



Issued: August 29, 2022

Hazardous Materials Investigation Report: HZIR-22/01

# Anhydrous Ammonia Release from a Nurse Tank Trailer During Transport

Beach Park, Illinois  
April 25, 2019

## 1. Factual Information

### 1.1 Incident Description

On April 25, 2019, about 4:20 a.m. local time, two 1,000-gallon nurse tanks (tank unit 200) on a trailer towed by a farm tractor released about 650 gallons of anhydrous ammonia (AA) gas on a public road near John Kevek Farms, Inc. (Kevek Farms) in Beach Park, Illinois.<sup>1</sup> The farm tractor was towing a fertilizer applicator and trailer carrying tank unit 200 from one agricultural field to another when the applicator coupling disconnected, releasing AA gas through the adapter.<sup>2</sup> The farm tractor operator was an independent contractor fertilizing fields for Kevek Farms, which owned the farm tractor, fertilizer applicator, applicator hose, and applicator coupling.<sup>3</sup> Conserv FS, an

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<sup>1</sup> (a) Visit [ntsb.gov](https://www.ntsb.gov) to find additional information in the [public docket](#) for this NTSB accident investigation (case number HMD19FR002). Use the [CAROL Query](#) to search safety recommendations and investigations. (b) All times in this report are local time unless otherwise noted. (c) Anhydrous ammonia (AA) is also referred to as NH<sub>3</sub>. (d) Nurse tanks are cargo tanks used to transport AA during fertilization. They do not have a US Department of Transportation (DOT) specification. Nurse tanks must be manufactured to American Society of Mechanical Engineers (ASME) Code Section VIII, "Rules for Construction of Pressure Vessels" standards and have a minimum design pressure of 250 pounds per square inch, gauge.

<sup>2</sup> (a) The *applicator coupling* was an Acme-threaded fitting on the end of the applicator hose. Its internal (female) threads were designed to engage the external (male) threads of the Acme-threaded adapter mounted on the trailer bulkhead. *Acme thread* or *Acme thread form* is a type of trapezoidal thread, in which the thread's cross-section has angled sides and a flat top narrower than its base. (b) An *adapter* connects two or more thread forms or sizes together.

<sup>3</sup> The farm tractor operator had an informal bartering relationship with Kevek Farms under which they traded goods and services; they did not have a monetary arrangement.

agricultural cooperative, owned tank unit 200 and the trailer on which it was mounted. A total of 83 people, including first responders and residents, were treated at local hospitals in the 24 hours following the release. Fourteen of the 83 people were admitted and, of those, 8 were admitted to the intensive care unit. Symptoms included respiratory difficulty, eye pain, dizziness and nausea. Conditions were dark at the time of the release, and the temperature was 37°F with a wind speed of 6 mph.

Based on information the farm tractor operator provided to investigators, he began work on April 25 between 3:00 a.m. and 4:00 a.m. and fertilized a field in Winthrop Harbor, Illinois.<sup>4</sup> He did not close any valves on the tank unit or disconnect the applicator hose before driving the farm tractor over public roads to reach another field. While on the way, he noticed the cab of the farm tractor begin to fill with AA gas. He immediately jumped out of the cab to escape the gas cloud and yelled for bystanders to call 911. He was not injured.

The first 911 call was received at 4:24 a.m. by a Gurnee Communications Center dispatcher.<sup>5</sup> The caller reported a vehicle fire and one person lying on the ground, along with a strong smell and difficulty breathing. The Gurnee Communication Center dispatched a fire engine and ambulance. After emergency responders on the scene reported the presence of hazardous materials (hazmat), the response expanded to involve multiple fire and police departments.

During the response, a hazmat technician on the scene found the applicator coupling disconnected from the adapter mounted on the nurse tank unit's bulkhead and the main shutoff valve open.<sup>6</sup> Both tanks were empty. He closed the shutoff valve and instructed two firefighters to check the valves on top of the nurse tanks, which they found open.<sup>7</sup> The hazmat technician instructed the firefighters to close the valves. The incident ended about 12:04 p.m.

Based on the starting load of AA and the acreage fertilized before the release, the owner of Kevek Farms estimated about 30 percent of the loaded AA remained in tank unit 200. The AA release study later conducted by the National Transportation Safety Board (NTSB) estimated that about 3,640 pounds (or 650 gallons) of AA was released over 30 to 40 minutes.

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<sup>4</sup> The farm tractor operator was interviewed by local law enforcement and provided written answers to NTSB questions.

<sup>5</sup> Like Beach Park, Gurnee is a village in Lake County, Illinois.

<sup>6</sup> The *main shutoff valve* is a manual valve that, when closed, prevents material from reaching the adapter.

<sup>7</sup> These were the tanks' multipurpose valves. Multipurpose valves are described in section 1.4.

## 1.2 Hazardous Materials Information

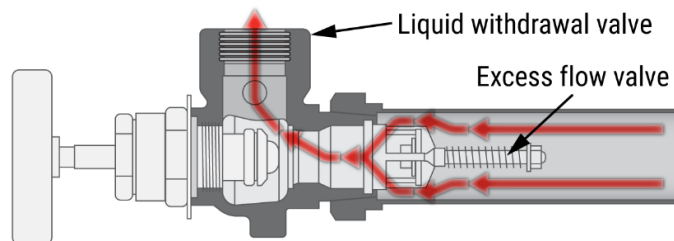
AA is a manufactured chemical commonly used as a commercial fertilizer and stored or transported in nurse tanks as a liquid under pressure. When transported over land domestically and as a liquid under pressure, AA is classified by the U.S. Department of Transportation (DOT) federal Hazardous Materials Regulations (HMR) as a Division 2.2 non-flammable, non-poisonous compressed gas under Title 49 *Code of Federal Regulations (CFR) Part 173.2*. AA is toxic through inhalation and corrosive to skin and several metals. AA is immediately dangerous to life or health at a concentration of 300 parts per million or higher.<sup>8</sup>

## 1.3 Equipment Information

### 1.3.1 Tank Configuration

The two 1,000-gallon nurse tanks were manufactured by Trinity Industries, Inc., in 1970 and 1971. By 2015, Conserv FS had assembled the two tanks into a parallel configuration, creating one tank unit: tank unit 200.

Tank unit 200 was mounted on a trailer that was hitched to the fertilizer applicator that was in turn hitched to the farm tractor. A hose from each nurse tank's multipurpose valve directed the AA forward to a tee assembly, which combined the two input flows and directed the exit flow forward into a single outlet. Each multipurpose valve had liquid withdrawal valve (LWV) and excess flow valve (EFV) capabilities.<sup>9</sup> (See figure 1.)



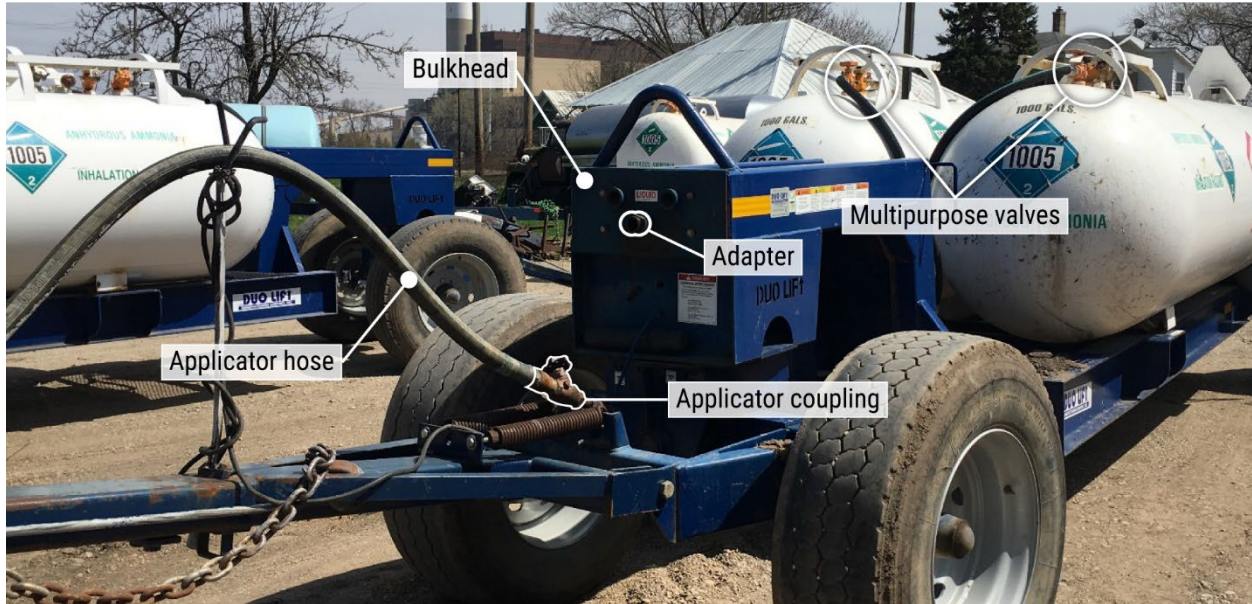
**Figure 1.** Multipurpose valve.

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<sup>8</sup> See "Ammonia," Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health, accessed July 7, 2021, <https://www.cdc.gov/niosh/npg/npgd0028.html>.

<sup>9</sup> (a) The manufacturer of the multipurpose valve, Continental NH<sub>3</sub> Products Co. Inc. (Continental), calls the EFV the "excess flow check." (b) The EFV is a safety device that functions automatically: when the flow of material into the multipurpose valve rises above a threshold, the force overcomes a spring and shuts the EFV, preventing further material from being released. (c) An LWV is connected to the liquid withdrawal line inside a nurse tank and operated with an external handle. To release material from the tank, the LWV must be in the open position.

From the multipurpose valve, AA continued from the outlet through a pipe to the main shutoff valve, then through a bulkhead to an adapter. The applicator coupling on the end of the applicator hose, which conveyed AA to the applicator itself, was designed to be screwed onto the adapter and hand tightened. (See figure 2 for a postrelease image of the nurse tanks and trailer.)



**Figure 2.** On-scene photograph of trailer and tank unit 200 showing the applicator coupling disconnected from the adapter. (Photograph courtesy of PHMSA.)

## 1.4 Operator Information

The farm tractor operator had an informal bartering arrangement with Kevek Farms under which he would perform tasks, such as fertilizing farm fields, in exchange for goods or services. The farm tractor operator reported that he received “on-the-job” training while applying chemical fertilizer over the past 3 decades but that he had never attended formal training classes on AA.<sup>10</sup>

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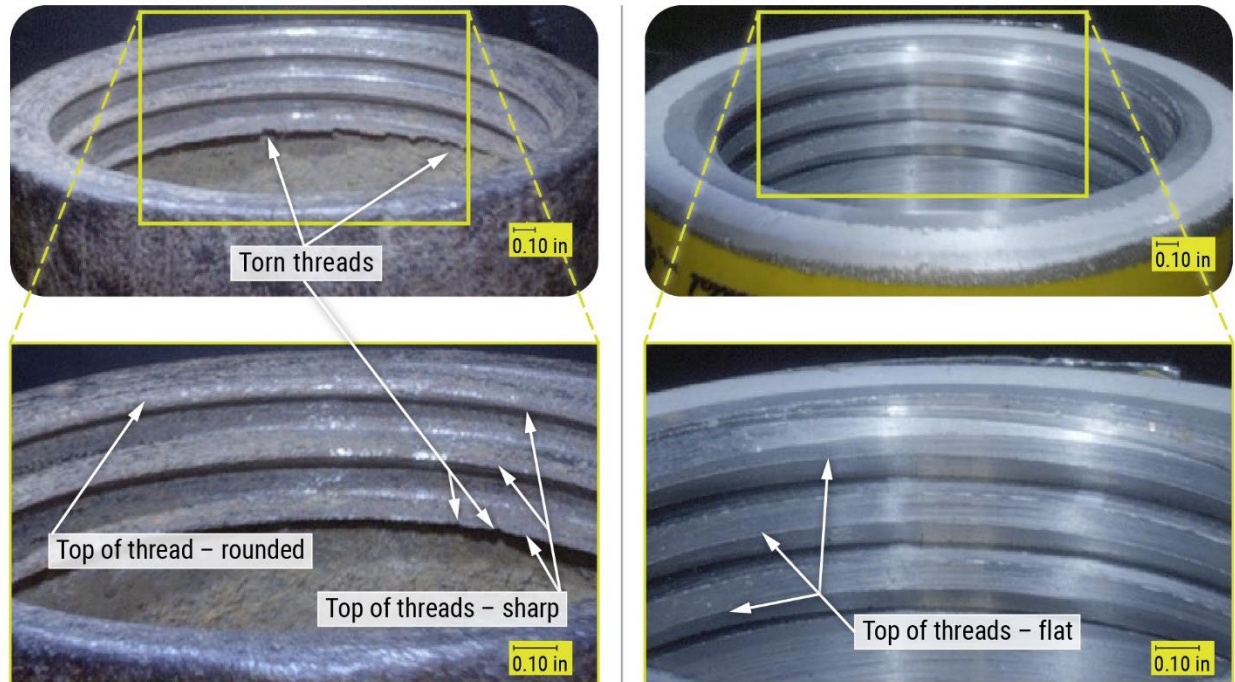
<sup>10</sup> The HMR under 49 *CFR* Part 172, Subpart H “Training” require that employees who handle hazmat have documented training every 3 years to recognize and identify hazmat, function-specific training for the employees’ responsibilities, emergency response safety training, and security training on the company’s security plans and procedures. The tractor operator was considered an employee by regulation.



## 1.5 Postincident Examinations and Testing

### 1.5.1 Applicator Coupling and Adapter Examination

The NTSB Materials Laboratory examined the applicator coupling and adapter with stereomicroscopy to determine their age and condition.<sup>11</sup> Figure 3 shows the internal threads from the incident applicator coupling (left) and an exemplar applicator coupling (right). The incident coupling had variously rounded, sharp, and torn threads.



**Figure 3.** Threads from the incident (left) and exemplar (right) applicator couplings.

Additionally, the NTSB examined the adapter and found that its threads showed significant wear and corrosion. The crest flat (the peak surface of an Acme thread) was smaller than an exemplar's, and the outermost thread of the adapter was bent slightly away from the rest of the adapter.

### 1.5.2 Valve Testing

Investigators observed no issues with the main shutoff valve or LWV function of the multipurpose valves.

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<sup>11</sup> No date markings, stampings or codes were found on the applicator coupling, but the manufacturer estimates that it was manufactured around 1988.

The multipurpose valves installed on tank unit 200 at the time of the release were type A-1206-E and manufactured by Continental. Because of markings on the valve bodies, they are referred to in this report as valve 2 and valve 6. Both had a working pressure of 265 pounds per square inch gauge, and their EFVs were designed to close at a flow rate of 42 gallons per minute (gpm).

The NTSB tested valve 2 and valve 6 at Continental to determine the minimum flow rate that would close each valve. For safety reasons, this testing used water rather than AA to determine a “measured closure flow rate.” The NTSB then used this information to determine a “calculated closure flow rate”: the flow rate necessary for AA to close the valve. The table below summarizes the results of the testing.<sup>12</sup>

**Table.** EFV flow rate for closure testing results.

EFV	Year of Manufacture	Measured Closure Flow Rate Water	Calculated Closure Flow Rate AA	Expected Rated Flow of AA
<b>Valve 2</b>	1999	46-47 gpm	59-60 gpm	42 gpm
<b>Valve 6</b>	2014	36 gpm	46 gpm	42 gpm

The functionality of EFVs is sensitive to tank configurations, which can affect flow rates through multipurpose valves. The NTSB evaluated the configuration of the dual nurse tank trailer to determine whether the AA flow rate would have been sufficient to close the valves during the release. The evaluation determined that at 37°F, the configuration used on tank unit 200 resulted in an AA flow rate of 25 gpm from each tank. At this flow rate, the EFVs would not close when the applicator hose disconnected.

## 1.6 Regulations

### 1.6.1 Federal Regulations

The DOT regulates the transportation of hazmat under the HMR developed by the Pipeline and Hazardous Materials Safety Administration (PHMSA) in 49 *CFR* Parts 100-185. A memorandum of agreement gives DOT modal agencies specific coordination guidelines for the civil enforcement of the HMR. AA is classified as hazmat and regulated within the HMR.

A PHMSA letter of interpretation of 49 *CFR* 173.24(b) “General requirements for packagings and packages” indicates any “package” used for hazmat shipment must be “designed, constructed, maintained, filled, its contents so limited, and closed” so there will not be a leak under normal transportation conditions.<sup>13</sup> The letter also references 49 *CFR* 173.24(f), which requires closures on packaging be designed and closed so there is

<sup>12</sup> Refer to the docket for more details on testing protocols.

<sup>13</sup> For more information, see PHMSA Interpretation Response #21-0061.

no identifiable release of hazmat “under conditions normally incident to transportation.” Federal hazmat regulations do not explicitly require the closing of LWVs on a nurse tank during transport.

### **1.6.2 State Regulations**

Illinois regulates nurse tanks transporting AA under Title 8 *Illinois Administrative Code* Part 215, Subpart A. Illinois prohibits the joining of an applicator hose “between any nurse tank unit and any tool bar during transport upon a public right-of-way.”<sup>14</sup> This prohibition implies, but does not explicitly state, that valves controlling the release of material must be closed during transport; if an applicator hose were disconnected without first closing a shutoff valve or the multipurpose valves, the disconnection could result in an immediate release of material.

Illinois also requires that EFVs must close automatically at the rated flows of vapor or liquid as specified by the EFV manufacturer.<sup>15</sup>

## **1.7 Postincident Actions**

### **1.7.1 Conserv FS**

Among other actions taken in response to this release, Conserv FS prohibited the configuration of nurse tanks used in tank unit 200 (two source tanks with a single delivery line) and began removing existing units from service. Conserve FS began reconfiguring nurse tanks to discharge singularly from each tank regardless of the number of tanks mounted on a trailer. They also provided emergency contact information to their customers in case of a release.

### **1.7.2 Kevek Farms**

Kevek Farms replaced the applicator coupling and severed its relationship with the independent contractor who was operating the tractor at the time of the release.

### **1.7.3 The State of Illinois**

Illinois revised its AA regulations to require that all nurse tank valves be closed during transport on public rights of way. The revised regulation also requires “all multiple tank configurations to have equally rated liquid withdrawal valves on each tank,” that EFVs with the same rated flow be installed at the junction where the lines meet

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<sup>14</sup> Title 8 *Illinois Administrative Code* 215.120.

<sup>15</sup> Title 8 *Illinois Administrative Code* 215.40 (d) and (g).

downstream, and a shutoff valve be installed downstream of the EFV. These requirements must be met on or before December 31, 2025.<sup>16</sup>

## 2. Analysis

On April 25, 2019, about 4:20 a.m., about 650 gallons of AA gas was released from two 1,000-gallon nurse tanks on a trailer towed by a farm tractor on a public road in Beach Park, Illinois. The farm tractor was traveling from one agricultural field to another when the applicator coupling on the applicator hose disconnected from the adapter on the trailer bulkhead, allowing AA gas to escape through the adapter.

Although Illinois law requires that applicator hoses be disconnected from the nurse tank while in transit (implying but not stating that manual valves controlling the release of material should be shut), emergency responders at the scene of the AA release found that the main shutoff and multipurpose valves on tank unit 200 were open, and the farm tractor operator reported leaving the valves open during transit. Illinois has since revised its regulations on the transportation of anhydrous ammonia in nurse tanks to require explicitly that valves be closed to prevent the release of material, and Kevek Farms has severed its relationship with the farm tractor operator.

Emergency responders also found that the applicator coupling disconnected from the adapter mounted on the nurse tank unit bulkhead. The NTSB examined the threads on the applicator coupling that connected the applicator hose to the adapter and observed that the threads were variously rounded, sharp, and torn in comparison with an exemplar coupling. Combined with the wear and corrosion examination identified on the adapter's threads, this condition led to a poor connection between the applicator coupling and the adapter, which allowed the applicator coupling to come unscrewed and disconnect while tank unit 200 was in transit. Because the multipurpose valves and main shutoff valve were open, AA was then able to flow from the tanks out through the adapter and into the environment. Kevek Farms has replaced the applicator coupling with a new coupling.

Both tanks emptied, indicating that the EFVs did not stop the flow of material. The NTSB's AA release study evaluated the excess flow function of the multipurpose valves on tank unit 200 and found that the EFVs would not close because the dual-tank configuration reduced the flow rate from each tank to about 25 gpm, which was insufficient to activate the 42 gpm-rated EFVs. Following this incident, Conserv FS prohibited the twin-tank plumbing configuration that prevented the EFVs on tank unit 200 from functioning properly and began removing such tanks from service. For multi-tank units, Conserv FS now uses configurations that discharge from tanks singly rather

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<sup>16</sup> The regulation also states the following: "AGENCY NOTE: If tanks are not plumbed (configured) together, they shall be treated as single tanks. Tanks with equally rated internal valves with remote actuators are exempt from this requirement."



than merging multiple inlets per outlet. These changes are intended to ensure the proper function of EFVs.

### 3. Probable Cause

The National Transportation Safety Board determines that the probable cause of the April 25, 2019, Beach Park, Illinois, anhydrous ammonia release was the unscrewing of the applicator coupling from the anhydrous ammonia tank unit. Contributing to the severity of the release was Conserv FS's configuration of the multiple tank unit piping, which restricted the flow rate such that the excess flow valves did not close when the applicator coupling unscrewed, allowing both tanks to release anhydrous ammonia until empty.

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974, to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)).

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident ID HMD19FR002. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting—

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