Drinking Water & Groundwater Program

Wisconsin Department of Natural Resources 101 S. Webster Street, P.O. Box 7921 Madison, WI 53707-7921

Guidance for Chemical Storage Compatibility at Community Water Systems and Operations Handbook Chapter 2.2.9 Updates

March 2022

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

Guidance for Chemical Storage Compatibility at Community Water Systems

Sections NR 811.40 (1)(L), Wis. Adm. Code

Purpose: This guidance is intended to clarify the type of risk associated with chemical storage. Risks from drinking water chemicals include health and safety issues related to mixing of vapors, mixing of liquids and explosion hazards, corrosion of equipment, spill containment to prevent environmental damage and contamination of a drinking water chemical or source. Additionally, this guidance clarifies code intentions by outlining general chemical storage requirements for chemical feed and storage systems. This guidance provides specific chemical installation details which may require additional isolation measures and includes scenarios where chemicals are required to be completely isolated from one another in separate rooms.

Background: During engineering plan reviews and sanitary surveys department staff often identify situations where more than one chemical is stored in the same chemical room or in the same room as the source of water (well or surface water intake shore structure). According to section NR 811.40(1)(L), Wis. Adm Code, design of chemical storage and handling facilities should be such that incompatible chemicals are not stored together or handled in common areas. This section of code does not include the specific chemical interactions intended to protect against which has led to inconsistent interpretations.

This guidance was created by the department's Public Water Engineering Section to ensure statewide consistency in program implementation. This guidance was developed to provide a clearer understanding for DNR plan review staff, DNR field staff, community water system staff and consultants of chemical storage.

Document Organization: This guidance outlines chemical storage and ventilation requirements of ch. NR 811, Wis. Adm. Code. Theguidance provides a list of commonly used drinking water chemicals and provides the storage expectations of these dissimilar chemicals.

Periodic Review Required: This guidance will be periodically reviewed by the department's Public Water Engineering Section.

Guidance for Chemical Storage Compatibility at Community Water Systems

Sections NR 811.40 (1)(L), Wis. Adm. Code

CORRESPONDENCE/MEMORANDUM State of Wisconsin

DATE: March 10, 2021

TO: Public Drinking Water Engineers and Agents

FROM: Wisconsin Department of Natural Resources Bureau of Drinking Water and Groundwater

SUBJECT: Chemical Storage Compatibility at Community Water Systems – Guidance for Field and Plan Review Staff (Chemical Storage Compatibility)

During engineering plan reviews and sanitary surveys department staff often identify situations where more than one chemical is stored in the same chemical room or in the same room as the source of water (well or surface water intake shore structure). According to section NR 811.40(1)(L), Wis. Adm Code, design of chemical storage and handling facilities should be such that incompatible chemicals are not stored together or handled in common areas. This section of code does not include the specific chemical interactions intended to protect against which has led to inconsistent interpretations.

This document is intended to[1]:

1. Clarify the type of risk associated with chemical storage. Risks from drinking water chemicals include health and safety issues related to mixing of vapors, mixing of liquids and explosion hazards, corrosion of equipment, spill containment to prevent environmental damage and contamination of a drinking water chemical or source.

2. Clarify code intentions by outlining general chemical storage requirements for chemical feed and storage systems. This document provides specific chemical details which may require additional isolation measures and includes scenarios where chemicals are required to be completely isolated from one another in separate rooms.

General Chemical Considerations

The EPA chemical compatibility guidance document included on pages 4 and 5 of this memo outlines storage considerations and identifies specific chemicals which are incompatible. This information was used to develop the Chemical Compatibility Matrix of Common Drinking Water Chemicals on page 6. This table provides a list of common drinking water chemicals and the assigned chemical compatibility category between chemicals. Department concerns related to the storage of the various chemical phases (solid, gas, liquid) are outlined below.

Dry/powdered chemical storage: Dry or powdered chemicals such as powdered activated carbon, potassium permanganate, or lime to be mixed into a slurry may not be stored in common rooms with liquid or gaseous chemicals. Dry chemicals pose a dust and explosion hazard and must not interact with liquid chemicals. Gas cylinders that are not properly vented or leak during cylinder changes may act as an oxidizer further fueling and increasing potential risks during the combustion of powders.

Gaseous chemical storage: Gaseous chemicals must be properly restrained and should not be stored in the same room with liquid or solid chemicals. Gases from poorly ventilated cylinders or from leaks during cylinder changes may act as an oxidizer or fuel source in other chemical interactions. Routine exposure to corrosive conditions poses a risk to the safety of gaseous chemical storage,

[1]Specific guidance or requirements from the Occupational Safety and Health Administration shall supersede any recommendations and suggestions in this memo. Other state, local, and federal codes may require more stringent protections.

therefore gaseous chemical storage should be separated from other liquid chemicals.

Liquid chemical storage: Fluoride and liquid ammonia products are the only products which are required to be stored in a separate chemical room from all other chemicals in new installations. Off-gassing from fluoride and ammonia chemicals may result in the release of hazardous and corrosive chemicals released in to the pumphouse. These chemicals may damage equipment and place operators in potentially harmful situations. All other liquid chemicals may remain in the same room but should be provided with a means to minimize common areas of incompatible chemicals such as through the installation of divider walls or maximizing physical distances.

Storage Adjacent to Water Sources: The specific risks identified above and in Table 1 shall be considered in existing situations where chemicals are stored near the groundwater well or pumps in wellhouses or surface water shore wells. Chemicals stored in common rooms with groundwater wells or surface water sources should be provided with secondary containment. Lack of secondary containment should be identified as a non-conforming feature.

Chemical Storage Requirements

Secondary Containment: Incompatible chemical groups are required to have their own secondary containment in accordance with ss. NR 811.39 (3)(d) and NR 811.40 (1)(L), Wis. Adm. Code. Incompatible chemicals as defined on pages 4 and 5 may not share any waste floor drains designed for the conveyance of chemical spills. Unless otherwise identified below, lack of secondary containment should be identified by field staff as a non-conforming feature to be upgraded the next time the existing tank is removed or replaced.

Isolation: Some drinking water chemicals must be stored separately in isolated rooms to minimize the risk of chemical interactions and the risk of cross contamination between chemicals. All chemical feed rooms containing incompatible chemicals must minimize common incompatible chemical feed areas to the greatest extent possible. Chemicals not appearing in this document are not considered exempt from protections and will be evaluated in accordance with similar guidelines to minimize the risk of inadvertent hazardous chemical byproduct formation. Fluoride and liquid ammonia products are required to meet Category 1 installation requirements for new construction but for existing installations may be permitted to meet the requirements of Category 2. The chemical compatibility categories and the required level of isolation are defined below:

Category 1: Category 1 chemical incompatibility is determined to be at the greatest risk of generation of a hazardous chemical byproduct and poses the greatest health and safety risk to water system staff. The risk identified for Category 1 is due to potential mixing of vapors as well as liquids during leaks or spills. Chemicals must be isolated from each other in separate rooms in all new and retrofit situations. Existing installations not meeting this requirement must be identified as a significant deficiency by field staff and assigned a corrective action deadline. Category 1 incompatibilities identified by plan review staff during reviews will be required to be corrected during the submitted review project.

Category 2: Category 2 chemical incompatibility risk is determined to be a reduced risk of chemical interaction. Chemicals with a Category 2 incompatibility should be provided with their own chemical feed areas. Common compliance strategies in new and existing installations include the use of divider walls or separate feed areas within larger rooms to maximize physical separation. Each group of incompatible chemicals should be provided with its own secondary containment. In existing installations, the lack of containment basins shall be identified by the DNR field representative as a non-conforming feature. The field representative shall note the lack of containment may pose a health and safety issue for the operator during leaks or spills. If it is determined that an *immediate health risk* exists due to the lack of containment, then the field rep should identify it as a significant deficiency and assign a corrective action deadline.

Category 3: Category 3 chemicals have no health and safety risk if vapors or liquids are mixed; however, separation is required to ensure that the chemicals are not cross contaminated rendering one or more ineffective for water treatment. Category 3 chemicals may be permitted to have common secondary containment.

Liquid Chemical Storage Tank Ventilation: Section NR 811.40 (1)(n), Wis. Adm. Code requires all liquid chemical storage tanks be vented to the outside. The original intent of this code language was to require ventilation to reduce the health and safety risk to operators and reduce corrosion of equipment and facilities from highly volatile chemicals. Inhalation of ammonia and fluoride vapors may result in fluid buildup in the lungs resulting in difficulty breathing for the impacted person. Liquid ammonia products and liquid fluoride products are the only products which are required by code to be provided with a dedicated tank ventilation to the building exterior at the time of installation. Some existing installations lack tank ventilation, but have an integrated tank lid to mitigate chemical fume release. Existing installations where an integrated tank lid or external vent are not installed and corrosion issues are documented must be identified as a deficiency under s. NR 810.03, Wis. Adm. Code. Additional chemical ventilation may be required in situations where the pumphouse is a single room containing both the chemical feed and electrical equipment. Tank vents shall terminate to the exterior of the building downward facing with a 24-mesh corrosion resistant screen a minimum of 24 inches above the surrounding grade.

United States Environmental Protection Agency

Incompatible Chemicals Storage

A sanitary survey quick reference guide for determining how to properly store chemicals at a water treatment plant

Dos and Don'ts

Do not store liquid chemicals and dry chemicals together regardless of which compatibility group they fall into.

Do not store chemicals from different **compatibility groups** together. Water treatment chemicals are divided into six incompatible groups: Acids, Bases, Salts & Polymers, Adsorption Powders, Oxidizing Powders, and Compressed Gasses. **To ensure the safety of system personnel and the system itself, store each of these groups of incompatible chemicals separately (compatibility groups listed on reverse side).**

Do not store products such as paint, antifreeze, detergent, oil, grease, fuel, solvent, and beverages in the same area as water treatment chemicals.

DO store all chemicals in secure, well-ventilated areas that are free of moisture (especially dry chemicals), excessive heat, ignition sources and flammable/ combustible materials.

DO see your Material Safety Data Sheet (MSDS) if you encounter a chemical that is not listed on one of the following tables (MSDS required by OSHA Regulation 29.CFR.1910.1200 for all organizations/water systems that handle hazardous chemicals).

Warning

Storing incompatible chemicals together could create a hazardous reaction such as the production of toxic gas, accelerated corrosion, or an exothermic reaction (a chemical reaction that releases heat), which could result in an explosion and/or fire. This reaction could be catastrophic, resulting in loss of life and rendering the water plant inoperable.

Examples:

Examples of Incompatible Chemicals	Hazardous Reactions
Powdered Activated Carbon (PAC), an adsorption powder, should not be mixed with Potassium Permanganate, an oxidizing powder	Excessive heat generation, with the possibility of explosion and fire. Note: PAC alone is extremely combustible.
Calcium Hypochlorite, a combination base/oxidizer should not be exposed to moisture or mixed with viscous fluid such as oil.	Excessive heat, fire or explosion possible. Can provide an ignition source for combustible materials.
Concentrated Sulfuric Acid, a strong acid, should not be mixed with Concentrated Sodium Hydroxide, a strong base.	Excessive heat and liquid explosion. Note: Highly concentrated acids and bases when mixed together will have a much more hazardous reaction than weak acids and bases.
Calcium Oxide, a strong base available only as a powder, should not be exposed to moisture	Excessive heat, fire. Can provide an ignition source for combustible materials.

Compatibility Groups: Common Water Treatment Chemicals

Group I: Acids

Name	Common Name	Available Forms
Acetic Acid	Ethanoic Acid	Liquid
Hydrofluosilicic Acid	Fluosilic Acid	Liquid
Hydrogen Fluoride Acid	Hydrofluoric Acid	Liquid
Hydrochloric Acid	Muriatic Acid	Liquid
Nitric Acid	Sulfuric Acid	Liquid

Group II: Bases

Name	Common Name	Available Forms[1]
Calcium Hydroxide	Hydrated Lime	Dry
Calcium Oxide	Quicklime	Dry
Calcium Hypochlorite	HTH	Dry
Sodium Bicarbonate	Sodium Bicarbonate	Dry
Sodium Carbonate	Soda Ash	Dry
Sodium Hydroxide	Caustic Soda, Lye	Liquid, Dry
Sodium Hypochlorite	Bleach	Liquid
Sodium Silicate	Water Glass	Liquid

[1] Certain concentrated dry chemicals, like calcium hypochlorite and calcium oxide (quicklime) will produce an exothermic reaction when exposed to liquid or even small amounts of moisture.

Group III: Salts & Polymers

Name	Common Name	Available Forms
Aluminum Sulfate	Alum	Liquid, Dry
Copper Sulfate	Blue Stone	Liquid, Dry
Ferric Chloride	Ferrichlor	Liquid, Dry
Ferric Sulfate	Ferri-Floc	Dry
Ferrous Sulfate	Copperas	Liquid Dry
Polyaluminum Chloride	PACL	Liquid
Polyelectrolytes (Cationic, Anionic, Non-ionic)	Polymer	Liquid, Dry
Sodium Aluminate	Soda Alum	Liquid, Dry
Sodium Fluoride	Sodium Fluoride	Liquid, Dry
Sodium Hexametaphosphate	Glassy Phosphate	Dry
Sodium Phosphate	Sodium Phosphate	Liquid, Dry
Zinc Orthophosphate	Zinc Ortho	Liquid

Group IV: Adsorption Powders

Name	Common Name	Available Forms
Powdered Activated Carbon	PAC	Dry
Granular Activated Carbon	GAC	Dry

Group V: Oxidizing Powders

Name	Common Name	Available Forms
Potassium Permanganate	Permanganate	Dry

Group VI: Compressed Gases[2]

Name	Common Name	Available Forms	Incompatible Chemicals Within This Category[3]
Ammonia	Ammonia	Liquid, Gas	Chlorine
Chlorine	Gas Chlorine	Liquid, Gas	Ammonia
Carbon Dioxide	Dry Ice	Liquid, Gas	-
Sulfur Dioxide	SO_2	Liquid, Gas	-

[2] Each compressed gas should have its own separate storage/feed area.
[3] Chlorine and ammonia should be stored separately from each other, as well as from all other chemical groups.

Chemical Compatibility Matrix of Common Drinking Water Chemicals

1	Chemicals must be stored in separate rooms in all new and existing installations. Existing installations not satisfying this requirement shall be considered a significant deficiency
2	Chemicals must be separated to avoid storage in common areas. Potential options include maximizing physical separation in larger chemical rooms or the construction of divider walls. Existing installations may maintain chemical storage in the same room but must be provided with dedicated secondary containment and precautions should be taken to maximize the physical separation of the incompatible chemicals. Situations without these protections should be identified as non-conforming features.
3	Chemicals may be stored in the same room in all new and retrofit situations. Secondary containment is necessary to prevent chemical spills. Situations without these protections should be identified as non-conforming features.
*	Chemicals required to be stored in separate rooms meeting category 1 in new installations. Existing installations may meet the requirements of category 2.

Chemical Symbol Matrix	
(s)	Used to identify chemical compounds in solid or powdered form
(aq)	Used to identify chemical compounds in a liquid or slurry form.
(g)	Used to identify chemical compounds in a gaseous form.

	Activated Carbon (s)	Aluminum Sulfate (aq)	Ammonia (g)	Ammonia Solutions (aq)	Blended phosphate products (aq)	Carbon Dioxide (g)	Chlorine (g)	Ferric Chloride (aq)	Ferric Sulfate (aq)	Hydrofluoric Acid (aq)	Hydrofluorosilicic Acid/Fluosilicic Acid (aq)	Hydrous Manganese Oxide (aq)	Lime/Calcium Hydroxide (s)	Phosphoric Acid (aq)	Polymers (aq)	Potassium Permanganate (aq)	Potassium Permanganate (s)	Sodium Carbonate (aq)	Sodium Chlorite (s)	Sodium Hydroxide (aq)	Sodium Hypochlorite (aq)	Sodium Permanganate (aq)	Sodium Permanganate (s)	Sodium Silicate (aq)
Activated Carbon (aq)	1																							
Aluminum Sulfate (aq)	1	1																						
Ammonia (g)	1	1	1																					
Ammonia Solutions (aq)	1	*	1	1																				
Blended phosphate products (aq)	1	3	1	*	1																			
Carbon Dioxide (g)	1	2	1	1	2	1																		
Chlorine (g)	1	1	1	1	1	1	1																	
Ferric Chloride (aq)	1	3	1	*	3	2	1	1																
Ferric Sulfate (aq)	1	3	1	*	3	2	1	3	1															
Hydrofluoric Acid (aq)	1	*	1	*	*	1	1	*	*	1														
Hydrofluorosilicic Acid/Fluosilicic Acid (aq)	1	*	1	*	*	1	1	*	*	*	1													
Hydrous Manganese Oxide (aq)	1	2	1	*	2	2	1	2	2	*	*	1												
Lime/Calcium Hydroxide (s)	1	1	1	1	1	1	1	1	1	1	1	1	1											
Phosphoric Acid (aq)	1	2	1	*	2	2	1	2	2	1	1	2	1	1										
Polymers (aq)	1	3	1	*	3	2	1	3	3	*	*	3	1	2	1									
Potassium Permanganate (aq)	1	2	1	*	2	2	1	2	2	*	*	3	1	2	3	1								
Potassium Permanganate (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
Sodium Carbonate (aq)	1	2	1	*	3	2	1	2	2	*	*	2	1	2	2	2	1	1						
Sodium Chlorite (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
Sodium Hydroxide (aq)	1	2	1	*	3	2	1	2	2	*	*	2	1	2	2	2	1	3	1	1				
Sodium Hypochlorite (aq)	1	2	1	*	3	2	1	2	2	*	*	2	1	2	2	2	1	3	1	3	2			
Sodium Permanganate (aq)	1	2	1	*	2	2	1	2	2	*	*	2	1	2	3	2	1	2	1	2	2	1		
Sodium Permanganate (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Sodium Silicate (aq)	1	2	1	*	3	2	1	2	2	*	*	2	1	2	2	2	1	3	1	3	3	2	1	1