

A Review of Recent Accidents Involving Explosives Transport

*By Richard J. Mainiero and James H. Rowland III
NIOSH, Pittsburgh Research Laboratory
Pittsburgh, PA*

When most people think of explosives transport they think of a hazardous operation. We all know that we aren't allowed to transport explosives through tunnels and are discouraged from traveling through heavily populated areas. Popular opinion suggests that explosives transport is a very risky operation. The authors decided to look into this a little more thoroughly and found just the opposite to be true.

While there have been some disastrous worldwide accidents involving the transport of industrial explosives, this is not the case in the U.S. Over the past 10 years, accidents related to the transport of explosives used in mining and construction have resulted in five major injuries, 11 minor injuries, and no fatalities. Explosives and ammonium nitrate (AN) transport outside the U.S. has not had such a good record; there have been four major explo-

sives or AN transport accidents resulting in a total of more than 300 deaths. Most of these fatalities could have been prevented if the accident site had been evacuated once the explosive or AN cargo began burning.

The safe history of explosives and AN transport in the U.S. is due to diligent efforts by government, labor, and industry. However, accidents will become more common and disastrous if we become complacent.

Introduction

The authors decided to determine whether the hazards are as great as people believe. A search of the internet identified a number of explosives and AN transport accidents, as shown in **Table 1**. The more serious explosives transport accidents all occurred outside the U.S. The most serious were the transportation accidents in Walden, Ontario, Canada (1998), Neyshabur, Iran (2004), Ryongchun, North Korea (2004), Mihailesti, Romania (2004), and Shengang-zhai, China (2005). These will be discussed below.

On August 5, 1998 an explosives truck consisting of a tractor and trailer carrying 18,000 kg (40,000 lb) of blasting explosives went off the road near Walden, Ontario, Canada. A fire started immediately. Drivers passing by stopped and helped the driver exit the truck and took him to safety. Explosive placards and the driver's warning alerted people to the hazard and they evacuated the site. The truck exploded about 35 minutes after the accident. The explosion caused two minor injuries, threw fragments of the truck up to 2,740 m (5,800 ft), and damaged several houses. At the time the truck exploded firefighters were in contact with the Canadian Transport Emergency Centre (CANUTEC) and were advised against approaching the scene. Evacuation of the accident site prevented any fatalities or serious injuries. The accident scene is shown in **Figure 1**.



Figure 1. Site of explosives truck accident in Walden, Ontario.

On February 18, 2004 a runaway train consisting of 17 cars of sulfur, six cars of petrol, seven cars of fertilizer, and 10 cars of cotton wool derailed, burned, and exploded in northeastern Iran, killing more than 300 people and injuring 450. ChinaDAILY reported that 182 of the dead were emergency workers. Among the dead were the local governor, mayor, and fire chief. The large number of injuries and fatalities could have been prevented. The loss of so many firefighters and rescuers suggests that they were trying to fight the fire. The section of the U.S. Department of Transportation Emergency Response Guide (2004) (USDOT ERG) on AN states, "For massive fire use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn." The firefighters and rescue workers should have evacuated the area and let the fire burn.

On April 22, 2004 a train disaster occurred in the town of Ryongchun, North Korea. It is unclear what was on the train but one explanation is provided by the UN Office for the Coordination of Humanitarian Affairs.



Figure 2. Crater produced by train explosion in Ryongchun, North Korea. Accident may have been the result of cars of AN coming into contact with electrical wires."

"The Government has now confirmed that there was a large explosion at Ryongchun Station, Ryongchun County, North Phyongan Province, and that it occurred during shunting operations at the city railway station. Two train wagons carrying AN came into contact with a wagon containing fuel oil. Each wagon contained 40 MT (44 t) of AN. This resulted in a massive explosion creating a large crater and leveling everything in a 500-m (1,640-ft) radius.

...the explosives were enroute to a construction site for the Pak-macheol san irrigation project.

...the explosion injured approximately 1,300 people, 370 of which were hospitalized. So far, 154 bodies have been recovered, including 76 children."

The explosion produced a 15 m (49 ft) deep crater. The cause of the accident is also unclear but one report indicates that the accident may have occurred when the rail cars being shunted came into contact with a live electrical wire. **Figure 2** shows the crater produced by the explosion. Damage to the Ryongchun Primary School is shown in **Figure 3**.

On May 24, 2004 a truck carrying more than 20 MT (22 t) of "nitrous fertilizers" overturned 50 km (31 mi) northeast of Bucharest (**Figure 4**). The driver tried to extinguish the fire but when he was unable to he asked for help at a nearby village. A few cars stopped and some curious people watched the fire. A television news crew filmed the fire. Firefighters arrived and were preparing to fight the fire. The truck exploded killing 20 people, including seven military firefighters, two journalists, three local people

Location	Date	Product	Outcome	Comments
Walden, Ontario	8/5/1998	18,000 kg (40,000 lb) blasting explosives	Fire followed by explosion about 32 to 37 minutes later.	Two minor injuries, debris thrown 2,470 meters (5,800 ft)
Neyshabur, Iran	2/18/2004	Cargo included sulfur, petrol, fertilizers, cotton wool	Explosion	More than 300 killed. 182 of those killed were emergency workers who apparently tried to fight the fire. 450 injured.
Ryongchon, North Korea	4/22/2004	80 MT (88 t) AN, tank car of fuel oil	Explosion	154 killed, 1,300 injured. Town severely damaged.
Mihailesti, Romania	5/24/2004	20 Mt (22 t) of "nitrous fertilizer"	Fire, explosion	Killed: 7 firemen, 2 TV journalists, and 8 people who got out of their cars to watch fire. Police chief of Nechita injured. 5 firemen severely burned. Crater 10 meters deep. Damaged 20 houses.
Gwinnett County, Georgia	9/2004	AN, detonators, and blasting boosters	No fire, no explosion	I-85 interstate closed. Cleared 150-m (500-ft) radius around accident scene.
Wells, Maine	5/13/2005	1,360 kg (3,000) lb of an AN-based liquid and detonation devices	No fire, no explosion	Nearby homes and businesses evacuated. 30 km (18 miles) of Maine Turnpike closed.
Salt Lake City, Utah	8/2005	16,102 kg (35,500 lb) of boosters	Explosion	Crater 9 m (30 ft) deep and 21 m (70 ft) wide. 11 injured, 4 hospitalized.
Shengangzhai, China	9/12/2005	18-MT (19.5t) truckload of AN	Explosion	Crater 5.6 m (18 ft) deep, 18.5 meters (60 ft) in diameter, 12 villagers killed, 43 injured.
Ouray, Utah	5/31/2006	18,200 kg (40,000 lb) AN, 10,000 blasting caps, several hundred pounds of dynamite	No fire, no explosion	Sparsely populated area. Authorities evacuated homes within 3.3-km (2-mile) radius.
Mesa, Arizona	6/16/2006	10,000 kg (22,050 lb) AN, 8 cases dynamite, and 1,466 blasting caps	Fire, no explosion	Newspaper clipping suggests that emergency responder did not handle this correctly.
Tumbarumba, New South Wales	2/1/2007	AN	No fire, no explosion	Truck rolled over into creek.

Table 1. Notable Explosive Transport Accidents Over the Past Decade.

watching the fire, and five people who stopped their cars to watch the fire. Again the accident site should have been evacuated once the "nitrous fertilizers" started burning.

On September 12, 2005 a truck carrying 18 MT (19.5 t) of AN exploded in the village of Shengangzhai, China. It is unclear what caused the truck to explode. Twelve villagers were killed and 43 were injured. The explosion produced a crater 18.5 m (60 ft) in diameter and 5.6 m (18 ft) deep. Some of the damage caused by the accident is shown in

Figure 5.

The accidents previously mentioned all occurred outside of the U.S. Table 1 lists five industrial explosives transport accidents in the U.S. None of the U.S. accidents resulted in fatalities. (There was a fatal accident involving Division 1.3 fireworks but the authors have limited this discussion to explosives used in industrial applications.) The worst accident was the explosion of 16,102 kg (35,500 lb) of explosives along Route 6 in Utah in August, 2005. The truck



Before Explosion



After Explosion



Figure 3. Ryongchon Primary School was severely damaged by the train explosion.



Figure 4. Accident in Romania in which 20 MT (22 t) of "nitrous fertilizer" caught fire and exploded, killing 17 people.



Figure 5. Damage caused by the 2005 explosion of an 18-MT (19.5-t) truckload of AN in Zhenganzhai, China.

driver apparently lost control of the truck on a curve and the truck tipped over and caught fire. Cars stopped and passengers rescued the driver and co-driver from the truck. The driver told his rescuers that the truck was carrying explosives. People were in the process of moving everyone away from the accident scene when the truck exploded. The explosion produced a crater 9 m (30 ft) deep and 21 m (70 ft) in diameter. The driver and co-driver were hospitalized. Seventeen others were injured but most were not serious; two were hospitalized. The response to this accident was consistent with the guidelines in USDOT ERG; people were evacuating the accident site as quickly as possible.

Discussion

The authors realized that a search of the internet would identify the more serious accidents but would not identify all of them. To get a more complete picture USDOT's Hazardous Material Incident Data (HMID) were reviewed. Information on explosives transport accidents from this source is shown Tables 2, 3, and 4. Review of the tables reveals many zeroes. There was only one accident that resulted in a fatality. This was a 2003 accident involving fireworks (see Table 3). The accident occurred while fireworks were being unloaded from a trailer. Apparently the trailer caught fire and exploded. Five workers were killed and one was injured.

Year	Incidents		Major Injuries		Incidents Involving Major Injuries		Minor Injuries		Incidents Involving Minor Injuries		Deaths		Incidents Involving Deaths	
	Division		Division		Division		Division		Division		Division		Division	
	1.1	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1	1.2
1997	3	2	0	0	0	0	0	0	0	0	0	0	0	0
1998	2	1	0	0	0	0	0	0	0	0	0	0	0	0
1999	3	3	0	0	0	0	0	0	0	0	0	0	0	0
2000	3	2	0	0	0	0	0	0	0	0	0	0	0	0
2001	3	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003	3	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	4	2	4	0	1*	0	7	0	1*	0	0	0	0	0
2006	3	0	0	0	0	0	0	0	0	0	0	0	0	0

*These were the same incident.

Table 2. U.S. explosives transport incidents involving Class 1.1 and 1.2 explosives.

Year	Incidents		Major Injuries		Incidents Involving Major Injuries		Minor Injuries		Incidents Involving Minor Injuries		Deaths		Incidents Involving Deaths	
	Division		Division		Division		Division		Division		Division		Division	
	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.3	1.4
1997	1	4	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	13	0	1	0	1*	0	2	0	1*	0	0	0	0
1999	2	11	0	0	0	0	0	1	0	1	0	0	0	0
2000	1	10	0	0	0	0	0	0	0	0	0	0	0	0
2001	2	8	0	0	0	0	0	1	0	1	0	0	0	0
2002	1	9	0	0	0	0	0	0	0	0	0	0	0	0
2003	1	5	1	0	1	0	0	0	0	0	5	0	1	0
2004	0	3	0	0	0	0	0	0	0	0	0	0	0	0
2005	5	21	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	19	0	0	0	0	0	0	0	0	0	0	0	0

*These were two different incidents.

Table 3. U.S. explosives transport incidents involving Class 1.3 and 1.4 explosives

Year	Incidents		Major Injuries		Incidents Involving Major Injuries		Minor Injuries		Incidents Involving Major Injuries		Deaths		Incidents Involving Deaths	
	Division		Division		Division		Division		Division		Division		Division	
	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
1997	4	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	9	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	9	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	4	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	5	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	4	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	8	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	2	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	6	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. U.S. explosives transport incidents involving Class 1.5 explosives.

References

- Smith, M., 1999, "Walden Explosion Summary", Dangerous Goods Newsletter, the Transport Dangerous Directorate, Transport Canada, Ottawa, Ontario, Canada, Vol. 19, No. 1, pp. 4-6.
- Release of Report into 1998 Truck Explosion at Walden, Ont. News Release No. H030/99, Transport Canada, Ottawa, Ontario, Canada, March 30, 1999 (available at http://www.tc.gc.ca/mediaroom/releases/nat/1999/99_h030c.htm)
- Lightfoot, P.D., B. von Rosen, R.C. Rouchard, R. Guilbeault, D.E.G. Jones, and E. Contestabile, 2005, "Thermal Decomposition of ANTO at Low Heating Rates", Proceedings of the 29th Annual Conference on Explosives and Blasting Technique, Orlando, FL, February 6-9, Volume 1, 8 pp.
- Alive News [September 28, 2004], 185 Reopens After Truck Tips. In: 11alive.com. [http://www.11alive.com/news/article_news.aspx?storyid=52490]. Date accessed: July, 2007.
- Wack, K., 2005, "Explosives Truck Crashes in Wells", Kennebec Journal, Augusta, ME, May 13, Page 6B.
- KSL TV [May 31, 2006], Truck Carrying Explosives Crashed in Utah County. In: KSL.com [<http://www.ksl.com/?nid=148&sid=184415>]. Date accessed: July, 2007.
- News 92.3 KTAR [June 15, 2006], Fire Involving Truck Hauling Explosives Shuts 202 in Mesa. In: KTAR.com [<http://www.620ktar.com/index.php?sid=189194&nid=6>]. Date accessed: July, 2004.
- ABC News Online [February 2, 2007] Homes Evacuated Amid Fears of Truck Explosion. In: ABC Online. [<http://abc.net.au/news/newsitems/200702/s1837851.htm>]. Date accessed: July, 2007.
- Cable News Network [2004], Iranian Train Blast Toll Now 309. In: CNN.com [<http://www.cnn.com/2004/WORLD/meast/02/19/iran.train/>]. Date accessed: August 2007.
- China Daily [February 19, 2004], More Than 200 Die in Iran Train Blast. In: CHINA Daily. [http://www.chinadaily.com.cn/english/doc/200402/19/content_307267.htm]. Date accessed: July, 2007.
- Democratic People's Republic of Korea-Explosion in Ryongchon County. OCHA Situation Report No. 2. United Nations Office for the Coordination of Humanitarian Affairs. Ref: OCHA/GVA - 2004/0062.
- GlobalSecurity.org [April 2004] Ryongchon, DPRK-Train Wreck and Explosion. In: GlobalSecurity.org [<http://www.globalsecurity.org/military/world/dprk/ryongchon-imagery.htm>]. Date Accessed: July, 2007.
- Romanian truck explosion kills at least 16 UPI Newstrack. United Press International, May 24, 2004.
- China View [September 15, 2005], Chemical Blast Kills 12, Injures 43. In: China View [http://news.xinhuanet.com/english/2005-09/15/content_3493395.htm]. Date accessed: July, 2007.
- USA Today [August 11, 2005], Truck Carrying 35,500 Pounds of Explosives Crashes in Utah. In: USA Today. [http://www.usatoday.com/news/nation/2005-08-10-utah-explosion_x.htm]. Date accessed: July, 2007.

This article was presented by the authors at the ISEE's 34th Annual Conference on Explosives and Blasting Technique in January, 2008 in New Orleans, LA. This paper has been updated from its original version. The opinions and ideas expressed are not necessarily those of the International Society of Explosives Engineers or the editorial/publishing staff of the Journal of Explosives Engineering. See "The Proceedings of the 34th Annual Conference on Explosives and Blasting Technique" for full text and references for this paper.

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the National Institute for Occupational Safety and Health.



Crater, 20-35 feet deep



Crater and damaged roadway



Remains of truck

Figure 6. Results of the explosion of 16,102 kg (35,500 lb) of explosives along Route 6, in Utah.

Another serious incident is listed in Table 2. This is the previously reviewed accident in which a truckload of Class 1.1 explosives overturned, caught fire, and exploded on Route 6 in Utah.

In 1998 there were two Memphis, TN accidents involving Class 1.1 smoke-producing signaling units. In both cases a package of signaling units initiated while on a conveyor belt in a package sorting facility.

Another incident occurred in 2001 in Richmond, VA. In this case, some type of tear-gas ammunition initiated while at a trucking company, causing three minor injuries.

During the ten year period from 1996 to 2006 there was only one serious transport incident involving construction, seismic, or mining explosives in the U.S. This is a good safety record. The review of explosives accidents outside the U.S. illustrate the potential for significant fatalities and injuries resulting from an explosives transport accident. As an example, consider the Utah accident in which the truckload of Class 1.1 explosives overturned, caught fire, and exploded. The results of the accident could have been much more serious if it hadn't occurred in a remote area and the area wasn't being evacuated when the explosion occurred. Everything worked right to prevent a disaster. Suppose the accident had occurred in a more heavily populated area? Would there have been time to evacuate people from near-

by homes and businesses? What if the driver had been unconscious and was unable to tell his rescuers that the truck was carrying explosives? Suppose the drivers and passengers in the nearby cars hadn't moved quickly to begin evacuating the area? A disaster can happen if everyone isn't diligent.

Conclusion

Explosives and AN transport in the U.S. is very safe. Unfortunately the same cannot be said of explosives and AN transport in all parts of the world. The safe history of explosives and AN transport in the U.S. is due to diligent efforts by government, labor, and industry. However, accidents will become more common and disastrous if we become complacent.

Most of the incidents described above involved AN and there was a delay between the time the accident occurred, the cargo caught fire, and the cargo exploded. There is a potential to significantly reduce injuries and fatalities if the time between the fire and explosion were used for evacuation rather than fighting the fire.

Acknowledgement

The authors wish to acknowledge the valuable contributions of Audrey Podlesny, Statistical Assistant, who provided valuable assistance in evaluating the statistical data from USDOT.



The Journal of

www.isee.org

EXPLOSIVES ENGINEERING

Volume 26 Number 2

March/April 2009

The Official Publication of the International Society of Explosives Engineers

Inside:

Explosives Transport Issues 6

***Bulk Transport Vehicle Fire Safety: Preventing a
Mine Site Disaster 14***

***Highlights of the 35th Annual Conference on
Explosives and Blasting Technique 40***

The Journal of Explosives Engineering
Published by International Society
of Explosives Engineers
30325 Bainbridge Road
Cleveland, Ohio 44139
www.isee.org

Publisher
International Society of Explosives Engineers

Editor
Dede Manross
explo@comcast.net

Contributing Writers
John Brulia
Paul Downing
R.B. Hopler
S. S. "Bud" Jenkins
Bill Reisz

Board of Directors
President
Jerry R. Wallace
Vice President Administration
Ron J. Elliott
Vice President, Technical
John E. Capers
Treasurer
Michael J. Koehler
Secretary
Roger G. Sprague
Past President
Lawrence E. Gilmore

Directors
Nancy Allen
James P. Daley
Dennis A. Efstratiadis
Jack W. Eloranta
Fred Grabner
David Harrison
Phyllis E. Hasser
Richard M. Hosley, Jr.
Thomas S. Jenkins
P. D. (Takis) Katsabanis
Alastair C. Torrance
John E. Wiegand

Executive Director & General Counsel
Jeffrey L. Dean, IOM, CAE

Assistant to the Executive Director
Arlene Chafe

Director of Communication
Dede Manross

Director of Development
Christopher Howell, IOM

Meetings & Conference Manager
Lynn Mangol, CMP

Web Manager
Debbie Kapes

Office Manager
Mary Spena-Bosch

Publications Coordinator
Renee Piontkowski

Membership Manager
Yuliya Rodzianko

Membership Assistant
Ruth Schaefer

Meeting Assistant
Lauren Creneti



FEATURES

- 6 **A Review of Recent Accidents Involving Explosives Transport**
Popular opinion suggests that explosives transport is a very risky operation. The authors decided to look into this a little more thoroughly and found just the opposite to be true.
- 14 **Bulk Transport Vehicle Fire Safety: Preventing a Mine Site Disaster**
Fire and subsequent explosion incidents involving bulk transport vehicles are discussed. Although such fire incidents are rare, knowing the hazard and having the appropriate safety protocol can serve to prevent a life-threatening disaster.
- 20 **Transportation of Explosive Materials in the EU**
- 22 **Transportation of Explosives in Canada**
- 40 **Highlights of the 35th Annual Conference on Explosives and Blasting Technique**
- 44 **Call for Papers**

DEPARTMENTS

- 4 **From the Executive Director**
- 24 **Calendar of Events**
A list of upcoming events in the explosives industry.
- 28 **Explosives, 100 Years Ago, More or Less**
Methods of Testing Electric Detonators and electric shot-firing.
- 34 **Industry News**
News about people, companies, events, and new products.
- 38 **Chapter News**
Annual ISEE Chapter Awards.



On the Cover: Photo taken in Sudbury, Ontario, Canada during a Contractor Verification for an Explosive Emulsion Transfer. As part of the ERAP assessment that is conducted by Transport Canada, the offerer of transport of UN0332 needs to demonstrate emergency response capabilities. See "Transportation of Explosives in Canada" story on page 22.

Copyright © 2009 Society of Explosives Engineers, Inc., dba International Society of Explosives Engineers

The Journal of Explosives Engineering, published six times per year, is the official publication of the International Society of Explosives Engineers. The Society is not responsible for opinions expressed and statements made by authors in articles or advertisements published in the Journal. ISEE assumes no responsibility for the completeness, accuracy, or conclusions reached in any of the articles or items published in this Journal.

Since the information is unique and because each job site is different, information presented in this Journal may not apply to your specific field situation. Readers are cautioned to carefully consider ideas presented and decide for themselves if the procedures described are safe and appropriate for the intended use. The International Society of Explosives Engineers cannot be responsible for the specific application of the information presented. Also, remember to always consult the manufacturer of the product(s) you are using for recommended practices.

Mention in this publication of a commercial or proprietary product does not constitute an endorsement or recommendation for its use. Registered names, trademarks, logos, artwork, photographs, etc., used in this publication, even without specific indication thereof, are to be considered protected by law.

Yearly subscription rates: \$65 U.S.A., \$80 all others (International Air Mail). All members of the Society receive a complimentary subscription.

All correspondence should be directed to: International Society of Explosives Engineers,
30325 Bainbridge Road, Cleveland, Ohio 44139. Telephone: (440) 349-4400. Fax: (440) 349-3788.
E-mail: isee@isee.org WebSite: www.isee.org