# CHEMICAL APPLICATION



## 5.0 GENERAL

No chemicals shall be applied to treat drinking waters unless specifically permitted by the reviewing authority.

### 5.0.1 Plans and specifications

Plans and specifications shall be submitted for review and approval, as provided for in Part 2, and shall include

a. descriptions of feed equipment, including maximum and minimum feed ranges,

b. location of feeders, piping layout and points of application,

c. storage and handling facilities,

d. specifications for chemicals to be used,

e. operating and control procedures including proposed application rates, and

f. descriptions of testing equipment and procedures.

### 5.0.2 Chemical application

Chemicals shall be applied to the water at such points and by such means as to

a. assure maximum efficiency of treatment,

b. assure maximum safety to consumer,

c. provide maximum safety to operators,

d. assure satisfactory mixing of the chemicals with the water,

e. provide maximum flexibility of operation through various points of application, when appropriate, and

f. prevent backflow or back-siphonage between multiple points of feed through common manifolds.

### 5.0.3 General equipment design

General equipment design shall be such that

a. feeders will be able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed,

b. chemical-contact materials and surfaces are resistant to the agressiveness of the chemical solution,

c. corrosive chemicals are introduced in such a manner as to minimize potential for corrosion,

d. chemicals that are incompatible are not stored or handled together,

e. all chemicals are conducted from the feeder to the point of application in separate conduits,

f. chemical feeders are as near as practical to the feed point,

g. chemical feeders and pumps shall operate at no lower than 20 per cent of the feed range unless two fully independent adjustment mechanisms such as pump pulse rate and stroke length are fitted when the pump shall operate at no lower than 10 percent of the rated maximum, and

h. chemicals may be fed by gravity where practical.

## 5.1 FACILITY DESIGN

### 5.1.1 Number of feeders

a. Where chemical feed is necessary for the protection of the supply, such as chlorination, coagulation or other essential processes,

1. a minimum of two feeders shall be provided, and

2. the standby unit or a combination of units of sufficient capacity should be available to replace the largest unit during shut-downs;

3. where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power.

b. A separate feeder shall be used for each chemical applied.

c. Spare parts shall be available for all feeders to replace parts which are subject to wear and damage.

### 5.1.2 Control

a. Feeders may be manually or automatically controlled, with automatic controls being designed so as to allow override by manual controls.

b. At automatically operated facilities, chemical feeders shall be electrically interconnected with the well or service pump and should be provided a nonstandard electrical receptacle.

c. Chemical feed rates shall be proportional to flow.

d. A means to measure water flow must be provided in order to determine chemical feed rates.

e. Provisions shall be made for measuring the quantities of chemicals used.

f. Weighing scales

1. shall be provided for weighing cylinders at all plants utilizing chlorine gas,

2. may be required for fluoride solution feed,

3. should be provided for volumetric dry chemical feeders, and

4. shall be capable of providing reasonable precision in relation to average daily dose.

g. Where conditions warrant, for example with rapidly fluctuating intake turbidity, coagulant and coagulant aid addition may be made according to turbidity, streaming current or other sensed parameter.

### 5.1.3 Dry chemical feeders

Dry chemical feeders shall

a. measure chemicals volumetrically or gravimetrically,

b. provide adequate solution water and agitation of the chemical in the solution pot, and

c. completely enclose chemicals to prevent emission of dust to the operating room.

### 5.1.4 Positive displacement solution pumps

Positive displacement type solution feed pumps should be used to feed liquid chemicals, but shall not be used to feed chemical slurries. Pumps must be capable of operating at the required maximum rate against the maximum head conditions found at the point of injection.

### 5.1.5 Liquid chemical feeders - siphon control

Liquid chemical feeders shall be such that chemical solutions cannot be siphoned or overfed into the water supply, by

a. assuring discharge at a point of positive pressure, or

b. providing vacuum relief, or

c. providing a suitable air gap, or

d. providing other suitable means or combinations as necessary.

### 5.1.6 Cross-connection control

Cross-connection control must be provided to assure that

a. the service water lines discharging to solution tanks shall be properly protected from backflow as required by the reviewing authority,

b. liquid chemical solutions cannot be siphoned through solution feeders into the water supply as required in Section 5.1.5, and

c. no direct connection exists between any sewer and a drain or overflow from the feeder, solution chamber or tank by providing that all drains terminate at least six inches or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle.

### 5.1.7 Chemical feed equipment location

Chemical feed equipment

a. shall be readily accessible for servicing, repair, and observation of operation, and

b. should be located in a separate room where required to reduce hazards and dust problems, and

c. should be conveniently located near points of application to minimize length of feed lines.

### 5.1.8 In-plant water supply

In-plant water supply shall be:

a. ample in quantity and adequate in pressure,

b. provided with means for measurement when preparing specific solution concentrations by dilution,

c. properly treated for hardness, when necessary,

d. properly protected against backflow, and

e. obtained from a location sufficiently downstream of any chemical feed point to assure adequate mixing.

### 5.1.9 Storage of chemicals

a. Space should be provided for

1. at least 30 days of chemical supply,

2. convenient and efficient handling of chemicals,

3. dry storage conditions, and

4. a minimum storage volume of 1 ½ truck loads where purchase is by truck load lots.

b. Storage tanks and pipelines for liquid chemicals shall be specified for use with individual chemicals and not used for different chemicals. Offloading areas must be clearly labeled to prevent accidental cross-contamination.

c. Chemicals shall be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved storage unit.

d. Liquid chemical storage tanks must

1. have a liquid level indicator, and

2. have an overflow and a receiving basin capable of receiving accidental spills or overflows without uncontrolled discharge; a common receiving basin may be provided for each group of compatible chemicals, that provides sufficient containment volume to prevent accidental discharge in the event of failure of the largest tank.

### 5.1.10 Solution tanks

a. A means which is consistent with the nature of the chemical solution shall be provided in a solution tank to maintain a uniform strength of solution. Continuous agitation shall be provided to maintain slurries in suspension.

b. Two solution tanks of adequate volume may be required for a chemical to assure continuity of supply while servicing a solution tank.

c. Means shall be provided to measure the liquid level in the tank.

d. Chemical solutions shall be kept covered. Large tanks with access openings shall have such openings curbed and fitted with overhanging covers.

e. Subsurface locations for solution tanks shall

1. be free from sources of possible contamination, and

2. assure positive drainage for ground waters, accumulated water, chemical spills and overflows.

f. Overflow pipes, when provided, should

1. be turned downward, with the end screened,

2. have a free fall discharge, and

3. be located where noticeable.

g. Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.

h. Each tank shall be provided with a valved drain, protected against backflow in accordance with Sections 5.1.5 and 5.1.6.

i. Solution tanks shall be located and protective curbings provided so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins.

### 5.1.11 Day tanks

a. Day tanks shall be provided where bulk storage of liquid chemical is provided.

b. Day tanks shall meet all the requirements of Section 5.1.10.

c. Day tanks should hold no more than a 30 hour supply.

d. Day tanks shall be scale-mounted, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during a day.

e. Hand pumps may be provided for transfer from a carboy or drum. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an over-flow from the day tank, must be provided.

f. A means which is consistent with the nature of the chemical solution shall be provided to maintain uniform strength of solution in a day tank. Continuous agitation shall be provided to maintain chemical slurries in suspension.

g. Tanks and tank refilling line entry points shall be clearly labeled with the name of the chemical contained.

### 5.1.12 Feed lines

a. should be as short as possible, and

1. of durable, corrosion-resistant material,

2. easily accessible throughout the entire length,

3. protected against freezing, and

4. readily cleanable;

b. should slope upward from the chemical source to the feeder when conveying gases;

c. shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixtures conveyed; and

d. should be color coded.

### 5.1.13 Handling

a. Carts, elevators and other appropriate means shall be provided for lifting chemical containers to minimize excessive lifting by operators.

b. Provisions shall be made for disposing of empty bags, drums or barrels by an approved procedure which will minimize exposure to dusts.

c. Provision must be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers, in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of

1. vacuum pneumatic equipment or closed conveyor systems,

2. facilities for emptying shipping containers in special enclosures, and/or

3. exhaust fans and dust filters which put the hoppers or bins under negative pressure.

d. Provision shall be made for measuring quantities of chemicals used to prepare feed solutions.

### 5.1.14 Housing

a. Floor surfaces shall be smooth and impervious, slip-proof and well drained.

b. Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes.

## 5.2 CHEMICALS

### 5.2.1 Shipping containers

Chemical shipping containers shall be fully labeled to include

a. chemical name, purity and concentration, and

b. supplier name and address.

### 5.2.2 Specifications

Chemicals shall be approved by the reviewing authority or meet the appropriate ANSI/AWWA standards and/or ANSI/NSF Standard 60.

### 5.2.3 Assay

Provisions may be required for assay of chemicals delivered.

## 5.3 OPERATOR SAFETY

### 5.3.1 Ventilation

Special provisions shall be made for ventilation of chlorine feed and storage rooms.

### 5.3.2 Respiratory protection equipment

Respiratory protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled, and shall be stored at a convenient heated location, but not inside any room where chlorine is used or stored. The units shall use compressed air, have at least a 30 minute capacity, and be compatible with or exactly the same as units used by the fire department responsible for the plant.

### 5.3.3 Chlorine leak detection

A bottle of concentrated ammonium hydroxide (56 per cent ammonia solution) shall be available for chlorine leak detection; where ton containers are used, a leak repair kit approved by the Chlorine Institute shall be provided. Continuous chlorine leak detection equipment is recommended. Where a leak detector is provided it shall be equipped with both an audible alarm and a warning light.

### 5.3.4 Protective equipment

a. At least one pair of rubber gloves, a dust respirator of a type certified by NIOSH for toxic dusts, an apron or other protective clothing and goggles or face mask shall be provided for each operator as required by the reviewing authority. A deluge shower and eyewashing device should be installed where strong acids and alkalis are used or stored.

b. A water holding tank that will allow water to come to room temperature must be installed in the water line feeding the deluge shower and eyewashing device. Other methods of water tempering will be considered on an individual basis.

c. Other protective equipment should be provided as necessary.

## 5.4 SPECIFIC CHEMICALS

### 5.4.1 Chlorine gas

a. Chlorine gas feed and storage shall be enclosed and separated from other operating areas. The chlorine room shall be

1. provided with a shatter resistant inspection window installed in an interior wall,

2. constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed, and

3. provided with doors equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior.

b. Full and empty cylinders of chlorine gas should be

1. isolated from operating areas,

2. restrained in position to prevent upset,

3. stored in rooms separate from ammonia storage, and

4. stored in areas not in direct sunlight or exposed to excessive heat.

c. Where chlorine gas is used, the room shall be constructed to provide the following:

1. each room shall have a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied; where this is not appropriate due to the size of the room a lesser rate may be considered,

2. the ventilating fan shall take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets to any rooms or structures,

3. air inlets should be through louvers near the ceiling,

4. louvers for chlorine room air intake and exhaust shall facilitate airtight closure,

5. separate switches for the fan and lights shall be located outside of the chlorine room and at the inspection window. Outside switches shall be protected from vandalism. A signal light indicating fan operation shall be provided at each entrance when the fan can be controlled from more than one point,

6. vents from feeders and storage shall discharge to the outside atmosphere, above grade,

7. the room location should be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.,

8. floor drains are discouraged. Where provided, the floor drains shall discharge to the outside of the building and shall not be connected to other internal or external drainage systems.

9. where deemed necessary by the reviewing authority, provision shall be made to chemically neutralize chlorine gas before discharge from the water treatment plant building into the environment. Such equipment shall be designed as part of the chlorine gas storage and feed areas to automatically engage in the event of any measured chlorine release. The equipment shall be sized to treat the entire contents of the largest storage container on site.

d. Chlorinator rooms should be heated to 60$^{o}$F, and be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.

e. Pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

### 5.4.2 Acids and caustics

a. Acids and caustics shall be kept in closed corrosion-resistant shipping containers or storage units.

b. Acids and caustics shall not be handled in open vessels, but should be pumped in undiluted form from original containers through suitable hose, to the point of treatment or to a covered day tank.

### 5.4.3 Sodium chlorite for chlorine dioxide generation

Proposals for the storage and use of sodium chlorite must be approved by the reviewing authority prior to the preparation of final plans and specifications. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of fire or explosion associated with its powerful oxidizing nature.

a. Storage

1. Chlorite (sodium chlorite) shall be stored by itself in a separate room and preferably shall be stored in an outside building detached from the water treatment facility. It must be stored away from organic materials because many materials will catch fire and burn violently when in contact with chlorite.

2. The storage structures shall be constructed of noncombustible materials.

3. If the storage structure must be located in an area where a fire may occur, water must be available to keep the sodium chlorite area cool enough to prevent heat induced explosive decomposition of the chlorite.

b. Handling

1. Care should be taken to prevent spillage.

2. An emergency plan of operation should be available for the clean up of any spillage.

3. Storage drums must be thoroughly flushed prior to recycling or disposal.

c. Feeders

1. Positive displacement feeders shall be provided.

2. Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be Type 1 PVC, polyethylene or materials recommended by the manufacturer.

3. Chemical feeders may be installed in chlorine rooms if sufficient space is provided or facilities meeting the requirements of subsection 5.4.1 shall be provided.

4. Feed lines shall be installed in a manner to prevent formation of gas pockets and shall terminate at a point of positive pressure.

5. Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

### 5.4.4 Sodium hypochlorite

Sodium hypochlorite storage and handling procedures should be arranged to minimize the slow natural decomposition process either by contamination or by exposure to more extreme storage conditions. In addition, feed rates should be regularly adjusted to compensate for this progressive loss in chlorine content.

a. Storage

1. Sodium hypochlorite shall be stored in the original shipping containers or in sodium hypochlorite compatible containers.

2. Storage containers or tanks shall be sited out of the sunlight in a cool area and shall be vented to the outside of the building.

3. Wherever reasonably feasible, stored hypochlorite shall be pumped undiluted to the point of addition. Where dilution is unavoidable, deionized or softened water should be used.

4. Storage areas, tanks, and pipe work shall be designed to avoid the possibility of uncontrolled discharges and a sufficient amount of appropriately selected spill absorbent shall be stored on-site.

5. Reusable hypochlorite storage containers shall be reserved for use with hypochlorite only and shall not be rinsed out or otherwise exposed to internal contamination.

b. Feeders

1. Positive displacement pumps with hypochlorite compatible materials for wetted surfaces shall be used.

2. To avoid air locking in smaller installations, small diameter suction lines shall be used with foot valves and degassing pump heads.

3. In larger installations flooded suction shall be used with pipe work arranged to ease escape of gas bubbles.

4. Calibration tubes or mass flow monitors which allow for direct physical checking of actual feed rates shall be fitted.

5. Injectors shall be made removable for regular cleaning where hard water is to be treated.

## 5.4.5 Ammonia

Ammonia for chloramine formation may be added to water either as a water solution of ammonium sulfate, or as aqua ammonia (ammonia gas in water solution), or as anhydrous ammonia (purified 100% ammonia in liquid or gaseous form). Special provisions required for each form of ammonia are listed below.

### 5.4.5.1 Ammonium sulfate

A water solution is made by addition of ammonium sulfate solid to water with agitation. The tank and dosing equipment contact surfaces should be made of corrosion resistant non- metallic materials. Provision should be made for removal of the agitator after dissolving the solid. The tank should be fitted with a lid and vented outdoors. Injection of the solution should tank place in the center of treated water flow at a location where there is high velocity movement.

### 5.4.5.2 Aqua ammonia (ammonium hydroxide)

Aqua ammonia feed pumps and storage shall be enclosed and separated from other operating areas. The aqua ammonia room shall be equipped as in Section 5.4.1 with the following changes:

a. A corrosion resistant, closed, unpressurized tank shall be used for bulk storage, vented through an inert liquid trap to a high point outside and an incompatible connector or lockout provisions shall be made to prevent accidental addition of other chemicals to the storage tank.

b. The storage tank shall be fitted either with cooling/refrigeration and/or with provision without opening the system to dilute and mix the contents with water to avoid conditions where temperature increases cause the ammonia vapor pressure over the aqua ammonia to exceed atmospheric pressure.

c. An exhaust fan shall be installed to withdraw air from high points in the room and makeup air shall be allowed to enter at a low point.

d. The aqua ammonia feed pump, regulators, and lines shall be fitted with pressure relief vents discharging outside the building away from any air intake and with water purge lines leading back to the headspace of the bulk storage tank.

e. The aqua ammonia shall be conveyed direct from storage to the treated water stream injector without the use of a carrier water stream unless the carrier stream is softened.

f. The point of delivery to the main water stream should be placed in a region of rapid, preferably turbulent, water flow.

g. Provisions should be made for easy access for removal of calcium scale deposits from the injector.

h. Provision of a modestly-sized scrubber capable of handling occasional minor emissions should be considered.

**5.4.5.3 Anhydrous ammonia**

Anhydrous ammonia is readily available as a pure liquefied gas under moderate pressure in cylinders or as a cryogenic liquid boiling at -15 Celsius at atmospheric pressure. The liquid causes severe burns on skin contact.

a. Anhydrous ammonia and storage feed systems (including heaters where required) shall be enclosed and separated from other works areas and constructed of corrosion resistant materials.

b. Pressurized ammonia feed lines should be restricted to the ammonia room.

c. An emergency air exhaust system, as in Section 5.4.1c but with an elevated intake, shall be provided in the ammonia storage room.

d. Leak detection systems shall be fitted in all areas through which ammonia is piped.

e. Special vacuum breaker/regulator provisions must be made to avoid potentially violent results of backflow of water into cylinders or storage tanks.

f. Carrier water systems of soft or pre-softened water may be used to transport ammonia to the finished water stream and to assist in mixing.

g. The ammonia injector should use a vacuum eductor or should consist of a perforated tube fitted with a closely fitting flexible rubber tubing seal punctured with a number of small slits to delay fouling by lime deposits.

h. Provision should be made for the periodic removal of scale/lime deposits from injectors and carrier piping.

i. Consideration shall be given to the provision of an emergency gas scrubber capable of absorbing the entire contents of the largest ammonia storage unit whenever there is a risk to the public as a result of potential ammonia leaks.

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