



Risk Evaluation Determining Whether Environmental Emergency Planning is Required Under the *Environmental Emergency Regulations* set under the *Canadian Environmental Protection Act, 1999* (CEPA 1999)

This report is a consolidation of two substances listed under Schedule 1 of the Environmental Emergency Regulations set under CEPA 1999. The substances inherent hazardous properties are virtually the same.

**Ammonium Nitrate (in solid form) (CAS #: 6484-52-2)
AND Ammonium Nitrate (in liquid form) (CAS #: 6484-52-2)**

**(Industry requested this substance to be assessed for possible addition
to the Environmental Emergency Regulations)**

Introduction

Ammonium nitrate (CAS number 6484-52-2) is found in the Domestic Substances List (DSL) (Environment Canada, 1996). According to the *Canadian Chemical Directory*, *ammonium nitrate* is distributed by 19 companies and manufactured by 4 companies (Camford, 2004). In 2005, Canada produced 1,245,000 tonnes of *ammonium nitrate* (CFI, 2005). Environment Canada has not yet undertaken a Priority Substances List (PSL) Assessment Report on *ammonium nitrate*.

Summary of Risk Evaluation Analysis

The Risk Evaluation Framework (REF), developed by Environment Canada, is applied to chemical substances in order to determine whether or not an environmental emergency (E2) plan should be required. For those substances that are evaluated as requiring an E2 plan, the next step is to determine a threshold quantity for the total quantity of the substance and the maximum storage container size on site. Within the REF, three

categories are used to evaluate chemicals and assign threshold quantities. Shown below are the details within the three categories for *ammonium nitrate*:

1. Environment Hazard

(Persistence, Bioaccumulation and Aquatic Toxicity Analysis)

- No data was found for persistence (half-lives).
- No data was found for bioaccumulation (BCF or Log Kow).
- For aquatic toxicity, it was determined that *ammonium nitrate* is practically non-toxic (LC₅₀ at 96 hrs greater than 100 mg/L) based on the most sensitive species, rainbow trout (Technical Services Branch, 1984).

2. Human Hazard

(Inhalation Toxicity and Carcinogenicity Analysis)

- Since *ammonium nitrate* has a vapour pressure below 1.33 kPa at 20°C (Technical Services Branch, 1984a), there is insufficient vapour from the substance to cause an inhalation problem.
- *Ammonium nitrate* has currently not been evaluated for carcinogenicity (IARC, 2010; Genium, 2007).

3. Physical Hazard

(Flammability and Combustibility Analysis)

- *Ammonium nitrate* is considered unstable under normal storage and requires special storage conditions, and is moderately soluble (between 100 and 1,000 mg/L) to water (Genium, 2007).

Flammability and Combustibility Analysis Table

	Value	Vapour Cloud Explosion (Yes/No)	Combustible (Yes/No)	References
Boiling point (°C)	210	No	No	(Cheminfo, 2004; Genium, 2007)
Flash point (°C)	Non-flammable			(Genium, 2007; HSDB, 2007)

Threshold

The data from the above mentioned categories were used to determine the various environmental/human thresholds. The threshold quantities relate to: carcinogenicity, aquatic toxicity, inhalation toxicity, vapour cloud explosion, combustibility, and reactivity.

The threshold quantity for carcinogenicity is defaulted to 0.22 tonnes, if it meets the following criteria:

- 1) have an IARC rating of 1, 2A or 2B, or have a US EPA rating of A, B1, or B2;
- 2) be persistent in any media for greater than 5 years.

Threshold quantities assigned as a result of aquatic toxicity are based on the following table:

Threshold Quantities Assigned as a Result of Aquatic Toxicity

Criteria	Extremely Toxic	Highly Toxic	Moderately Toxic	Slightly Toxic
Persistence (water)	≥ 6 months	≥ 2 months to < 6 months	N/A	N/A
Bioaccumulation	BCF ≥ 5000 or Log Kow ≥ 5	BCF ≥ 500 to < 5000 or Log Kow ≥ 4 to < 5 (unless BCF < 500)	N/A	N/A
Acute Aquatic Toxicity (96 hrs LC₅₀ – mg/L)	≤ 0.1	> 0.1 to ≤ 1	> 1 to ≤ 10	> 10 to ≤ 100
Threshold Quantity Tonnes (lbs)	0.22 (500 lbs)	1.13 (2 500 lbs)	4.50 (10 000 lbs)	9.10 (20 000 lbs)

A substance is a candidate for a vapour cloud explosion if its flash point is < 23°C and its boiling point is < 35°C. A substance is considered combustible if its flash point is < 23°C or its boiling point is < 35°C. In accordance with the precautionary principle, the category with the lowest threshold will be used. For further explanation, please refer to the *Implementation Guidelines for Part 8 of the Canadian Environmental Protection Act, 1999 – Environmental Emergency Plans* (<http://www.ec.gc.ca/ee-ue/>).

Accidents

Ammonium nitrate is considered hazardous because of its potential to ignite, to thermally decompose and to explode. In itself, *ammonium nitrate* does not readily burn but is considered to be an oxidizing agent which facilitates the induction of fire and increases the fire intensity in the presence of combustible material. When *ammonium nitrate* decomposes, it produces toxic fumes of nitrogen oxides such as: NO, NO₂, N₂O, N₂O₃, etc. (Reiss, 2004). Since *ammonium nitrate* is an oxidizing agent, it may explode when confined because of the increase in pressure. The potential to explode is increased by the following criteria:

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- heating of ammonium nitrate such as in a fire,
- contamination by, for example, chlorinated products, and
- high confinement, for example, in drains and in pieces of equipment (Reiss, 2004).

When heated to high temperatures in a confined location, the decomposition products and the heat of reaction are not able to dissipate, thus the temperature and the pressure increase dangerously to provoke an explosion. The impact of an explosion from various quantities can be found in Table 1.

Table 1: Estimation of the impact distance caused by the explosion of ammonium nitrate

Weight (Metric tonnes)	Impact distance (m) 1 psi – 68 mbar	Impact distance (m) 2 psi – 140 mbar
40	462	217
100	626	295
250	850	400
500	1071	504
1000	1349	635

(Reiss, 2004)

An overpressure of 140 mbar corresponds to the first sign of mortality while an overpressure of 68 mbar represents a partial zone of house demolition. An overpressure of 207 mbar (3 psi) would create a complete destruction of housing in that zone. On the other hand, an overpressure of 2.07 mbar (0.03 psi) is sufficient to cause breakage of windows which can produce severe injury or even death due to fragment projection (Reiss, 2004).

Because *ammonium nitrate* has the potential to explode, many accidents involving *ammonium nitrate* have occurred in the past. Three major accidents occurred in 2004: Ste-Catherine, Québec (Canada); Barracas, Spain; and Mihailesti, Romania. The incident in Canada was caused by an accidental mixture of *ammonium nitrate* with another substance resulting in one injury. In Barracas, a truck transporting 25 tonnes of *ammonium nitrate* exploded after a collision which resulted in two deaths and 5 people being injured. The explosion created a crater of 20-m in diameter and 5-m deep. The accident in Romania followed a traffic accident where 50-kg bags caught fire and exploded. This accident resulted in 18 deaths and 10 severely injured persons.

These accidents have resulted in *ammonium nitrate* threshold quantities being specified in various regulations. The threshold quantities vary greatly between countries as indicated below (J.P. Lacoursière Inc., 2005).

- Switzerland:
 - i The assigned threshold quantity is 20 tonnes based on the capacity of *ammonium nitrate* to be flammable and explosive.

- Sweden:
 - ı No more than 50 tonnes can be stored in the same storage area.
 - ı A permit must be obtained if quantities are equal to or greater than 10 tonnes.
- France:
 - ı For 24.5% to 28% nitrogen with less than 0.4% of combustible material, or more than 28% nitrogen with less than 0.2% of combustible material, the following threshold quantities apply:
 - ◆ ≥ 2500 tonnes (Safety Case)
 - ◆ ≥ 350 to 2500 tonnes (Authorization)
 - ◆ ≥ 100 to 350 tonnes (Declaration)
 - ı Off-specification *ammonium nitrate* requires a safety case for amounts ≥ 50 tonnes and an authorization for amounts ≥ 10 tonnes.
- United States of America
 - ı Code 490 of the National Fire Protection Association is applied by the authority having jurisdiction.
 - ı An amount of 454 kg requires a permit for storage.
 - ı An amount of 54.4 tonnes (60 U.S. Tonnes) requires the approval of the location and storage facility by the authorities taking into account the proximity of residential occupancies, places of public assembly, railroads and highways. A limitation of quantities may be required in function of the neighborhood.

Based on expert opinion, a threshold quantity of 20 tonnes is recommended for *ammonium nitrate* in Canada. The only bag size available for *ammonium nitrate* in Canada is 20 kg (50 lbs). According to paragraph 3(2)(b) of the *Environmental Emergency Regulations*, “**quantities of the substance in a container that has a maximum capacity of 30 kg or less**” (Government of Canada, 2003) are exempted. For this reason, bagged *ammonium nitrate* will not be subject to the proposed regulations.

The Canadian Fertilizer Institute (CFI) recognizes the potentially dangerous effects of *ammonium nitrate* and “**urges anyone who handles ammonium nitrate to implement security plans, maintain records of all sales of ammonium nitrate and alert law enforcement officials of suspicious activity**” (CFI, 2005). The campaign “On Guard for Canada” provides information to farmers and agri-retailers on *ammonium nitrate* through a brochure that can be found at the CFI website: [http://www.fssc.ca/_documents/2010_OnGuard%20\(English\)%20final.pdf](http://www.fssc.ca/_documents/2010_OnGuard%20(English)%20final.pdf).

Conclusion

For *ammonium nitrate*, the E2 hazard threshold was triggered by:

1) Reactivity – threshold set at 20 tonnes.

Therefore, *ammonium nitrate* is recommended for addition to Schedule 1 of the *Environmental Emergency Regulations* under Part 1 with a threshold quantity of 20 tonnes.

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Cat. No.: En14-55/3-2011E-PDF
ISBN: 978-1-100-19692-3

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