Lessons learned from major accidents involving fertilizers

Zsuzsanna Gyenes and Maureen Heraty Wood

European Commission, Joint Research Centre (JRC),

Institute for the Protection and Security of the Citizen (IPSC)

Security Technology Assessment Unit (STA), Major Accident Hazards Bureau (MAHB)

www.jrc.ec.europa.eu

Serving society

Stimulating innovation

Supporting legislation

Outline

I. Objective and methodology – the eMARS database

II. Common causal and contributing factors

III. Lessons learned

IV. Conclusion

I. Objective and methodology

European Commission

Objective

- Study major accidents involving fertilizers;
- Analysis of causes and contributing factors;
- Derive lessons learned and offer recommendations.

Methodology

- Review 900+ events reported in eMARS database;
- Identify accidents involving fertilizers;
- Finding causal and contributing factors of the accidents.


https://emars.jrc.ec.europa.eu
Login
Major Accident Hazards Bureau | Legal notice | Contact | Search |
European Commission
JOINT RESEARCH CENTRE
EMARS - Major Accident Reporting System
European Commission > JRC > Emars
Welcome to the Major Accident Reporting System
eMARS
330
494
297
46
Release
Fire
Explosion
Transport
AD - Other
About eMARS
The Major Accident Reporting System (MARS and later renamed eMARS) was first established by the EU's Seveso Directive 82/501/EEC in 1982 and has remained in place with subsequent revisions to the Seveso Directive in effect today. The purpose of the eMARS is to facilitate the exchange learned from accidents misses involving substances in order chemical accident


Typi can be any to 30 monti sionally sh These lagti commonly
delays in releasing the final inve on report pending on of legal and ssues, and to a tent, the time ary
to translate the report into English. This means that users of the dashboard should avoid using statistics of the most recent 3 years without this caveat because the numbers are likely to change (usually in an upward direction).
To view or search events in the database, click on the "eMARS" logo (above) or the following link: https://emars.jrc.ec.europa.eu/?id=4. Access is open to the public without a password. The log-in section is for the reporting community (only) to access the eMARS reporting tool. eMARS currently functions properly using the following browsers: Internet Explorer- up through version 9.0, Google Chrome and Mozilla. These options will be updated as new IT programming developments are introduced in 2014.
Please note that although the JRC takes care in reviewing the information inserted by the competent National Authorities, neither the JRC nor the European Commission can accept any liability for the use made of the data stored in eMARS. For further information please read the Disclaimer note.
For feedback or more information on eMARS, contact emars@jrc.ec.europa.eu.

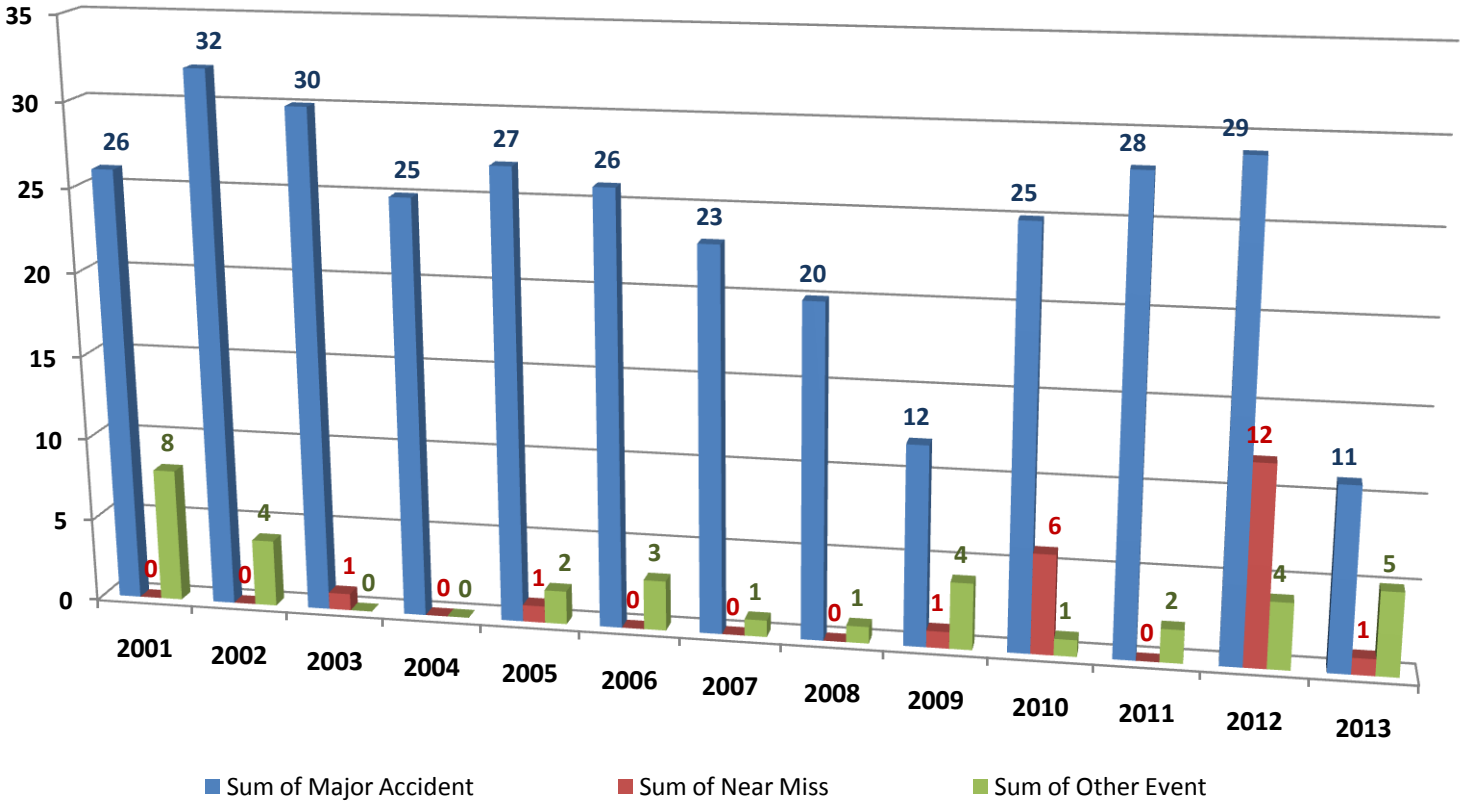
Number of events per year

European Commission

900+ events reported in eMARS

of which

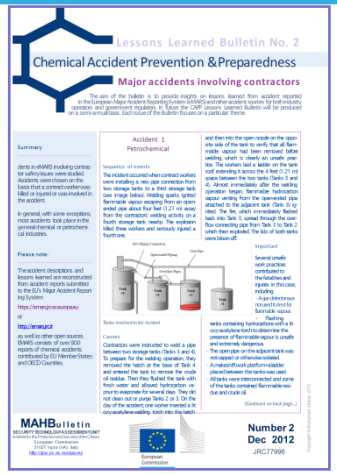
700 major accidents

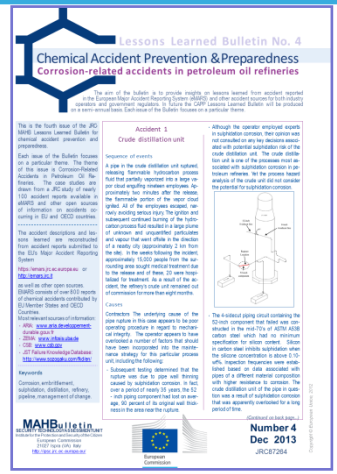


Joint Research Centre

MAHB
Lessons Learned Bulletins

European Commission





https://minerva.jrc.ec.europa.eu/en/content/f30d9006-41d0-46d1-bf43-e033d2f5a9cd/publications

Joint Research Centre

Lessons Learned Bulletin on Fertilizers

European Commission

Lessons Learned Bulletin No. 5

Chemical Accident Prevention & Preparedness

Major accidents involving fertilizers

The aim of the bulletin is to provide insights on lessons learned from accident reported in the European Major Accident Reporting System (eMARS) and other accident sources for both industry operators and government regulators. In future the CAPP Lessons Learned Bulletin will be produced on a semi-annual basis. Each issue of the Bulletin focuses on a particular theme.

Summary

In preparing this bulletin, 25 major accidents in eMARS involving fertilizers were studied together with an additional 25 accidents from other free sources, including also accidents in transport. Events were chosen on the basis that ammonium nitrate or NPK fertilizer (nitrogen-phosphorus-potassium) was involved in the accident.

In general, with some exceptions, most accidents occurred in warehouses or general chemicals manufacturers, but transport accidents involving ammonium nitrate fertilizers have also caused serious accidents resulting in severe casualties and property damage.

Please note:

The accident descriptions and lessons learned are reconstructed from accident reports submitted to the EU's Major Accident Reporting System

https://emars.jrc.ec.europa.eu

as well as other open sources. EMARS consists of over 800 reports of chemical accidents contributed by EU Member States and OECD Countries.

Accident 1

Wholesale and retail storage and distribution

Sequence of events

A fire occurred in a warehouse storing fertilizers and chemical products belonging to a wholesale distributor of numerous products, including sugar, molasses, fertilizers, and cereals. The storage installation was subdivided into 8 compartments of which two contained NPK (15% N, 8% P, 22% K) fertilizers in quantities of 600 tonnes and 850 tonnes respectively. In addition, one compartment also contained 650 tonnes of ammonium nitrate fertilizer and the other was also storing 200 tonnes of 46% urea solution. On 29th October 1987 smoke was detected by an operator in Box No. 2 of the warehouse, that is, the compartment that contained 850 tonnes of NPK fertilizer. The first reaction of the personnel was to attack the source of the fire with portable fire extinguishers, in the absence of activated fire hose reels. Arriving on the site, firemen observed that very thick smoke was emitted from the storage compartment. It also appeared that a fire was burning beneath the mass. However, the intervention of the firefighters appeared to focus solely on the presence of ammonium nitrate fertilizer, ignoring, the nature of the other chemical products. Further, disagreements between experts occurred which delayed the application of effective response methods. The accident resulted in the slight injury of three employees and 38000 people were evacuated for 8 hours.

(Continued on back page..)

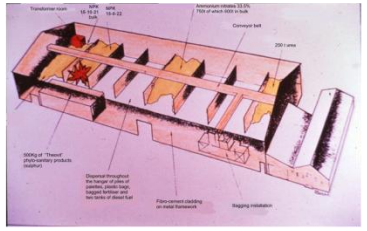


Figure 1: The installation concerned Source: ARIAN' 5009

MAHBulletin

SECURITY TECHNOLOGY ASSESSMENT UNIT

Institute for the Protection and Security of the Citizen

European Commission

21027 Ispra (VA) Italy

http://ipsc.jrc.ec.europa.eu/

European Commission

Number 5

June 2014

JRC91057

Chemical Accident Prevention & Preparedness

Major accidents involving fertilizers

Production and storage of fertilizers

As a substance, ammonium nitrate has a long history. (It was first produced in 1659). It is a "dual-use" substance from which either fertilizers or explosives can be produced. It is produced at a large scale throughout the world (over 20 million tonnels in 1998) with over a third of this production based in Europe (over 7 million tonnes in 1998). It is without doubt important for western society. It is an easily absorbed and efficient source of nitrogen for plants and particularly suitable to growth conditions of the European climate. Its efficient absorption rate means that it is relatively friendly to the environment relative to other manufactured fertilizers; the amount of nitrogen lost to the atmosphere is normally low.

History of accidents involving ammonium nitrate fertilizers

Ammonium nitrate caused a few of the most catastrophic events of the 20th century in peaceful times. The two most notorious and disastrous accidents in the western world were the Oppau, Germany, accident from the detonation of 450 tonnes of sulfo-ammonium nitrate fertilizers in storage that killed 561 people. In 1947, in Texas City, Texas (USA) a ship carrying 2600 t of ammonium nitrate exploded and set fire to a nearby vessel hold 960 tonnes of ammonium nitrate. 581 people in total were killed. Detailed descriptions and lessons learned from these accidents can be found from many sources. Several books have been written that cover these disasters and there is also substantial information on these and other ammonium nitrate accidents available in open sources online.

Still since then, ammonium nitrate has been involved in numerous accidents causing explosions, fires, and releasing toxic fumes. It has been recognized in many countries that even small storages of ammonium nitrate fertilizers, defined as low as 10 tonnes in some legislation, may place the population at high risk if proper safety measures and procedures are not fully in place (http://ipsc.jrc.ec.europa.eu/fileadmin/repository/sta/mahb/docs/SpecialRegulatoryTopics/Ammonium_nitrate_safety.pdf) . The chart below depicts the fatalities and tonnage associated with AN accidents identified by this study from 1916 until present.

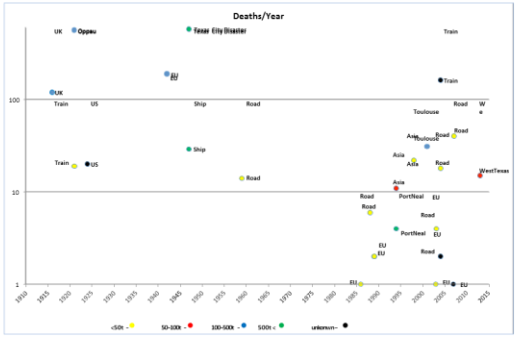


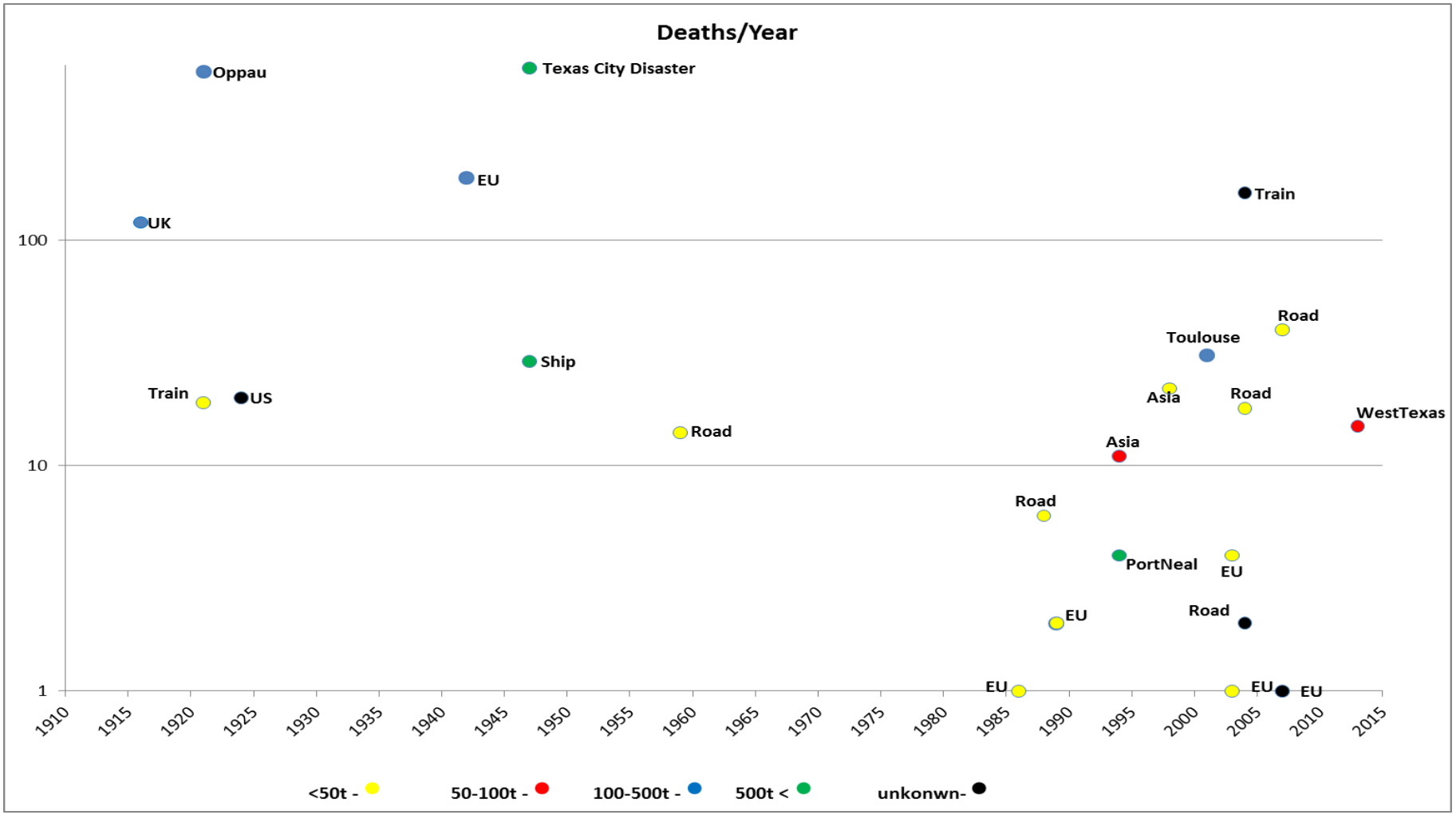
Figure 2 Fatalities and tonnage associated with AN accidents (Source: eMARS and http://en.wikipedia.org/wiki/Ammonium_nitrate_disasters.) If you would like a list of the accidents in this chart and references used, please send an email with your request to emars@jrc.ec.europa.eu.

https://minerva.jrc.ec.europa.eu/EN/content/4cda0e81-6b78-42d7-830d-7c3dbded4206/mahbbulletinno5finalforthewebpdf

Joint Research Centre

Distribution of accidents involved fertilizers

European Commission



Joint Research Centre

Analysed accidents

1. Fire in a warehouse storing NPK and AN fertilizers
2. Self-decomposition of NPK fertilizers led to a fire in a storage silo
3. Explosion in an NP buffer in the neutralization process
4. Toulouse accident 2001
5. West Fertilizer Company accident 2013

Examples of cases
Short description

Self-decomposition of NPK fertilizers led to a fire in a storage silo and release of toxic substances, mainly nitrogen oxides. The silo contained approximately 15,000 tonnes of the product, but the fire was detected early enough (probably from the fumes rather than automatic detection) to avoid serious consequences.

An explosion occurred in an NP buffer in the neutralization process of the production activity. Production in the fertilizer plant had been stopped due to maintenance work in the ammonia storage area, and as a result, there could be no supply of ammonia to the plant. Just prior to the explosion, an automatic fire detector, directly connected to the control room of the local emergency preparedness unit and the plant, went off. In addition, gas was observed by the operators in the factory and the building was evacuated with staff directed to the designated meeting points. Shortly after the evacuation, the explosion took place.

II. Common causal factors

- Insufficient fire prevention, protection and control systems in place in 4 cases.
- Lack of knowledge of the inherent hazards associated with the handling and storage of ammonium nitrate fertilizers in 6 cases.
- In 14 cases potential decomposition of such fertilizers was not considered.
- In 4 cases storage conditions allowed the introduction of contaminants to the ammonium nitrate.
- Wooden pallets were allowed to be stored in the affected warehouses in 4 cases.

III. Lessons learned

- Hazard identification should pay particular attention to the sensitivity of ammonium nitrate to changes in operating conditions.
- Written safety procedures and guidelines should be in place.
- Storage facilities should strive to eliminate the possibility that impurities are introduced into the ammonium nitrate.
- Employees should be regularly trained and tested on critical safety procedures.
- It is recommended to establish adequate safety procedures in particularly relating of training and awareness of hazards.
- Authorities are responsible for intervening to address land-use planning concerns around ammonium nitrate installations.
- Lessons learned from past major accidents could be beneficial for operators to recognize gaps in the safety management system.

IV. Conclusions

European Commission

- The unique safety challenges associated with ammonium nitrate coupled with poor safety management culture could largely be considered as the most important contributing factors across the accidents studied.

- Insufficient fire prevention, protection and control systems were also a common element in these accidents.

- One of the biggest problems in the analysed cases was the lack of knowledge of the inherent hazards associated with the handling and storage of ammonium nitrate fertilizers.

- Also, the lack of knowledge on the possible decomposition of fertilizers led to major accidents.

European Commission

THANK YOU FOR YOUR ATTENTION

IPSC - INSTITUTE FOR THE PROTECTION AND SECURITY OF THE CITIZEN

ISPRA, ITALY

https://emars.jrc.ec.europa.eu/

https://minerva.jrc.ec.europa.eu

http://ipsc.jrc.ec.europa.eu/

http://www.jrc.ec.europa.eu/

Joint Research Centre