Investigation Update

December 2025

This document provides an update on the CSB's investigation into incidents that occurred at two facilities owned by Austin Powder Company on November 24, 2024, in Midway, Tennessee, and on June 11, 2025, in McArthur, Ohio.

Incident Summaries

- On November 24, 2024, two releases of nitrogen oxides (NO_x) occurred at Austin Powder's U.S. Nitrogen facility in Midway, Tennessee. The U.S. Nitrogen facility makes nitric acid that is used at Austin Powder's Red Diamond explosives manufacturing facility in Ohio. The first NO_x release at the U.S. Nitrogen facility, which happened at 6:47 a.m., was from the facility's exhaust stack and occurred during startup activities of the facility's nitric acid unit. The second release of NO_x was also from the exhaust stack and occurred at approximately 8:42 a.m. during a second failed startup of the nitric acid unit. The company estimated that 910 pounds of NO_x was released during the two incidents. No injuries were reported.
- On June 11, 2025, at 8:30 a.m., an estimated 3,945 pounds of NO_x was released to the atmosphere through an emergency pressure relief valve and a process vent at Austin Powder's Red Diamond explosives manufacturing facility in McArthur, Ohio. The release lasted for over three hours. The nearby community of Zaleski, Ohio, was evacuated by the local incident command, which was headed by the Zaleski Fire Department. Additionally, during the incident, airspace was restricted by the Federal Aviation Administration for a 30-mile radius around the facility. No injuries were reported.

Figure 1. Austin Powder Facility Entry Signage (Credit: CSB)

Background Information

- The Austin Powder Company is headquartered in Cleveland, Ohio. Founded in 1833, the company produces explosives for blasting and firearms [1]. The company and its affiliates operate facilities in multiple countries across five continents. Two of these facilities include the Austin Powder Red Diamond facility in McArthur, Ohio, and the U.S. Nitrogen facility in Midway, Tennessee [2].

- NO_x is a collective term for seven nitrogen oxide chemicals. The two commonly discussed components of NO_x are nitric oxide (NO) and nitrogen dioxide (NO_2). The term NO_x also includes nitrous oxide (N_2O), nitrate (NO_3), dinitrogen trioxide (N_2O_3), dinitrogen tetroxide (N_2O_4), and dinitrogen pentoxide (N_2O_5). NO_x can cause serious human health impacts, such as respiratory illnesses. When combined with water, NO_x can form acid rain, which can cause environmental damage. NO_x can also react with other chemicals to form solid particulates, such as ammonium nitrate, which contributes to smog formation. [3, pp. 38-39, 4].

    - Nitric oxide is a colorless gas and reacts with oxygen to form nitrogen dioxide in the atmosphere. Exposure to nitric oxide concentrations as low as 100 parts per million (ppm) is considered immediately dangerous to life or health (IDLH). Nitric Oxide does not form a flammable mixture with air, but can act as an oxidizer [5].

    - Nitrogen dioxide is a reddish-brown gas and is the major component of visible NO_x emissions. Exposure to nitrogen dioxide concentrations as low as 13 ppm is considered IDLH. Nitrogen dioxide is heavier than air and tends to travel near the ground during a release. Although nitrogen dioxide does not form a flammable mixture with air, it does act as an oxidizer [6].

- Nitric Acid (HNO_3) is a pale yellow to reddish brown liquid that can produce reddish brown vapors and an acrid odor. It is toxic by inhalation and corrosive. It can accelerate the burning of combustible material and may cause ignition of combustible materials upon contact. [7]. Fuming nitric acid is a type of concentrated nitric acid that contains dissolved nitrogen dioxide. Inhalation of concentrations as low as 25 ppm is considered IDLH [8].

- Nitrogen oxides and nitric acid are regulated substances under the OSHA Process Safety Management (PSM) standard and the EPA Risk Management Program (RMP) rule.[a] These materials and the respective threshold quantities for applicability of the PSM standard and RMP rule are summarized in **Table 1**.

Table 1. Regulated substances and threshold quantities involved in the incidents (Credit: CSB)

Chemical Name	CAS Number	Regulation	Threshold Quantity (pounds)
Nitric Oxide (NO)	10102-43-9	OSHA PSM	250
		EPA RMP	10,000
Nitrogen Dioxide (NO_2)	10102-44-0	OSHA PSM	250
Nitrogen Oxides (NO, NO_2, N_2O_4, N_2O_3)	10102-44-0	OSHA PSM	250
Nitric Acid (Concentration: 94.5% by weight or greater)	7697-37-2	OSHA PSM	10,000
Nitric Acid (Concentration: 80% by weight or greater)	7697-37-2	EPA RMP	15,000

Austin Powder Red Diamond Facility

- The Red Diamond facility is located in McArthur, Ohio. It was built in 1930 and originally manufactured dynamite. The facility now manufactures several products used in the blasting and mining industries. Austin Powder began producing pentaerythritol tetranitrate (PETN) at the Red Diamond site in 2016 [1, p. 2, 9].

- PETN is a white, crystalline explosive solid that is used in blasting and mining applications. PETN is sensitive to friction, impact, electrostatic discharge, and heat. PETN can undergo decomposition at approximately 320 degrees Fahrenheit (°F) or 160 degrees Celsius (°C) [10, 11].

- The PETN production area at the Red Diamond facility consists of multiple buildings and utilities. All of the PETN manufacturing process is contained in one building. Several acids used in the production of PETN and the acid that is reprocessed are stored in an acid tank farm, some distance from the PETN process. An acid recovery process (**Figure 2**) is used to reprocess the nitric acid to the appropriate concentration for PETN manufacturing. The acid recovery building also contains the absorber column, which treats the NO_x and nitric

[a] 29 CFR § 1910.119 Appendix A and 40 § CFR 68.130

acid vapors that vent from the acid storage tanks. The area has a cooling tower, which provides cooling water for the processes. The utility room houses a chiller system and air compressors used to supply air, which actuates valves in the process. All the processes are controlled and monitored from the control room, also shown in **Figure 2**.

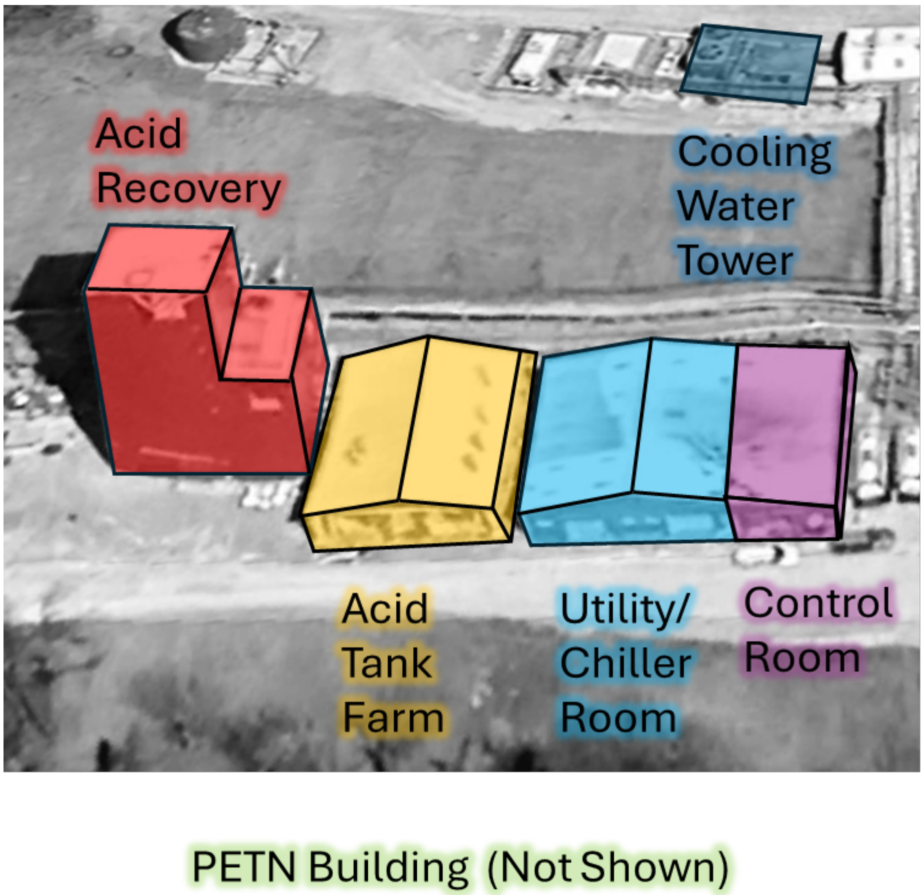

Figure 2. Overview of the Acid Recovery area. (Credit: CSB)

- PETN is manufactured by reacting pentaerythritol (PE) and concentrated nitric acid (98 weight percent) in a series of reactors [12, p. 6, 13, pp. 185-191]. During PETN production, concentrated nitric acid is diluted through the reaction, resulting in nominal 85 weight percent nitric acid, known as “excess nitric acid.” In the PETN area, PETN is separated from the excess nitric acid, which is then collected in the receiver tank and returned to the excess nitric acid storage tank. The excess nitric acid storage tank feeds the acid recovery unit, which converts the excess nitric acid back into concentrated nitric acid. Vapors from the excess nitric acid storage tank are removed by a compressor and are subsequently treated in the absorber column, as shown in **Figure 3**.

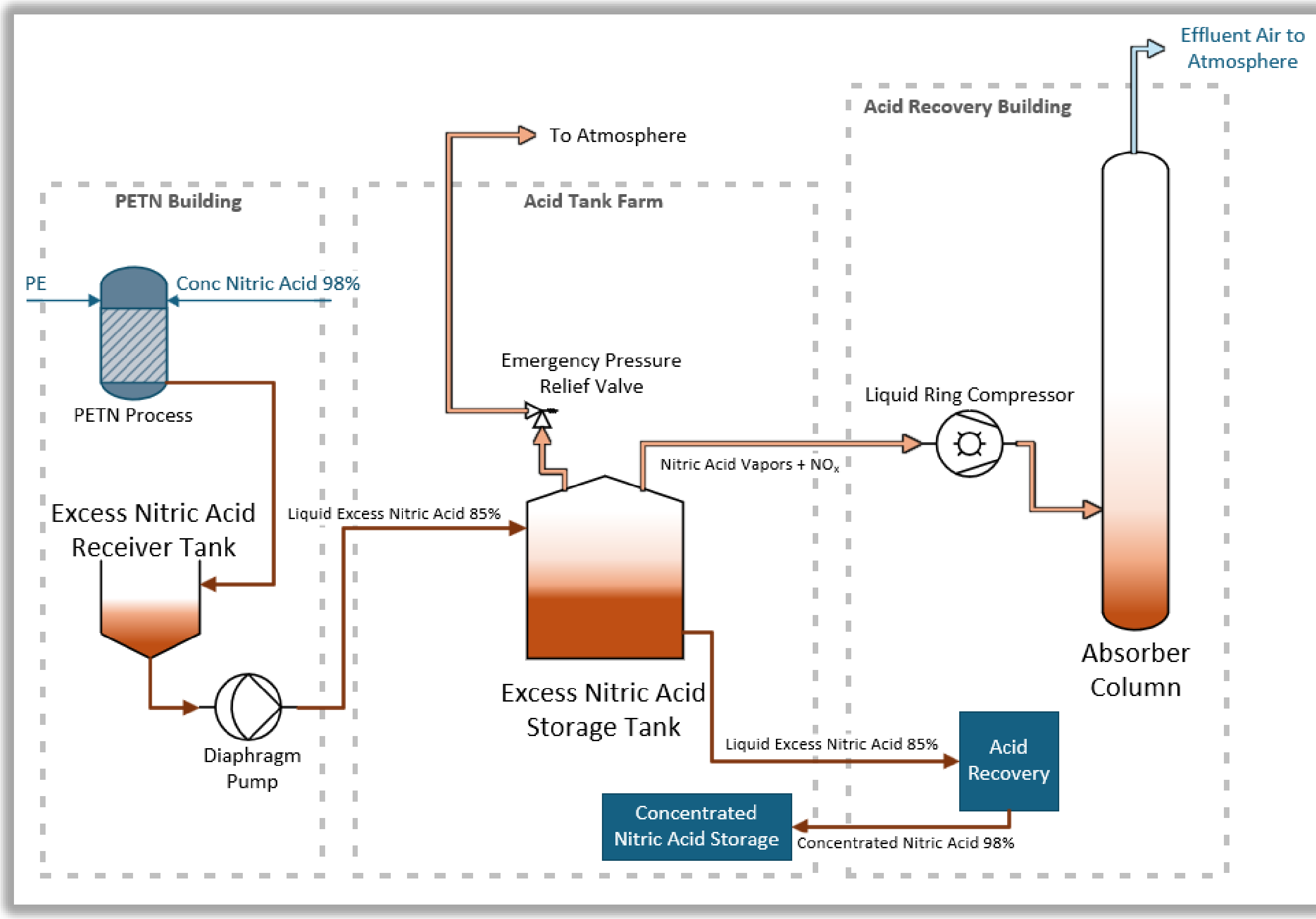

Figure 3. Simplified excess nitric acid flows through the Red Diamond Plant. (Credit: CSB)

Austin Powder Red Diamond Incident

- On June 11, 2025, at approximately 5:00 a.m., oncoming day shift personnel in the PETN process unit smelled an acidic odor and began searching for an acid leak in the area.
- At approximately 6:00 a.m., a maintenance employee discovered a leak in the acid tank farm. A corroded 316 stainless steel threaded plug on the vent piping to the absorber column was emitting NO_x and nitric acid vapors. The employee installed a new threaded plug to stop the release to the atmosphere.
- At approximately 6:40 a.m., small visible NO_x gas emissions began exiting the horizontal vent discharge piping on the absorber column (**Figure 4**). At the time, the equipment in the acid recovery building, including the absorber column, was shut down due to a piping failure on April 29, 2025. The emissions went unnoticed initially.

- Shortly after 7:54 am, maintenance personnel discovered that an emergency pressure relief valve was opening and closing repeatedly, approximately every 30 to 60 seconds. The emergency pressure relief valve was located on the excess nitric acid storage tank in the acid tank farm (**Figure 4**). The maintenance personnel observed visible NO_x gas exiting the horizontal discharge piping from the emergency pressure relief valve.

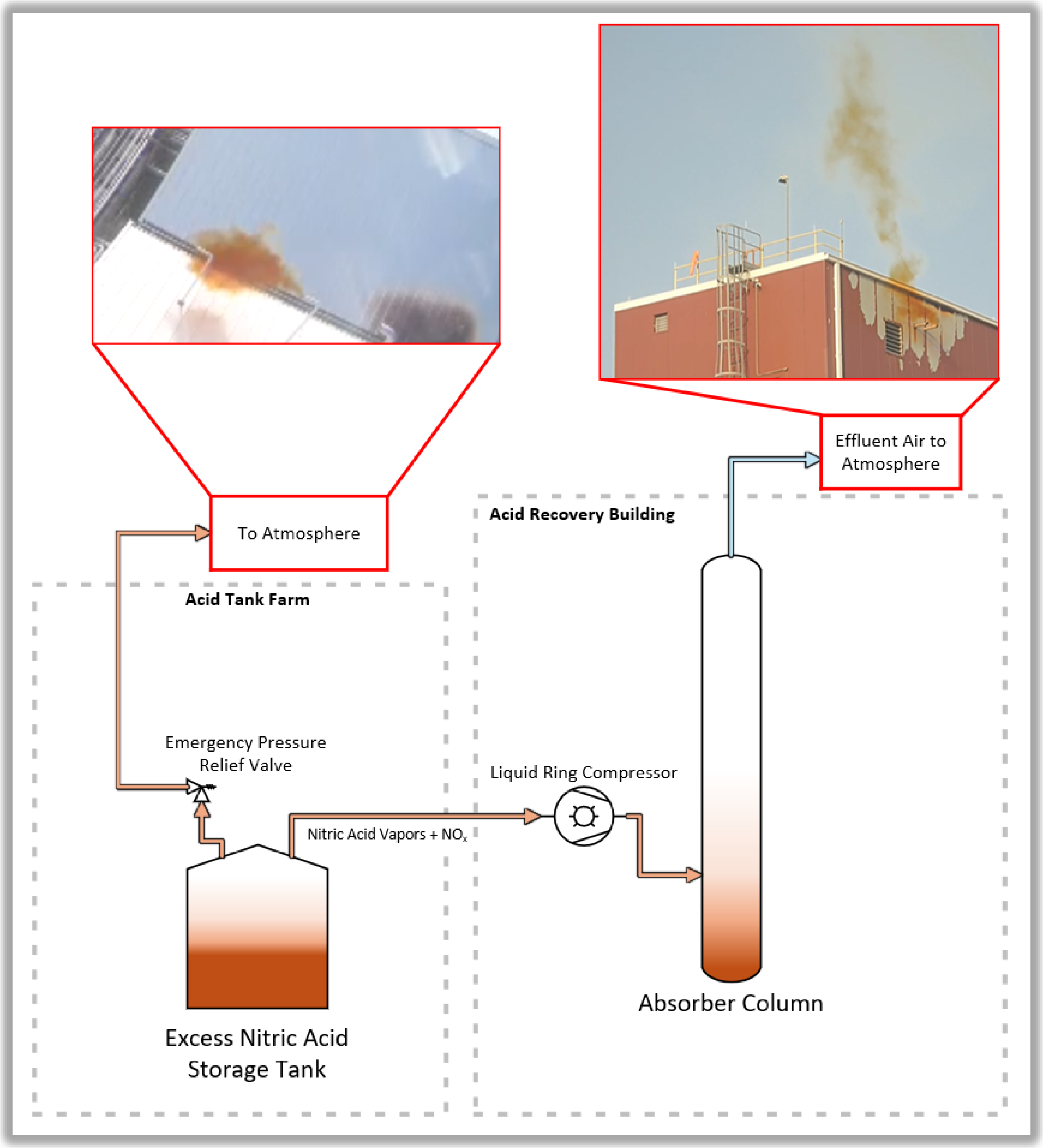

Figure 4. At 7:54 a.m., both the emergency pressure relief valve on the excess nitric acid storage tank (left) and the absorber column vent (right) were visibly emitting NO_x. (Credit: photos Austin Powder, drawing CSB.)

- By 8:19 a.m., the excess nitric acid tank's emergency pressure relief valve was open continuously and remained open until approximately 10:19 a.m.
- At approximately 8:24 a.m., facility personnel activated the plant emergency alarm. At approximately 8:30 a.m., a plant security guard contacted emergency services for assistance. Local agencies, including the Zaleski Fire Department, responded to the scene. The Vinton County Emergency Management Agency coordinated response efforts. Other agencies that responded to the scene include: McArthur Fire Department, Ohio Emergency Management Agency, Vinton County Emergency Medical Services, Vinton County Sheriff's Office, Wellston Fire Department and HAZMAT Team, Chillicothe Fire Department and HAZMAT Team, Ohio Department of Natural Resources, Ohio Environmental Protection Agency, Ohio Department of Transportation, Ohio Department of Public Safety, and the Ohio State Highway Patrol.
- At approximately 9:00 a.m., the incident command, headed by the Zaleski Fire Department, requested that the Federal Aviation Administration (FAA) close the surrounding airspace due to the nature of the release and the materials manufactured at the facility. The FAA approved the request for a 30-mile radius airspace restriction at 9:51 a.m.
- At approximately 9:33 a.m., the Red Diamond facility issued an evacuation order to all of its employees, except for critical employees who were necessary to respond to the ongoing incident.
- The incident command issued an initial shelter-in-place order for the residents of Zaleski, Ohio at approximately 9:14 a.m. Soon thereafter, however, the incident command issued an evacuation order for the community due to the NO_x plume and wind direction at approximately 10:09 a.m.
- The visible NO_x release continued through the morning (**Figure 5**), until approximately 11:25 a.m., when employees were able to get the absorber column back in service. The absorber column then began treating the acid vapors, which stopped the visible emissions to the atmosphere.

Figure 5. NO_x release approximately one hour into the event (9:15 a.m.). The emergency pressure relief valve discharge (left) and absorber column vent (right) are circled. (Credit: Austin Powder, annotated by CSB)

- At approximately 4:30 p.m., the incident command lifted the evacuation order for the community. The Vinton County Emergency Management Agency estimated that 100 to 150 people in the area were affected by the evacuation order.

- Austin Powder Red Diamond estimated that approximately 3,945 pounds of NO_x was released during the incident.

- Although some initial media reports described the incident as a nitric acid "spill," the release was purely NO_x vapor. No liquid nitric acid was spilled during the event.

Events Leading up to the Red Diamond Incident

- On April 29, 2025, the acid recovery process experienced a piping failure. As a result of this piping failure, the PETN production process was shut down because the plant was unable to reprocess the excess nitric acid.

- The PETN unit remained shut down until May 29, 2025, when it was restarted and operated for approximately 18 hours to consume remaining raw materials. After this short production run had concluded, PETN operators pumped the excess nitric acid from the receiver tank to the excess nitric acid storage tank (**Figure 3** above) on June 3, 2025.

- On June 2, 2025, the day before the excess nitric acid receiver tank was pumped to the storage tank, the PETN unit's cooling tower and chilled water systems had shut down, possibly due to a power fluctuation, which meant that there was no cooling to the excess nitric acid storage tank. On June 11, 2025, the day of the incident, the cooling tower and chilled water systems had to be restarted before the absorber column could restart and begin treating the acid vapors, which stopped the visible emissions to the atmosphere.

- The temperature in the excess nitric acid storage tank increased in the days leading up to the incident, between at least June 4 and June 11. During normal operation, the tank's bulk liquid temperature is below 50 degrees Fahrenheit (°F). With the chilled water system off, the temperature steadily increased during the week preceding the incident. By the morning of June 10, 2025, approximately 24 hours before the visible release began, the storage tank temperature had increased to over 80 °F, more than 30 °F greater than normal. The rate of temperature rise also increased in the 24 hours preceding the visible release. On the morning of the incident, the temperature increased to over 150 °F, more than 100 °F above normal. The actual temperature could have been even higher because the temperature instrument display for the excess nitric acid storage tank was designed to only read up to a maximum of 150 °F, meaning that the instrument display was incapable of indicating over 150 °F. The display read 150 °F for approximately 24 hours, during and after the incident.

- On the day of the incident, because the floor in the PETN control room was being resurfaced, the control room operators moved to a different room nearby, where they were unable to continuously monitor the acid tank farm and the video provided by security cameras, such as the images shown above in **Figure 4** and **Figure 5**. This contributed to the delayed discovery of the release.

U.S. Nitrogen Facility

- U.S. Nitrogen is a subsidiary of Austin Powder. The U.S. Nitrogen facility is located in Midway, Tennessee. Austin Powder began initial designs for the facility in 2010, and the facility started operations in 2016 [14].
- The U.S. Nitrogen facility manufactures nitric acid that is used at Austin Powder's Red Diamond explosives manufacturing facility in Ohio, in addition to anhydrous ammonia, aqueous ammonia, weak nitric acid, and liquid ammonium nitrate solution [14]. The two releases occurred in the U.S. Nitrogen facility's nitric acid plant, which manufactures "weak" nitric acid. Weak nitric acid is defined as an acid that is between 30 and 70 weight percent.[a]
- Nitric acid is used in several industries, including as an intermediate in the manufacture of ammonium nitrate for fertilizer production, in the manufacture of organic compounds, explosives, and precious metal separations [15, p. 1]. U.S. Nitrogen produces nitric acid predominantly to manufacture ammonium nitrate for explosives.
- Nitric acid is manufactured by reacting anhydrous ammonia on a platinum catalyst to generate nitric oxide, NO, as shown in Reaction 1. As it cools, nitric oxide reacts with oxygen to form nitrogen dioxide, NO_2, as shown in Reaction 2. Finally, Reaction 3 describes the nitrogen dioxide absorption by water in an absorption column to form nitric acid, HNO_3, and nitric oxide [16, pp. 3-4].

$$4\,NH_3 + 5\,O_2 \xrightarrow{catalyst} 4\,NO + 6\,H_2O \quad \text{(Reaction 1)}$$

$$2\,NO + O_2 \rightarrow 2\,NO_2 \quad \text{(Reaction 2)}$$

$$3\,NO_2 + H_2O \rightarrow 2\,HNO_3 + NO \quad \text{(Reaction 3)}$$

- The product nitric acid from the absorber column flows to a secondary column where air is injected to remove dissolved nitrogen dioxide, in a process called bleaching. The removed nitrogen dioxide then flows back into the absorption column to make additional nitric acid. Additionally, excess air provided by the bleach air flows into the absorption column to provide oxygen to further react with the nitric oxide generated in Reaction 3 [15, pp. 10-11, 17, p. 3].
- The residual NO_x that exits the top of the absorption column is treated to minimize the environmental emissions. Vaporized anhydrous ammonia reacts with NO_x and oxygen on a catalyst surface to form nitrogen and water prior to being released into the atmosphere (Reactions 4 and 5) [18, p. 14].

$$2\,NO + 2\,NH_3 + 2\,O_2 \xrightarrow{catalyst} 2\,N_2 + 3\,H_2O \quad \text{(Reaction 4)}$$

$$2\,NO_2 + 4\,NH_3 + 2\,O_2 \xrightarrow{catalyst} 3\,N_2 + 6\,H_2O \quad \text{(Reaction 5)}$$

[a] 40 CFR § 60.71(a)

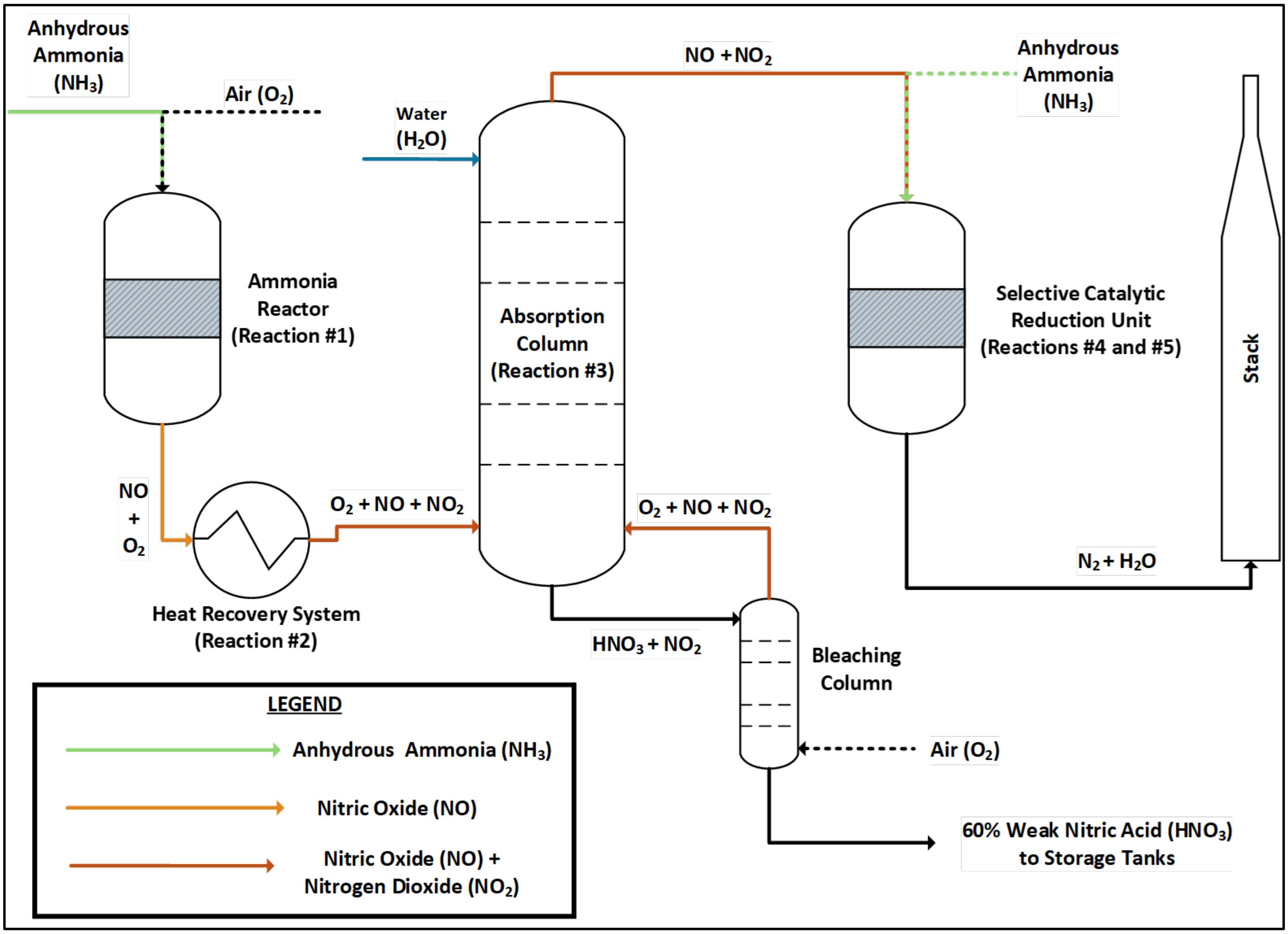

Figure 6. Simplified Process Flow Diagram of the U.S. Nitrogen Acid Plant. (Credit: CSB)

U.S. Nitrogen Incident

- The U.S. Nitrogen nitric acid unit was shut down for maintenance activities from November 13, 2024, to November 22, 2024. The company began preparations for restarting the nitric acid unit on November 22, 2024. This involved several steps, including preheating the process and starting the air compressor. These preparations were completed on November 23, 2024.

- On November 24, 2024, U.S. Nitrogen began the final steps to restart operations following maintenance activities. At approximately 6:42 a.m., the nitric acid unit restarted. Anhydrous ammonia and air were introduced to the reactor to begin making weak nitric acid.

- Approximately five minutes later, at 6:47 a.m., visible NO_x emissions began to exit the stack in the nitric acid unit (**Figure 7.A**). Operators shut down the process shortly thereafter. Visible emissions continued for approximately seven minutes (**Figure 7.D**).

Figure 7. Progression of the NO_x release during the first restart attempt. (Credit: U.S. Nitrogen, Annotated: CSB)

- Shortly after 7:14 a.m., the plant issued a text message alert stating that there was an “unsuccessful startup” and that NO_x had left the plant site. The alert was sent out to the surrounding community through a mass notification alert system to inform the community of the NO_x release. The plant issued a second alert at 7:32 a.m., stating that the NO_x emissions were dissipating and there was no danger to the public.
- According to local media, at approximately 7:25 a.m., US Nitrogen’s Environmental Health and Safety (EHS) Manager called Greene County 911 to advise them about the release. The EHS Manager reportedly told the 911 operator that the release was “probably one of our worst yet” but that “there’s absolutely no harm to human health or the environment” and that “there should be no worries” [19].
- The operators and shift supervisor for the nitric acid unit began troubleshooting the process, reviewed process parameters, checked valve positions, and visually inspected equipment to determine the cause of the excess emissions. The operators and supervisor found no issues with the process parameters or valve positions during their checks. Following the review, the plant manager, shift supervisor, and operators agreed to attempt a restart of the unit. At approximately 8:28 a.m., the nitric acid process was restarted.
- At approximately 8:42 a.m., visible emissions began to exit the stack in the nitric acid plant a second time (**Figure 8.A**). Operators immediately shut down the process again. Visible emissions continued for approximately ten minutes (**Figure 8.D**).

Figure 8. Progression of the NO_x release during the second restart attempt. (Credit: U.S. Nitrogen, Annotated: CSB)

- At approximately 8:48 a.m., another text message alert was sent out to the surrounding community stating that there was another failed startup and NO_x release. A follow-up alert was issued at 8:56 a.m., stating "all clear" and that the NO_x emissions were dissipating into the atmosphere.
- U.S. Nitrogen estimated that a total of approximately 910 pounds of NO_x was released during the two events.
- The Tennessee Department of Environment and Conservation (TDEC) issued a Notice of Violation to U.S. Nitrogen for the NO_x emissions on January 13, 2025, and followed up with an Order to the company on June 26, 2025, assessing a penalty of $11,000. Among other things in the Order, TDEC asserted that U.S. Nitrogen failed to follow its standard operating procedure (SOP) for starting up the nitric acid plant. U.S. Nitrogen appealed TDEC's Order on July 30, 2025.[a]

[a] https://dataviewers.tdec.tn.gov/dataviewers/f?p=9001:651::::651:P651_ORDER_ID:59661

Path Forward

- The CSB is continuing to gather facts and analyze several key areas in the Red Diamond investigation, including:
  - Testing the materials involved using calorimetry, to attempt to recreate the scenario and determine potential causes of the incident.
  - Evaluating existing safeguards and critical alarms that could prevent or mitigate excess emissions.
  - Evaluating the release and existing dispersion analyses of the excess emissions.
  - Assessing the Red Diamond plant's procedures related to the transfer of nitric acid to the excess acid storage tank, as well as procedures and equipment involved in monitoring the temperature in the storage tank.
  - Assessing the Red Diamond plant's protocols and procedures for monitoring the acid tank farm and other areas of the acid recovery process, as well as security cameras at the facility.
- The CSB is continuing to gather facts and analyze several key areas in the U.S. Nitrogen investigation, including:
  - Evaluating multiple scenarios by which excess nitrogen oxide emissions could occur from the nitric acid production process.
  - Evaluating the control systems, critical interlocks, and permissive controls that could cause excess emissions if deviations were to occur.
  - Analyzing the releases and dispersion of the excess emissions from the incident.
  - Assessing U.S. Nitrogen's startup and restart procedures related to the nitric acid unit, including ensuring adequate air flow at startup and validating correct valve positions.
  - Assessing U.S. Nitrogen's protocols and procedures for emergency response.
- The investigation is ongoing. Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

References

[1] Austin Powder, "History," 2025. [Online]. Available: https://austinpowder.com/unitedstates/company/history/. [Accessed 3 September 2025].

[2] Austin Powder, "Global Footprint," 2025. [Online]. Available: https://austinpowder.com/global-footprint/. [Accessed 2 September 2025].

[3] K. Wark, C. Warner and W. Davis, Air Pollution: Its Origin and Control, Addison Wesley, 1998.

[4] U.S. Environmental Protection Agency, "Basic Information about NO2," 10 July 2025. [Online]. Available: https://www.epa.gov/no2-pollution/basic-information-about-no2. [Accessed 12 September 2025].

[5] CAMEO Chemicals, "Nitric Oxide," [Online]. Available: https://cameochemicals.noaa.gov/chemical/1192. [Accessed 28 August 2025].

[6] CAMEO Chemicals, "Nitrogen Dioxide," [Online]. Available: https://cameochemicals.noaa.gov/chemical/4072. [Accessed 28 August 2025].

[7] CAMEO Chemicals, "Nitric Acid, other than red fuming," [Online]. Available: https://cameochemicals.noaa.gov/chemical/19337. [Accessed 9 September 2025].

[8] The National Institute of Occupational Safety and Health (NIOSH), "Nitric Acid," 30 October 2019. [Online]. Available: https://www.cdc.gov/niosh/npg/npgd0447.html. [Accessed 10 September 2025].

[9] Austin Powder, "Red Diamond," 2025. [Online]. Available: https://austinpowder.com/unitedstates/manufacturing/red-diamond/. [Accessed 9 September 2025].

[10] V. W. Manner, L. Smilowitz, C. E. Freye, A. H. Cleveland, G. W. Brown, N. Suvorova and H. Tian, "Chemical Evaluation and Performance Characterization of Pentaerythritol Tetranitrate (PETN) under Melt Conditions," *ACS Materials Au,* pp. 464-473, 2022.

[11] National Institute of Health - National Library of Medicine, "Pentaerythritol Tetranitrate," [Online]. Available: https://pubchem.ncbi.nlm.nih.gov/compound/6518. [Accessed 10 September 2025].

[12] D. M. Chambers, "Perspectives on Pentaerythritol Tetranitrate (PETN) Decomposition," Lawrence Livermore National Laboratory, 2002.

[13] T. Urbanski, Chemistry and Technology of Explosives (Volume II), 1965.

[14] Austin Powder, "US Nitrogen - Greenville, TN," 2025. [Online]. Available: https://austinpowder.com/unitedstates/manufacturing/us-nitrogen/?language=English. [Accessed 4 August 2025].

[15] U.S. Environmental Protection Agency, "Background Report - AP-42 Section 5.9 - Nitric Acid," [Online]. Available: https://www.epa.gov/sites/default/files/2020-09/documents/final_background_document_for_nitric_acid_section_8.8.pdf. [Accessed 2 September 2025].

[16] U.S. Environmental Protection Agency: Office of Air and Radiation, "Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Nitric Acid Production Industry," December 2010. [Online]. Available: https://www.epa.gov/sites/default/files/2015-12/documents/nitricacid.pdf. [Accessed 2 September 2025].

[17] U.S. Environmental Protection Agency: AP42 Section 8.8, "AP42 Section 8.8 - Nitric Acid," [Online]. Available: https://www.epa.gov/sites/production/files/2020-09/documents/8.8_nitric_acid.pdf. [Accessed 2 September 2025].

[18] U.S. Environmental Protection Agency, "Chapter 2: Selective Catalytic Reduction," 2019. [Online]. Available: https://www.epa.gov/sites/default/files/2017-12/documents/scrcostmanualchapter7thedition_2016revisions2017.pdf. [Accessed 2 September 2025].

[19] P. Gentry, "WUOT.org," Appalachia + Mid-South Newsroom, 7 July 2025. [Online]. Available: https://www.wuot.org/news/2025-07-07/my-skin-is-itching-off-of-me-us-nitrogen-downplays-harm-of-chemical-leaks-spills-in-tennessee. [Accessed 7 December 2025].