

LIQUID CHEMICAL FEED SYSTEM DESIGN AND INSTALLATION GUIDELINES

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Authority: Section 19-13-B102(d)(2) of the Regulations of Connecticut State Agencies (RCSA) requires approval from the Department of treatment works prior to construction. In addition, Section 19-13-B80 of the RCSA requires the review and approval by the Department of plans and specifications for any chemical treatment system. The following guidance is provided in the interest of facilitating the approval process. Discretion in the application of these guidelines is allowable except as required by regulation.

Definitions

(1) Chemical feed system: as used in these guidelines means a treatment system consisting of, but not limited to, chemicals, bulk and/or day storage tanks, chemical metering pumps (typically diaphragm or peristaltic positive displacement pumps), chemical feed lines, chemical injection taps, etc. by which a chemical solution is added to treat drinking water supplied by a public water system. Dry chemical feed systems (i.e. volumetric and gravimetric) and gaseous feed systems are not specifically covered in these guidelines although some portions of these guidelines may be applicable to those types of feed systems.

Chemicals

(1) All chemicals used to treat drinking water should be certified to NSF/ANSI Standard 60 or approved equal. Grocery store and swimming pool store off-the-shelf products such as bleach and calcium hypochlorite products should not be used unless certified to NSF/ANSI Standard 60 or approved equal. Such products, if not appropriately certified, may contain fragrances, dyes, and other undesirable ingredients that are not intended for human ingestion.

(2) All chemicals should conform to AWWA Standards if available.

Location

(1) Section 19-13-B102(d)(1) of the RCSA requires treatment plants to be located above the 100-year flood elevation. When feasible, the foundation for treatment facilities should be located at least three feet above the 100-year flood elevation. In addition, it is recommended that the finished floor elevation of the treatment facility be located at least six inches above the final established grade around the facility.

(2) Subsurface treatment facilities should be avoided whenever possible. If no other option is feasible appropriate drainage should be provided to prevent flooding of the subsurface facility.

Sizing

(1) Section 19-13-B102(p) of the RCSA requires treatment facilities to have sufficient capacity to provide flows in excess of the maximum flows experienced in the community public water system or service area to be served by the treatment facility.

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(2) In the absence of specific sizing criteria, the following general guidelines may be used to size chemical feed systems:

(a) Large chemical feed systems, such as those found in surface water treatment plants or large capacity wellfields, typically consist of bulk tanks, day tanks, and chemical metering pumps. The following general equation can be used to determine the feed rate:

$$\text{Feed Rate (lbs/day)} = (\text{dosage in ppm or mg/l}) \times (8.34) \times (\text{flow in MGD})$$

If the chemical concentration is expressed as a percent (i.e. 5.25% sodium hypochlorite), the feed rate as calculated above is divided by the percent strength in decimal format (i.e. percent strength / 100)

The feed rate can be expressed in gpd by the following equation:

$$\text{Feed Rate (gpd)} = \frac{\text{Feed Rate in lbs/day}}{\text{density of solution in lbs/gal}}$$

(i) chemical metering pumps: the minimum feed rate is based on the minimum chemical dosage and minimum daily flow. The maximum feed rate is based on the maximum chemical dosage and maximum day flow (typically plant capacity). The metering pumps should have a sufficient turndown ratio to cover the minimum and maximum feed rates. An alternative is to provide two sets of metering pumps to cover the range of feed rates.

(ii) day tanks: maximum 30 hours of storage based on average dosage and average daily demand.

(iii) bulk tanks: 30 days of bulk storage based on average dosage and maximum month demand.

(b) Small groundwater public water system (PWS) treatment systems typically consist of a solution tank (usually 30 - 55 gallons) and chemical metering pump(s). The following general equation can be used for sizing chemical metering pumps for small PWSs:

$$\text{Pump Feed Rate (gpd)} = \frac{(\text{well pump output in gpm}) \times (\text{dosage in ppm}) \times (1440)}{(\text{solution strength in ppm})}$$

Note: a 1% solution is equivalent to 10,000 ppm.

Solution tanks for small groundwater PWS treatment systems generally are sized to hold one week's worth of solution.

Chemical metering pump feed rate is often expressed in gallons per hour (gph). To convert gpd into gph simply divide the feed rate in gpd by 24. Refer to pump manufacturer for more specific or additional sizing requirements. In general, it is recommended that the calculated feed rate fall near

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the mid-setting of the selected metering pump (i.e. 50% stroke and speed for diaphragm pumps) to allow for pump adjustment and future reserve capacity.

General

(1) Chemical feed systems should be designed and constructed to maintain the sanitary quality of treated water. Chemical feed systems should be protected from rain, excessive dust, vermin, etc. to ensure reliable operation, and they should be designed and constructed to ensure safety, reliability, and ease of maintenance and repair. Adequate space should be provided around each chemical feed system to allow for sufficient operation, cleaning, repair, and maintenance.

(2) Chemical feed systems should have adequate space for the installation of additional chemical metering pumps, associated appurtenances, and tanks for future expansion.

(3) Fail safe provisions such as a flow switch wired in series with a chemical metering pump, or equivalent, should be provided to prevent chemical overfeed during no flow situations. A metering pump wired to the well pump motor starter as the only overfeed fail safe provision is not considered acceptable. It is recommended that at a minimum, a flow switch in conjunction with a metering pump wired to the well pump motor starter be provided. Metering pumps and well pumps should be on the same electrical circuit.

(4) Chemical feed rates should be paced proportional to flow when source water flow rates are variable. In addition, automatic controls to vary dosage based on parameter feedback (i.e. pH, chlorine residual, etc.) should be provided. Automatic controls should have provisions to allow for manual override. Flow pacing capability, or equivalent, should be provided whenever sources of supply are throttled to prevent chemical overfeed in the event the throttling valve malfunctions or is inadvertently moved out of position.

(5) Whenever possible, continuous analyzers and recorders should be installed with integrated alarms especially for chlorination, pH adjustment, and fluoridation treatment applications. Appropriate alarms should be transmitted to where they will be noticed by the individual(s) in charge of the treatment facility. Alarms should include, at a minimum, parameter high and low readings (i.e. chlorine residual, pH, etc.). Automatic shutdown of the chemical feed system, with the exception of chlorination, during high or low alarm conditions should be provided. Continuous analyzers must use approved testing methodologies in accordance with Section 19-13-B102(g) of the RCSA and the Department's regulation clarification document titled *Regulation Clarification for Operating Tests*. When only process chemicals are used, auto-analyzer discharge is not considered a source of pollution and may be discharged into a drywell located at least 50 feet from the nearest public water supply well when public sewers or a subsurface sewage disposal system are not available.

(6) If multiple chemicals are added, the sequence in which the chemicals are added should be evaluated to ensure that the chemicals will not counteract each other. For example, sequestering chemicals used for iron and manganese control should be added ahead of chlorine.

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- (7) Chemicals that are not compatible should not be fed, stored, or handled together to prevent undesirable chemical reactions and safety hazards. For example, dry calcium hypochlorite should not be stored near organic materials or chemicals such as oil or gasoline products. Applicable Material Safety Data Sheets (MSDS) should be reviewed for each chemical used.
- (8) Consideration should be given to chemicals that may oxidize minerals in water and any impact to water quality.
- (9) After injection of a chemical, satisfactory mixing by a static mixer or other means should be provided to achieve maximum effectiveness and uniform mixing. In addition, some chemicals may require adequate contact time.
- (10) A separate mixing tank, feed line, and injection tap should be used for each chemical applied.
- (11) Chemical feed lines should be clearly labeled or color coded.
- (12) Chemical feed systems should not be located on top of finished water storage facilities or on top of well pits.
- (13) Smooth nosed (threadless) sample taps should be installed, at a minimum, to allow for the collection of water quality samples representative of treated and untreated water (i.e. before and after the chemical injection point). All sample taps should be installed pointed downward and at least 12 inches above any possible high water level.
- (14) Appropriate safety equipment such as eyewash stations, showers, warning signs, gloves, goggles, aprons, etc. should be provided.
- (15) Plumbing components of the treatment facility should conform to the state plumbing code where applicable.
- (16) Heating, ventilation, and dehumidification should be provided to ensure efficient and reliable operation of all equipment.
- (17) Emergency power should be provided.
- (18) Locked fencing should be provided around the perimeter of the facility to prevent trespassing, vandalism, and sabotage. Unauthorized entrance alarms should be provided.

Materials

- (1) Chemical feed system components should not cause the water delivered to the customers to become impure, unhealthy, and non-potable, produce aesthetic problems such as taste and odors, or promote bacterial growth after being placed into active service. Chemical feed lines, bulk and day chemical tanks, etc. should be certified to NSF/ANSI Standard 61. Plastic trash cans will not be

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considered as acceptable for storage of chemicals since plastic trash cans may contain ingredients not made for human ingestion.

(2) Chemical feed system components should be compatible with the chemicals that will be used and should be resistant to corrosion.

Chemical Metering Pumps

(1) Chemical metering pumps should be able to accurately and reliably supply at all times the required dosage of chemical. Variable range of feed should be taken into consideration when selecting chemical metering pumps. In addition, chemical metering pumps will need to be able to pump chemicals at a pressure higher than the pressure in the line into which the chemicals are injected.

(2) Whenever feasible a minimum of two chemical metering pumps should be provided for redundancy for each chemical treatment process especially for critical treatment processes such as disinfection. If only one chemical metering pump is provided a spare pump should be kept on site as a backup. Spare parts should also be kept on site.

(3) Chemical metering pumps should be located as close as possible to the point of injection to minimize the length of chemical feed lines.

(4) Provisions should be made to protect metering pumps from air binding (losing prime) and damage to appurtenances if pumping chemicals that readily off gas such as sodium hypochlorite.

(5) Diaphragm pumps should be operated in a flooded suction configuration whenever possible especially if used for pumping off-gassing chemicals.

(6) Chemical metering pump suction lines should be straight and short as possible without loops to prevent air entrapment.

(7) If make-up water used for preparing chemical solutions has elevated levels of hardness, treatment should be provided to prevent scale formation inside the metering pump components.

Chemical Metering Pump Appurtenances

(1) An anti-siphon protection valve should be provided on the metering pump discharge line.

(2) Positive displacement chemical metering pumps should have a downstream pressure relief valve located prior to the first shut-off valve. The pressure relief valve should discharge to the chemical day tank.

(3) A back pressure control valve should be provided on the metering pump discharge line.

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(4) A bleed valve should be provided with the discharge directed into the chemical storage tank.

Note: Typically a “4-in-1,” “4-function,” or “multi-function” valve combines the functions of items 1-4 above.

(5) Calibration cylinders or equivalent should be provided on the suction side of the chemical metering pump between the solution tank and the metering pump to allow for routine checks and calibration of chemical feed pump outputs. Calibration cylinders should be vented to the chemical day tank.

(6) Pulsation dampeners or expansion chambers should be provided on the discharge side of the metering pumps to minimize surges which may damage chemical feed lines.

(7) Strainers should be provided on the metering pump suction feed lines.

(8) Chemical injection valves should have a check valve to prevent back flow.

(9) Chemical injection tips should be installed in the center of the pipe and should not be installed in a pipe stub to prevent chemical buildup and scaling.

(10) Foot valves should be provided on the end of the suction line for metering pumps utilizing suction lift. Foot valves should be located 3-6 inches from the bottom of the solution tank, or as recommended by the manufacturer, to prevent solids from fouling the metering pump.

Chemical Storage – General

(1) Chemical spill containment should be provided to contain accidental spills of chemicals. Whenever feasible containment areas should be capable of containing the full amount of chemical stored. At a minimum, containment should be sufficient to contain 110 percent of the volume of the largest chemical storage tank.

(2) Storage of chemicals should be under dry conditions.

(3) Corrosive chemicals should be kept away from equipment susceptible to corrosion damage.

(4) Space should be provided for at least 30 days of chemical supply.

(5) Adequate ventilation should be provided for the area in which chemicals are stored.

(6) Chemicals should not be stored past their useful life. Chemicals such as sodium hypochlorite lose their strength the longer they are stored.

(7) Special consideration should be given to storage of chemicals, such as sodium hypochlorite, that are temperature and light sensitive to minimize degradation.

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(8) Provisions should be made to measure the quantity of chemicals used by a scale, level indicator, or equivalent.

Chemical Storage – Bulk and Day Tanks

(1) Chemical storage tanks should be constructed of materials compatible with the chemical to be stored.

(2) Chemical storage tanks should have a liquid level indicator (i.e. translucent tank with gradations or sight glass).

(3) Chemical storage tanks should have screened vents to the outside, overflows, and drains. Overflows that discharge into an indoor containment area should be provided with a liquid trap.

(4) Chemical storage tanks should be covered to prevent dust, debris, and insects from falling into the tanks.

(5) Chemical storage tanks should be clearly labeled indicating the name of the chemical that will be stored.

(6) Large chemical storage tanks with access openings on top should have such openings curbed and fitted with overlapping covers.

(7) Chemical storage tanks should not be buried.

(8) Transfer of chemicals from bulk tanks to day tanks, either by transfer pumps or gravity line, should be provided with a fail safe “deadman” switch, “deadman” valve, or equivalent.

(9) Day tanks should be provided whenever large volume bulk tanks are utilized to prevent overfeed of bulk chemicals.

(10) Tanks that will store chemicals that may crystallize should have outlets located at least 6-12 inches from the tank bottom to prevent crystals from damaging pumping equipment.

(11) Mixers should be provided where necessary for solutions.

(12) Bulk tanks that are filled from the outside should have locked and clearly identified fill ports. In addition it is recommended that different size fill ports and connection fittings be used for each chemical to prevent accidental fillings of wrong chemicals during deliveries.

(13) All chemicals should be mixed and fed separately so that chemicals are not combined in the same day tank.

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Cross Connection Control

- (1) Appropriate cross connection control measures shall be implemented as necessary in accordance with Section 19-13-B38a of the RCSA especially for carrying water lines and make-up water lines for solution tanks.
- (2) There shall not be any piping bypass around a chemical feed system between untreated and treated water if the untreated water does not meet finished water standards (i.e. MCL violation) in accordance with Sections 19-13-B37 and 19-13-B38a of the RCSA.
- (3) Where chemicals are fed to both raw and finished water, completely separate chemical feed systems should be provided.