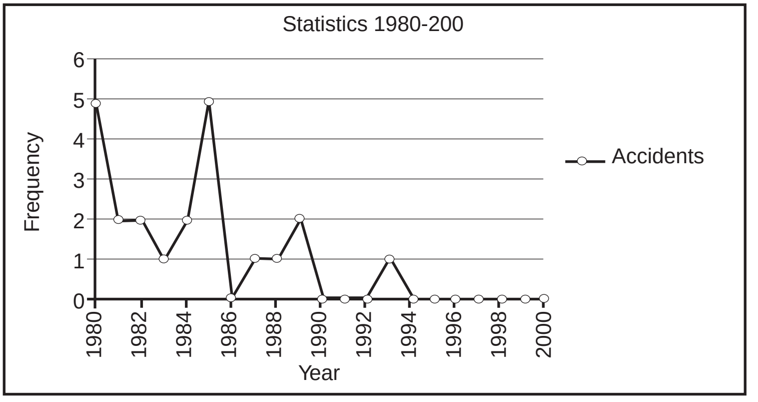

Figure 5. Recorded accidents at construction works in France during the period 1980 to 2001.

	Accidents	Fatalities	Injuries
Manufacture and storage	3	2	0
Charging, covering or flyrocks	8	5	9
Black powder fuse	2	2	0
Electric detonators	1	0	1
Misfires (drilling, early return)	7	0	10
Shot exploder (energy)	1	0	2
Total	**22**	**9**	**22**

Table 5. France. Statistics from the years 1980-2001.

3. CONCLUSIONS

- Material received from the authorities/organisations gives a good hint of the type of accidents occurred at the work sites.
- In most countries the statistics are collected by several authorities/organisations which makes it difficult to achieve a full picture of the total number of accidents in civil engineering, mining and quarrying.
- Definition of accidents varies but seems to become harmonised within EU.
- General trends are positive - decreasing rate of accidents.
- Flyrock and misfires seems to have the highest frequencies in accident reporting and in some countries the frequency has actually increased recent 5-10 years. This may be due to less experience of “reading” the geological structure (bad mapping of fissures and joints), less possibility to control the charge weight/ height with bulk explosives, establishing too small exclusion zones, wrong blast pattern or bad covering methods.

  Emulsion explosives have increased safety among users.

- The use of non-electric shock tube systems has reduced accidents with detonators.
- Use of black powder fuse has decreased - accidents are reduced.
- Redundant systems reduce risks with misfires.
- Important to perform regular training/education of personnel involved with explosives.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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