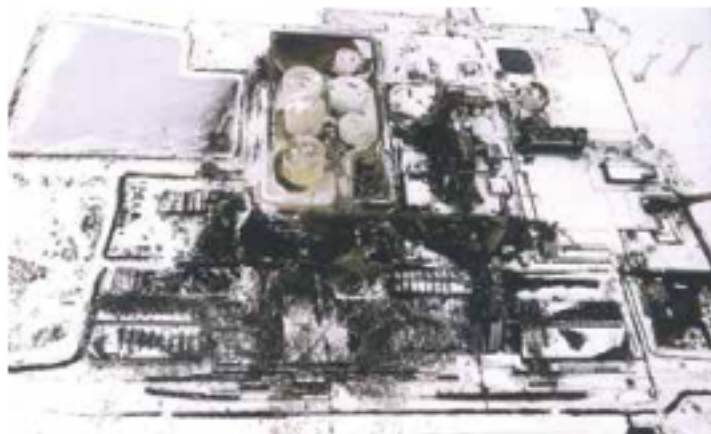


**Process Safety Incident of the Week**  
**Terra Industries Ammonium Nitrate Explosion: Monitor Equipment during Shutdown**

<https://www.aiche.org/sites/default/files/cep/20150323.pdf>

On December 13, 1994, a massive explosion occurred in the ammonium nitrate (AN) portion of Terra Industries' fertilizer plant in Port Neal, IA. The explosion occurred after the process had been shut down and ammonium nitrate solution was left in several vessels. The plant produced nitric acid, ammonia, ammonium nitrate, urea, and urea-ammonium nitrate. Ammonia from the urea plant off-gas or from ammonia storage tanks was added to the neutralizer through a sparger in the bottom of the vessel and 55% nitric acid was added through a sparging ring in the middle of the vessel. The product, 83% AN, was sent to a rundown tank via an overflow line for transfer to storage. A pH probe located in the overflow line controlled the nitric acid flow to the neutralizer to maintain the pH at 5.5-6.5. The temperature in the neutralizer was maintained at about 267F. Both the neutralizer and rundown tank were vented to a scrubber, where the vapors were absorbed. A stream of AN was recycled back to the neutralizer. About two weeks prior to the event, the pH probe in the overflow line was found to be defective, at which the plant switched to manual pH sampling. Two days prior to the event, the pH was measured as 1.5 and was not brought into the acceptable range until 1am on Dec. 12. The AN plant was shut down at about 3pm on Dec.12 because the nitric acid plant was out of service. At about 3:30pm, operators purged the nitric acid feed line to the neutralizer with air. At about 7pm, operators pumped the scrubber solution to the neutralizer. Then, 200 psig steam (around 387F) was applied through the nitric acid feed line to the nitric acid sparger to prevent backflow of AN into the nitric acid line. The explosion occurred at about 6am on Dec 13. AN is known to become more sensitive to decomposition, deflagration, and detonation at low pH levels at high temperatures, in low-density areas, in confined spaces, and in the presence of contaminants. Calculations showed that the nitric acid line clearing would have lowered the pH at the time of the shutdown to about 0.8. The steam sparge was left on for 9 hours, providing enough heat to raise the solution to its boiling point in about 2 hr. The air and steam sparge created gas bubbles in the solution. Chlorides, carried over from the nitric acid plant, were also present in the AN solution.



**Causes**

The conditions occurred due to lack of safe operating procedures. There were no procedures for putting vessels into a safe state at shutdown. Also no hazard analysis had been done on the AN plant.

**Key Lessons**

Operating procedures need to be implemented and cover all phases of operation. A hazard analysis needs to be done when shutting down to reveal any hazardous conditions.