



Reply to the attention of:

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MEMORANDUM FOR: REGIONAL ADMINISTRATORS

THROUGH:

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Deputy Assistant Secretary

FROM:

Thomas Galassi
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SUBJECT:

Guidance on the Ammonium Nitrate Storage Requirements in 29
CFR 1910.109(i)

On October 9, 2013, the Occupational Safety and Health Administration (OSHA) cited the Adair Grain Company (dba West Fertilizer Company) following the April 17, 2013, explosion that killed 15. The citations included violations related to hazards associated with improper storage of ammonium nitrate under 29 CFR 1910.109(i). This memorandum provides investigatory and citation guidance to OSHA enforcement personnel on particular elements of 1910.109(i).

OSHA promulgated 1910.109(i) by adopting the 1970 edition of the National Fire Protection Association's (NFPA) *Code for the Storage of Ammonium Nitrate* (NFPA 490)¹ pursuant to §6(a) of the Occupation Safety and Health Act of 1970 (OSH Act). Although NFPA 490-1970 addresses numerous hazards associated with the storage of ammonium nitrate, some aspects of the standard, as codified in 1910.109(i), are not enforceable by OSHA as they contain requirements specific to an authority having jurisdiction—typically a municipal or state code official. These officials have authority for enforcing municipal building, fire, plumbing, and electrical codes as related to building occupancy permits. OSHA, however, has no relevant permitting or approval authority unique to such municipal or state code officials.

OSHA cannot enforce the following two provisions of 1910.109(i):

1910.109(i)(2)(ii)

¹ NFPA withdrew NFPA 490 following the 2002 edition and incorporated requirements for storage of ammonium nitrate into NFPA 400 Chapter 11. However, NFPA 490 remains relevant as the basis for 1910.109(i).

1910.109(i)(2)(iii)(e)

The continued use of an existing storage building or structure not in strict conformity with this paragraph may be approved in cases where such continued use will not constitute a hazard to life;

The remainder of this memorandum provides investigatory and citation guidance to assist OSHA officials in enforcing 1910.109(i).

Scope and Application

1910.109(i)(1)(i)(a)

Except as provided in paragraph (i)(1)(i)(d) of this paragraph [sic] applies to the storage of ammonium nitrate in the form of crystals, flakes, grains, or prills including fertilizer grade, dynamite grade, nitrous oxide grade, technical grade, and other mixtures containing 60 percent or more ammonium nitrate by weight but does not apply to blasting agents. 1910.109(i)(2)(i)

This paragraph applies to all persons storing, having, or keeping ammonium nitrate, and to the owner or lessee of any building, premises, or structure in which ammonium nitrate is stored in quantities of 1,000 pounds or more.

The source standard for 1910.109(i) is NFPA 490 - 1970, which applied to the storage or possession of ammonium nitrate in all industries except transportation and US Coast Guard-regulated facilities. Because NFPA 490 - 1970 still provides an interpretative basis for 1910.109(i), the ammonium nitrate provisions of 1910.109(i) apply to all industries under OSHA jurisdiction and are not limited to those using ammonium nitrate in the production of explosives.

Compliance Guidance:

Although coverage of 1910.109(i) extends to the storage or possession of ammonium nitrate in all workplaces covered by OSHA, the following industries in OSHA jurisdiction are the most likely to manufacture, use, store, handle, or possess ammonium nitrate:

Nitrogenous Fertilizer Manufacturing – 325311
 Phosphatic Fertilizer Manufacturing – 325312
 Fertilizer (Mixing Only) Manufacturing – 325314
 Grain and Field Bean Merchant Wholesalers – 424510
 Other Farm Product Raw Materials Merchant Wholesalers – 424590
 Farm Supplies Merchant Wholesalers – 424910
 Farm Product Warehousing and Storage – 493130
 Various explosives storage, explosives wholesale, and blasting industries

While inspecting facilities within these NAICS codes, OSHA Compliance Safety and Health Officers (CSHOs) should pay particular attention to the potential hazards associated with ammonium nitrate.

Storage – General Requirements

1910.109(i)(2)(iii)(b)

Storage buildings shall have adequate ventilation or be of a construction that will be self-ventilating in the event of fire.

Ventilation during a fire event is accomplished mechanically or through building construction. The purpose of ventilating an ammonium nitrate storage building during a fire event is to prevent the accumulation of highly toxic off-gas products, such as nitrogen oxides, and remove hot gases from the structure to limit heating of the ammonium nitrate and reduce the risk of an explosion.

NFPA 490, the source standard, does not give guidance on the basis for ventilation design. Ventilation systems must be in place to address fire emergencies. Ventilation, either mechanical or natural,² must move products of combustion and ammonium nitrate decomposition out of the structure.²

Ventilation system designs differ from employer to employer based on building size, outside environmental conditions, the amount of ammonium nitrate stored, and the selected design approach. Employers can design ventilation systems to reduce nitrogen dioxide concentration to below the immediately dangerous to life and health (IDLH) concentration³, which would eliminate explosive gas concentrations as well. Other design factors could include number of air changes in the room or a hot gas removal rate to reduce energy input to the ammonium nitrate.

An example of an acceptable ventilation rate compliant with 1910.109(i)(2)(iii)(b) includes:

$$Q_v = (Q_m R_g T / k C_{ppm} PM) \times 10^6$$

Where:

Q_v = ventilation rate (ft^3/min)

Q_m = contaminant generation rate (lb_m/min) (generation of nitrogen oxides)

R_g = ideal gas constant ($0.7302 \text{ ft}^3 \text{ atm/lb-mol R}$)

T = temperature (R)

C_{ppm} = contaminant IDLH or TWA (ppm)

P = 1 atm

M = contaminant molecular weight ($\text{lb}_m/\text{lb-mol}$)

k = mixing coefficient (0.1 to 1.0 (perfect mixing)). (Values in this range are credible.)

² Remotely actuated, mechanical ventilation is preferred for fire response.

³ The IDLH concentration of nitrogen dioxide (one of the principal products of ammonium nitrate decomposition) is 50 parts per million.

Compliance Guidance:

CSHOs should ask employers how the ammonium nitrate storage area is ventilated in case of a fire. Ventilation systems designed in accordance with a basis such as those mentioned above are acceptable including open-air construction, manually operated vent fans, open ridge vents, roof-line louvered vents, continuously operated vent fans, etc., provided it is capable of removing products of combustion and decomposition.

CSHOs should consider a citation for a violation of this paragraph in situations where a ventilation system is not in place, such as storing ammonium nitrate in an interior room with no means of removing gaseous products of decomposition, or if the CSHO determines the ventilation system is inadequate. Examples of inadequate ventilation systems include, but are not limited to:

- Ventilation and HVAC systems designed solely for employee comfort,
- Reliance on open doors and windows, and
- Floor-mounted fans.

1910.109(i)(2)(iii)(d)

All flooring in storage and handling areas, shall be of noncombustible material or protected against impregnation by ammonium nitrate and shall be without open drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate could flow and be confined in the event of fire.

Use of combustible flooring is not always prohibited. Employers must either provide noncombustible flooring material or use a combustible flooring material coated or cladded to prevent ammonium nitrate impregnation. Ammonium nitrate impregnation of porous, combustible materials, such as wood, may accelerate combustion in the event of a structural fire and, thus, increase the explosion risk. The coating or cladding must be robust enough to withstand foot and vehicular traffic such as, but not limited to, that from fork trucks, bobcats, and front-end loaders. The employer must show that their chosen coating or cladding is impermeable to ammonium nitrate.

Compliance Guidance:

Flooring in ammonium nitrate storage buildings is almost universally made of concrete because it can withstand heavy loads and vehicle wear and tear. Concrete can become impregnated with ammonium nitrate but this does not pose any additional fire hazard because the concrete is noncombustible.

Employers choosing to use combustible materials for flooring must show how they protect the material from ammonium nitrate impregnation. CSHOs should pay particular attention to buildings with combustible flooring. Employers who cannot show how the flooring is protected from impregnation may be cited under this paragraph. For instance, the use of unprotected wooden plank flooring is a violation of this paragraph.

In addition, CSHOs should consider a citation for a violation of this paragraph in facilities with drains, pits, sumps, trenches, floor holes, etc. where molten ammonium nitrate can flow and accumulate.

Storage of Bags, Drums, and Containers of Ammonium Nitrate

1910.109(i)(3)(ii)(a)

Containers of ammonium nitrate shall not be accepted for storage when the temperature of the ammonium nitrate exceeds 130 deg. F.

To prevent hot spots and possible thermal decomposition, the average temperature within any ammonium nitrate container cannot exceed 130°F. Employers must ensure, through any appropriate means, that the maximum temperature has not been exceeded.

This requirement is particularly important for ammonium nitrate manufacturers. For employers that receive ammonium nitrate prills by truck or railcar, such as at fertilizer distributor and supplier facilities, this requirement is less of a factor as the ammonium nitrate is likely received at ambient temperature due to prolonged exposure to ambient temperatures while in transit.

Compliance Guidance:

This situation is only expected to arise between a manufacturer's prilling tower and bulk storage. CSHOs inspecting fertilizer manufacturers should determine how the employer establishes the temperature of the ammonium nitrate and how they ensure the ammonium nitrate is below 130°F prior to bulk storage.

Employers who cannot show that ammonium nitrate enters storage at or below 130°F following prilling may be cited under this paragraph.

Storage of Bulk Ammonium Nitrate

1910.109(i)(4)(i)(a)

Warehouses shall have adequate ventilation or be capable of adequate ventilation in case of fire.

See discussion under *1910.109(i)(2)(iii)(b)* above.

1910.109(i)(4)(ii)(b)

Due to the corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanized iron, copper, lead, and zinc shall not be used in a bin construction unless suitably protected. Aluminum bins and wooden bins protected against impregnation by ammonium nitrate are permissible. The partitions dividing the ammonium nitrate storage from other products which would contaminate the ammonium nitrate shall be of tight construction.

Bins constructed of wood, aluminum, galvanized iron, copper, zinc, or lead sheet are not recommended, however OSHA does not prohibit bin construction with these materials. Any impermeable coating or cladding for bins constructed with these materials is acceptable, such as two-part epoxy coatings, steel sheet cladding, or sodium silicate.

Compliance Guidance:

Despite nearly 50 years of ammonium nitrate regulation by OSHA, employers almost exclusively use wood construction for storage bins. However, untreated wooden bin construction is prohibited by this paragraph and only wood treated to prevent impregnation by ammonium nitrate prior to being placed in service is permitted. Treated wood must remain impregnable to ammonium nitrate throughout its use. During the course of an inspection, CSHOs should determine whether wood used in storage bins has been properly treated and may issue citations under this paragraph in instances where the wood is either untreated or improperly treated. CSHOs likely will encounter one of the following three situations:

1. Wooden bins that are not and never have been coated or treated to prevent ammonium nitrate impregnation.
2. Wooden bins that have been coated or treated to prevent ammonium nitrate impregnation but have not been maintained to protect the integrity of the coating or treatment, or
3. Wooden bins coated or treated with a material claimed to be chemically compatible with and impregnable to ammonium nitrate.

Situation #1 above is citable under this paragraph. Situation #2 may be readily apparent during the walk-around inspection. If a CSHO questions whether a coating or treatment, a sample of wood for testing is necessary to show hazard. If the laboratory determines the wood is impregnated with ammonium nitrate, OSHA may cite under this paragraph. In situation #3, the CSHO should obtain details of the coating or treatment such as SDS or manufacturer's literature to determine if it is chemically compatible and impregnable to ammonium nitrate.

Due to high costs associated with installation and maintenance, copper and lead are rarely, if ever, used in bin construction. However, CSHOs should closely examine any metal bin to determine if it is constructed of galvanized iron, unprotected aluminum, copper, or zinc. Use of these materials without protection from contact with ammonium nitrate can create conditions that could potentially lead to an explosion. If a CSHO determines that galvanized iron or unprotected aluminum, copper, or zinc is present, a citation may be issued for a violation of this paragraph.

In addition, CSHOs should closely examine bin walls separating ammonium nitrate storage from storage of other materials to ensure walls and separators are tight to prevent intermingling of materials.

Height or depth of piles shall be limited by the pressure-setting tendency of the product. However, in no case shall the ammonium nitrate be piled higher at any point than 36 inches below the roof or supporting and spreader beams overhead.

The tragic incident in Oppau, Germany, occurred in part because ammonium nitrate and ammonium sulfate had clumped in a storage silo and formed a huge solid mass. Workers in Oppau apparently used small explosive charges to break the ammonium nitrate mass into smaller fragments. The small charges set off a very powerful explosion that destroyed most of the city and killed nearly 600.

The pressure-setting tendency—the propensity for stored prills to agglomerate into a solid mass or clump—of ammonium nitrate is dependent on many factors including prill size, humidity, and storage temperature. Employers must show that they have evaluated the pressure-setting tendency of the ammonium nitrate they store and that they have set their pile height in accordance with that tendency.

Compliance Guidance:

Generally, fertilizer distributors do not store nearly enough ammonium nitrate to create the extent of hazard in Oppau. However, clumping can occur even in small pile. Ammonium nitrate readily absorbs moisture, agglomerates, and cakes. CSHOs should inspect for clumping, caking, and accumulation of ammonium nitrate in storage bins especially in corners and on ledges. Limited clumping that is easily broken up is expected and not a violation. Excessive clumping requiring substantial mechanical force to break up indicates that the employer is storing too much ammonium nitrate in individual piles and has not implemented practices to evaluate and manage the pressure-setting tendency of the material.

CSHOs should consider a citation for a violation of this paragraph where hardened accumulations of ammonium nitrate have formed in storage. Such accumulations are often found on the walls or floors of storage bins. CSHOs should pay particular attention to hard-to-reach areas such as back corners or ledges.

Fire Protection

1910.109(i)(7)(i)

Not more than 2,500 tons (2270 tonnes) of bagged ammonium nitrate shall be stored in a building or structure not equipped with an automatic sprinkler system. Sprinkler systems shall be of the approved type and installed in accordance with 1910.159.

Only aqueous sprinkler systems designed, built, and installed in accordance with 29 CFR 1910.159 satisfy the requirements of this standard. 29 CFR 1910.159(a)(2) allows for aqueous systems designed and built to standards in effect at the time of the system's installation.

Compliance Guidance:

The use of bagged ammonium nitrate is becoming exceedingly rare; however, facilities selling bagged material must have aqueous sprinkler systems for fires involving ammonium nitrate.

CSHOs may cite this paragraph if the employer does not have an automatic sprinkler system for bagged ammonium nitrate storage exceeding 2500 tons. CSHOs should consider grouping with 1910.159 if the automatic sprinkler system does not meet the requirements of 1910.159.

1910.109(i)(7)(ii)(a)

Suitable fire control devices such as small hose or portable fire extinguishers shall be provided throughout the warehouse and in the loading and unloading areas. Suitable fire control devices shall comply with the requirements of 1910.157 and 1910.158.

1910.109(i)(7)(ii)(b)

Water supplies and fire hydrants shall be available in accordance with recognized good practices.

All ammonium nitrate storage warehouses must have either fire extinguishers or small diameter fire hoses, or both. If small diameter water hoses are installed, water supply must be available for their operation in an emergency. Only employees trained in structural firefighting and equipped with appropriate personal protective equipment may use hose lines to fight fires.

In addition, water supplies and hydrants for structural firefighting must be available for crews to fight warehouse fires. In most cases, necessary water supply is guided by NFPA or International Code Council standards, or other state or municipal fire codes or standards. In areas without municipal water supply, the requirements of this paragraph could be met with on-site water storage.

These paragraphs do not require installation of fixed, automatic fire protection systems, with the exception of 29 CFR 1910.109(i)(7)(i) which requires installation of automatic sprinkler systems for storage of 2500 tons or more of bagged ammonium nitrate. While not required, nothing in the standard prohibits the installation of fixed, automatic fire protection systems in ammonium nitrate storage facilities. Employers must design and install fixed fire protection systems in accordance with 29 CFR 1910.159, NFPA 13 (appropriate for the year of system design and installation), or other appropriate design standard.⁴

Compliance Guidance:

CSHOs may cite violations of 109(i)(7)(ii)(a) where fire extinguishers or small diameter fire hoses are not provided.

Employers must ensure water supply for small diameter fire hoses or fire hydrants is available. CSHOs may cite 109(i)(7)(ii)(b) if a water supply is not provided.

⁴ Existing fire protection systems should have been installed in accordance with the version of NFPA 13, or other appropriate standard, in effect at the time of design and installation.

Questions

If you have questions on the application of these or any requirements in 29 CFR 1910.109(i), please call Mary Lynn, Director, Office of Chemical Process Safety and Enforcement Initiatives at (202) 693-1995 or Jeffrey Wanko, Office of Chemical Process Safety and Enforcement Initiatives at (202) 693-2137.