United States
Environmental Protection
Agency

Office of Solid Waste
and Emergency Response
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Rupture Hazard from Liquid Storage Tanks

The Environmental Protection Agency (EPA) is issuing this Alert as part of its ongoing effort to protect human health and the environment by preventing chemical accidents. EPA is striving to learn the causes and contributing factors associated with chemical accidents and to prevent their recurrence. Major chemical accidents cannot be prevented solely through regulatory requirements. Rather, understanding the fundamental root causes, widely disseminating the lessons learned, and integrating these lessons learned into safe operations are also required. EPA publishes Alerts to increase awareness of possible hazards. It is important that facilities, SERCs, LEPCs, emergency responders, and others review this information and take appropriate steps to minimize risk. This document does not substitute for EPA's regulations, nor is it a regulation itself. It cannot and does not impose legally binding requirements on EPA, states, or the regulated community, and the measures it describes may not apply to a particular situation based upon circumstances. This guidance does not represent final agency action and may change in the future, as appropriate.

CHEMICAL ALERT SAFETY

Problem

Over the past few years, there have been several catastrophic failures of liquid fertilizer storage tanks resulting in property damage and environmental contamination. These ruptures have involved site-erected storage tanks with capacities ranging from 500,000 to 1.5 million-gallons. The tank failures, which prompted this alert, were all built by either Carolyn Equipment Company of Fairfield, Ohio, or Nationwide Tanks Inc. of Hamilton, Ohio. Both of these companies have since gone out business. (Carolyn Equipment in 1990 and Nationwide Tanks in 1995.) This alert describes some of the tank failures and identifies standards and precautions that apply to aboveground liquid storage tanks. Owners of tanks produced by these two manufacturers are advised to take extra precautions to guard against tank failure.

NOTE: Though all failed storage tanks cited in this alert have been produced by these two companies, owners of all storage tanks should be aware of the risks associated with operating a storage tank.

Accident History

3/1997 in Iowa - A 1-million gallon tank containing ammonium phosphate ruptured and released its contents. The walls of the ruptured tank fell onto two other tanks and broke their valves. One tank contained 1- million gallons of a nitrogen liquid fertilizer and the other tank held ammonium thiosulfate. Much of the release was contained by an earthen dike, but immediate construction of a secondary, temporary dike was necessary to keep the release from flowing into the nearby Missouri River. Cleanup involved pumping the liquid out of the dikes and removing all contaminated soil.

7/1999 in Michigan - A 1-million gallon tank full of ammonium polyphosphate ruptured and damaged three other tanks. Fortunately, the tanks were surrounded by earthen dikes lined with polyethylene. This minimized the environmental damage.

1/8/2000 in Ohio - A 1-million gallon tank of liquid fertilizer ruptured and damaged four adjacent tanks. The wave of liquid broke a concrete dike wall and hit five tractor-trailer rigs, pushing two of the rigs into the river. A total of 990,000 gallons of material were released. More than 800,000 gallons of the liquid spilled into the Ohio River. Sampling detected amounts of the fertilizer mixture 100 miles downstream, which is expected to increase algae growth in the river. The company has discontinued use of seven other tanks

purchased from the same manufacturer.

3/8/2000 in Ohio - At the same facility, a 1.5-million gallon tank of ammonium phosphate ruptured and damaged three nearby tanks causing them to leak. Two of the damaged tanks held phosphoric acid and the third one held 'Ice-Melt', a magnesium chloride mixture. The released liquid overflowed the dike walls into nearby creeks. The four tanks were dismantled after the incident. Over 1.8 million gallons of contaminant were recovered, with an additional 450,000 gallons of contaminated water recovered from the sewer system. The release caused evacuation of a nearby school, and the public was forced to use bottled water because of concern that the drinking water supply may be contaminated by the spilled chemicals.

Hazard Awareness

Defective Welds

In the incidents cited, all of the above-ground liquid storage tanks that failed appeared to have had defective welds. The tanks were all produced by either Carolyn Equipment Company or Nationwide Tanks Incorporated. Both companies have since gone out of business. The tanks were under warranty for only one year, and the welding of the tanks was done by subcontractors hired by the two companies. The companies built tanks in Michigan, Ohio, Indiana, Illinois, Missouri, and Iowa between 1980 and 1995. Because of increased frequency in tank failures, the Ohio Fire Division is creating a voluntary registry of liquid storage tanks to help track and prevent similar failures.

Chemicals Involved

The failed tanks have held liquid fertilizers, such as ammonium phosphate, which are not considered hazardous and are not regulated by the U.S. Environmental Protection Agency. However, the failure of these tanks can damage nearby tanks containing hazardous substances and cause releases. In some cases, accidents have involved tanks containing hazardous materials like anhydrous ammonia and phosphoric acid, which are used to produce the fertilizer ammonium phosphate.

Hazard Identification

Facilities should evaluate their storage tanks for potential catastrophic failure. Some of the factors to consider include:

- Manufacturer's record for quality workmanship.

- Evidence of weakened or defective welds.

- Signs of corrosion around the base and direct contact with ground and exposed to moisture.

- Exposure to high winds or frequent precipitation.

- Age of the tank.

- Close proximity to other storage tanks containing hazardous chemicals.

Hazard Reduction/Prevention

The failure of liquid storage tanks can stem from inadequate tank design, construction, inspection, and maintenance. Hazard reduction and prevention starts with good design and construction. The risk to tanks already in service can be reduced through tank maintenance and weld inspection. To minimize effects from possible tank failures, there should be a secondary containment such as a dike or a berm surrounding the tank.

Tank Design and Construction

A tank should be designed and constructed according to API-650, "*Welded Steel Tanks for Oil Storage*." issued by the American Petroleum Institute (API). API-650 specifies an allowance for corrosion and for the specific gravity of the fertilizer liquid.
In each of the tank failures mentioned, welding has been the main cause of failure. To ensure durability and integrity, it is imperative that the tank is welded correctly. Several standards and specifications outline the proper techniques and procedures for welding including API-653, "*Tank Inspection, Repair, Alteration, and Reconstruction.*"

Operational Hazards and Maintenance

Tank buyers should insist on seeing the inspection record. Although tanks should undergo a rigorous inspection by a recognized inspection authority before a manufacturer's job is complete, the tanks should still be closely inspected by the buyer prior to purchasing the unit. For liquid storage tanks, the most important item to look for is complete penetration and complete

fusion of the welds joining shell plates. Once a tank has been purchased, it becomes the tank owner's duty to regularly inspect the tank. Inspection intervals may be set by using a risk-based inspection theory, as indicated by API-653. Various inspection methods can be used for those tanks already in service. Radiography is the technique applied to all tanks designed to API-650 to ensure that complete penetration and fusion of welded joints has occurred. Unfortunately, this procedure cannot detect poor mechanical properties in the welded regions. This and other standards cover what types of joints must be checked by a radiograph, as well as the number of tests that must be done. Additional inspections may be done visually or by a vacuum box for localized problems. The vacuum box, approximately 6 inches by 30 inches, is tightly sealed to the tank surface, and pressure is applied. Automated ultrasonic testing can be applied to all shell welds to examine for cracks, fusion and penetration, and porosity with greater resolution than radiography. It is also now possible to conduct floor scanning while the tank is full. Combined with chemical analysis and hardness testing, field replication can assess the toughness, or resistance to brittle failure of a weldment. If damage is found during an inspection, this needs to be assessed in accordance with API-RP579 *"Fitness for Service"* methodology. Any tanks that do not meet the acceptance requirements set by API-RP579 should be repaired or replaced.

Steps for Safety

Here are some additional ways to prevent rupture of liquid storage tanks:

- Realize the inherent risk of using and maintaining any storage tanks.

- Identify the manufacturers of the tanks on the property, being careful to identify any tanks built by either company mentioned in this alert. **NOTE:** If tanks were manufactured by Carolyn Equipment Company or Nationwide Tanks of Hamilton, take the following actions immediately:

  - A close external inspection should be made for leaks, corrosion, or any anomalies in the surface of the tank. Vent(s) should be checked for any blockages by foreign materials, such as snow or ice. The majority of the failures have occurred during the winter months, when steel becomes more brittle and when vents can become blocked by snow and ice. If liquid is drawn out of the tank when vents are plugged or restricted, a vacuum may be pulled on the tank causing it to collapse inward.

  - If you find evidence of leakage or corrosion during the inspection, the tank should be taken out of service and if possible, drained.

  - If there is no evidence of leakage or corrosion, arrange for an external evaluation by a qualified inspection agency.

  - Depending on the results of the evaluation, arrange for an internal inspection immediately or within the year.

- Ensure that employees are aware of the hazards associated with the failure of a liquid storage tank.

- Avoid overfilling tanks.

- Perform regular inspections of tanks. Be sure to look for all possible risks.

- Follow up on identified problems with repairs or replacement. Inspections are otherwise useless.

- Replace, repair, or modify any and all tanks not meeting the standards set forth in API-579, "*Fitness for Service*" methodology.

- Be on the alert for new tank regulations. (There were recently changes made to API-653 that improved the suggested calculations)

- Consider better mitigation in case of a leak to separate the content of a collapsing tank from the rest of the facility, and more importantly, prevent any leakage from going offsite.

- Develop an emergency plan that addresses a catastrophic tank failure.

Information Resources

References with information about the hazards of catastrophic failures and methods of minimizing them are listed below. Regulations potentially applicable to storage tanks and codes and standards that may be relevant are also included. A Chemical Safety Alert on catastrophic fires and explosions in storage tanks is available at www.epa.gov/swercepp/pubs/cat-tnks.pdf

Statutes and Regulations

Section 112(r) of the Clean Air Act focuses on prevention of chemical accidents. Facilities with regulated substances or other extremely hazardous substances have a general duty to prevent and mitigate accidental releases. Accident prevention activities include identifying hazards and operating a safe facility.

EPA's Risk Management Program (RMP) Rule [40 CAR 68] is intended to prevent and mitigate accidental releases of listed regulated substances. RAMP rule requirements include development of a hazard assessment, a prevention program, and an emergency response program.

EPA has tank inspection regulations under the Spill Prevention Countermeasure and Control Plan and Oil Pollution Control Act of 1990 [40 CFR112].

The Occupational Safety and Health Administration's (OSHA) Process Safety Management Standard [29 CAR 1910.119] includes regulations on tank inspection, and conduct during hot-work; and fire protection and prevention during welding, brazing, and cutting [29 CAR 1910.252].

Occupational Safety and Health Administration
Phone: (202) 219-8151 - Public Information Web site: http://www.osha.gov

Codes and Standards

The American Petroleum Institute (API) has tank standards and guidelines on safe welding:

American Petroleum Institute
1120 L St NW
Washington DC 20005
Phone: (202) 682-8000
Web site: http://www.api.org

Relevant API standards:

API Standard 620 – Design and Construction of Large, Welded, Low-Pressure Storage Tanks, ninth edition, February 1996 (includes Addendum 1, December 1996)

API Standard 650 – Welded Steel Tanks for Oil Storage, ninth edition, May 1993 (includes Addendum 1, December 1994; Addendum 2, December 1995; and Addendum 3, December 1996).

API Standard 653 – Tank Inspection, Repair, Alteration, and Reconstruction, second edition, December 1995 (inc. Addendum 1, December 1996)

The American Society of Mechanical Engineers (ASME) has the Pressure Vessel Code and other codes relevant to tanks and storage vessels:

American Society of Mechanical Engineers
1828 L St NW, Suite 906
Washington DC 20036
Phone: (800) 843-2863 or (202) 785-3756
Codes and standards: (212) 705-8500
Accreditation and certification programs (212) 705-8581
Web site: http://www.asme.org

The American Society of Nondestructive Testing (ANT) certifies welding and non-destructive examination (NDE) and non-destructive testing (NDT) inspectors:

American Society of Nondestructive Testing
P.O. Box 28518
1711 Arlingate Lane
Columbus, OH 43228
Phone: (800) 222-2768
Web site: http://www.asnt.org

The American Welding Society (AWS) certifies welding inspectors with the designation AWS QC-1 (Quality Control) Welding Inspector and has guidelines on safe welding.

American Welding Society
550 NW LeJeune Rd
Miami, FL 33126
Phone: (800) 443-9353 or (305) 443-9353
Web site: http://www.amweld.org

For More Information...

Contact the EPCRA Hotline at (800) 424-9346 or (703) 412-9810 TDD (800) 553-7672
Monday-Friday 9:00 a.m. to 6:00 p.m. EST
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