Preparing Activity: USACE Superseding
UFGS-11 24 27 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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AIR AND STEAM STRIPPING

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AIR AND STEAM STRIPPING
08/18

NOTE: This guide specification covers the requirements for systems to transfer volatile compounds from a water stream to an air stream.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: This guide specification covers air strippers for removal of volatile substances from water. Refer to Design Guide (DG) 1110-1-3 Air Stripping.

1.1 UNIT PRICES

NOTE: If the Contractor is required to treat water, as well as to furnish the equipment, measurement and payment and unit pricing may be necessary to cover treatment costs.

Determine measurement and payment and unit prices for quantities of water treated (if applicable) in accordance with the Bid Schedule.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C653	(2020) Disinfection of Water Treatment Plants
AWWA D100	(2021) Welded Steel Tanks for Water Storage
AWWA D102	(2021) Coating Steel Water-Storage Tanks
AWWA D103	(2019) Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D120	(2019) Thermosetting Fiberglass-Reinforced Plastic Tanks

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 [Pre-Installation Meetings] [Partnering Conference]

Participation by the Contractor in the [Pre-installation][Partnering] conference is [requested][required] by the Contracting Officer. Ensure that all of the involved subcontractors, suppliers, and manufacturers are represented. Furnish to the Contracting Officer the date and time of the conference for approval.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in

accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Process Flow Diagrams

Process and Instrumentation Diagram (P&ID)

Installation drawings

SD-03 Product Data

Air Stripping System

Qualifications

Field Training

Framed Instructions

Spare Parts

SD-05 Design Data

Calculations

Foundations

SD-06 Test Reports

Tests

SD-07 Certificates

Manufacturer's Representative

Materials and Equipment

SD-08 Manufacturer's Instructions

Air Stripping System

SD-09 Manufacturer's Field Reports

Air Stripping System

SD-10 Operation and Maintenance Data

Air Stripping System

Maintenance

1.5 QUALITY CONTROL

1.5.1 Qualifications

Submit qualifications of the installer, supplier's representative, and the people listed in the following subparagraphs.

1.5.1.1 Constructor

A minimum of [2][3][5][_____] years' experience in the construction of water treatment, wastewater treatment, and/or industrial wastewater treatment and/or industrial wastewater pretreatment plants is required for the Constructor to be considered qualified.

1.5.1.2 Manufacturer's Representative

Provide the services of a manufacturer's field representative who is experienced in the installation, adjustment, and operation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Submit names and qualifications of each manufacturer's field representative and training engineer with written certification from the manufacturer that each representative and trainer is technically qualified.

1.5.1.3 Welding

****
NOTE: Use wording in second set of brackets when critical pipe welding is required.
****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders are to be qualified in accordance with [_____]. Welding procedures qualified by others, and welders and welding operators qualified by another employer are acceptable as permitted by [_____]. Notify the Contracting Officer 24 hours in advance of tests. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures for piping is specified in Section 40 05 13.96 WELDING PROCESS PIPING.] [Welding qualifications for welding procedures, welders, and welding operators are to in accordance with Sections 8.2 and 8.8 of AWWA D100 and Section 40 05 13.96 WELDING PROCESS PIPING.] [Procedures and welders are required to be qualified in accordance with the code under which the welding is specified to be accomplished.]

1.5.2 Single Source Supplier

Assign to a single supplier the full responsibility for the furnishing of the air stripping system. The designated single supplier need not manufacture the system but is responsible for coordinating the design, assembly, installation, and testing of the entire system as specified herein. Submit a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions, performance charts, technical literature, catalog cuts for [packing,] [mist eliminator,] [perforated trays and number,] [perforated bubbler tubes,] [venturi design] stripper, instrumentation and controls, including capacities, make and model, materials of construction, valving, and pressure gauges.

1.6 DELIVERY, STORAGE, AND HANDLING

Preassemble parts to the maximum extent practical, compatible with transportation limitations and equipment protection considerations. Field assembly, if any, consists merely of bolting together of match-marked components. Crate and protect equipment against damage during shipping and delivery. Protect flange faces from damage. Cover openings to

prevent entrance of dirt, water and debris. Protect parts so that no damage or deterioration occurs during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation. Protect finished iron or steel surfaces to prevent rust and corrosion. Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

****

NOTE: The contaminant concentration and flow rate to be used in the design are critical to this specification. Install multiple strippers to accommodate extreme variations from the design flow rate and contaminant concentrations or to maintain the groundwater gradient.

Determine design wind speed from ASCE 7-16; use 161 km/h 100 mph minimum. Use 1.2 kPa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is insignificant. Local climates and topography may dictate that a value greater than 1.2 kPa 25 psf be used for snow loading. Consult ANSI A58 and local codes. Wind speed and snow load can be deleted if the air stripper is installed inside.

Seismic criteria are given in paragraph Seismic Protection. Consult NFPA 780 to determine if lightning protection is needed.

****

Provide a system complying with the following requirements:

	Maximum	Minimum
Water/wastewater flow rate	[_____] L/s gpm	[_____] L/s gpm
Water/wastewater temperature	[_____] degrees C F	[_____] degrees C F
Ambient air temperature	[_____] degrees C F	[_____] degrees C F
Air Stripper system dimensions Maximum vertical projection	[_____] mm ft	
Maximum ground surface coverage including blower, motor and other appurtenances	[_____] by [_____] mm [_____] by [_____] ft	
Soil bearing capacity	[_____] MPa psf	
Seismic parameters	[_____]	[_____]
Wind speed	[_____] km/h mph	

	Maximum	Minimum
Ground snow load	[_____] kPa psf	[_____] kPa psf
Design Life		[_____] years

2.1.2 Influent Inorganic Chemical Conditions

Measured influent inorganic chemical concentrations of [waste water][water from surface impoundment][ground water][total][filtered]have been:

	Average	Maximum
pH [_____] Minimum	[_____]	[_____]
Total Hardness as CaCO3	[_____] mg/L	[_____] mg/L
Total alkalinity as CaCO3	[_____] mg/L	[_____] mg/L
Hydroxide alkalinity as CaCO3	[_____] mg/L	[_____] mg/L
Carbonate	[_____] mg/L	[_____] mg/L
Bicarbonate	[_____] mg/L	[_____] mg/L
Total Dissolved Solids	[_____] mg/L	[_____] mg/L
Langelier Index	[_____]	[_____]
Total Suspended Solids	[_____] mg/L	[_____] mg/L
Total Iron	[_____] mg/L	[_____] mg/L
Dissolved Iron	[_____] mg/L	[_____] mg/L
Total Manganese	[_____] mg/L	[_____] mg/L
Dissolved Manganese	[_____] mg/L	[_____] mg/L
Calcium	[_____] mg/L	[_____] mg/L
Magnesium	[_____] mg/L	[_____] mg/L
Sodium	[_____] mg/L	[_____] mg/L
Potassium	[_____] mg/L	[_____] mg/L
Sulfate	[_____] mg/L	[_____] mg/L
Nitrate	[_____] mg/L	[_____] mg/L
Chloride	[_____] mg/L	[_____] mg/L
Fluoride	[_____] mg/L	[_____] mg/L

2.1.3 System Performance Requirements

2.1.3.1 Air to Water Ratio

Maximum at maximum flow	[_____] volume/volume
Minimum at minimum flow	[_____] volume/volume

2.1.3.2 Influent and Effluent Organic Contaminant Concentrations

****
NOTE: Either specify maximum effluent concentrations or percent removal requirements.
****

Maximum Influent	[_____] µg/L
Average Influent	[_____] µg/L
Minimum Influent	[_____] µg/L

[

Maximum Effluent	[_____] µg/L

][

Removal Required	[_____] percent
Determine removal percentage as follows: ((Maximum Influent concentration - Maximum Effluent concentration)/Maximum Influent concentration) times 100 percent	

]

2.1.3.3 Operating Schedule

****
NOTE: Air stripping systems can be designed to be operated either continuously or intermittently. Typically, groundwater treatment systems have a central influent holding tank. The air stripper may be designed to cycle on and off, depending on the water level in the influent holding tank. Use of an influent holding tank allows for greater flexibility in accommodating variable flow rates from extraction wells. However, the air stripping system must be designed to accommodate a maximum, projected flow rate.
****

Size the system for capacity and design the air stripper and accessories

to operate continuously for [24 hours per day, 7 days per week][_____].

2.1.4 Seismic Protection

****
NOTE: Provide seismic details on the drawings or remove the second bracketed sentence.
****

Design the air stripper shell and components structurally for seismic forces [in accordance with UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][as indicated]. [The calculations and drawings are required to be stamped by a professional engineer qualified to practice at the site.]

2.1.5 Design Loads

Structurally design the air stripper and appurtenances for the wind loads listed in the system performance requirements, plus live and dead loads resulting from internally supported parts, weight of operating liquid when the shell is completely full of water, piping structural supports, and internal or external pressures with an appropriate safety factor. Design the concrete base in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.6 Foundations

****
NOTE: Coordinate with paragraph Design Requirements.

The footprint and the piping connections for the air stripper on the floor plan, and height required may vary considerably depending on the type of air stripper. The designer should allow enough space for the type of air stripper that will be selected (usually, either a low-profile air stripper, or a packed tower).
****

Design the reinforced concrete foundations to support the stripper full of water in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and in accordance with Section 12 of AWWA D100 or Sections 11 and 8.5 of AWWA D103 for earth, with the bearing value stated in the design requirements. Provide an AWWA D100 Type 1 or an AWWA D103 Type 1 or Type 2 foundation for the stripper. Use a factor of safety on overturning under design wind load of 1.5 minimum. When a footing is required, using an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing in determining overturning stability is acceptable. Ensure the elevation at the top of the foundations is not less than 200 mm 8 inches above the finished grade. Submit calculations for the shell and concrete foundations, mounting and support details including the seismic analysis, where appropriate.

2.1.7 Anchors

2.1.7.1 Number of Anchors

Install an adequate number of anchors designed to prevent overturning of the [stripper][shell] when empty. If anchor bolts are used, provide with

a nominal diameter not less than 25 mm 1 inch, plus a corrosion allowance of at least 6 mm 1/4 inch on the diameter. If anchor straps are used, pre-tension them before welding to the shell.

2.1.7.2 Anchor Bolts and Straps

Provide bolts with a right angle bend, hook, or plate washer. Provide anchor straps with only a plate welded to the bottom. Insert the anchors into the foundation to resist the computed uplift.

2.1.7.3 Attachment

Attach anchors to the shell in a manner that does not add localized stresses to the shell in excess of the material tolerance. When determining the method of attachment, consider the effects of deflection and rotation of the shell. Do not attach anchors to the shell bottom. Attach the anchor bolts to the shell through stiffened chair-type assemblies or anchor rings of adequate size and height.

2.1.7.4 Seismic Requirements

Provide anchors in accordance with UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT.

2.2 EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment, which are the standard products of a manufacturer regularly engaged in the manufacture of the products, and that essentially duplicate equipment that has been in satisfactory operation for at least [2] [_____] years prior to bid opening. Support equipment by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit verification from a Registered Professional Engineer, registered in the state where the system is located, that the stack, [the shell, ladder, platform and cage calculations for the air stripper,] the foundation and lifting lugs were designed for the listed conditions in accordance with the appropriate requirements, codes and standards.

2.2.2 Nameplates

Provide major equipment items with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Ensure each piece of equipment bears the approval designation and the markings required for that designation. Mark valves in accordance with MSS SP-25 to bear a securely attached tag with the manufacturer's name, catalog number and valve identification permanently displayed.

2.3 COMPONENTS

****

NOTE: Consider if the influent or the stripper must be acid cleaned or chlorine-treated in selection of materials. Stainless steel may not be appropriate if a chlorine solution will be used for extended periods of time. Galvanized steel or corrodible metal internals should not be used.

****

2.3.1 Pump

Provide pumps in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.3.2 Blower

Provide fans, blowers and or vacuum pumps in accordance with Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

2.3.3 Pipe Connections

Provide influent pipe connections with full line diameter of the connecting pipe. Make effluent pipe connections with standard reducing fittings only if there is adequate vertical run to avoid back-up. Provide air and off-gas piping as specified in Section 31 21 00 OFF-GASSING MITIGATION. Provide liquid piping as specified in Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.3.4 Mist Eliminator

Provide a mist eliminator that has the minimum separation efficiency stated in the performance requirements. Ensure materials are provided as specified for the stripper internals.

2.3.5 Exhaust Stack

****

NOTE: Maintain velocities within limits to reduce condensation/freezing on the stack surface.

****

Size exhaust stack for gas velocity between 3 and 7.5 m/sec 10 and 25 feet/second. Ensure materials are provided as specified for the stripper.

2.3.6 Off-Gas Control

****

NOTE: An air pollution control device may not be required depending on state and local regulations. The air pollution control system is a separate unit process, with different design requirements.

****

Convey off gas from the air stripper column to an air pollution control unit for treatment as specified in Section [44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS] [44 13 51 THERMAL OXIDATION EQUIPMENT].

2.3.7 Instrumentation and Controls

****

NOTE: Specify the instrumentation and controls as either direct-reading instruments at the column or remote-reading at some other location.

****

Provide instrumentation and controls that conform to the requirements of Section 40 60 00 PROCESS CONTROL and the requirements specified for each

piece of the equipment with the interlocks and control devices specified herein.

a. Provide gauges with 150 mm 6 inch dials, stem mounted, that conform to ASME B40.100. Ensure the accuracy of gauges is Grade A or better. Calibrate gauges in kPa and psi psi in not more than 10 kPa and 2 psi 2 psi increments from 0 to 350 kPa and 0 to 50 psi 0 to 50 psi in excess of the normal operating pressure at the tank.

b. Control to shut down the system and activate an alarm if the blower fails and if water level in the bottom of the stripper exceeds the high-level set point.

c. Interlock for concurrent operation of blowers and influent [pumps] [control valves].

d. Water flow indicators [_____] to [_____] L/second [_____] to [_____] gpm.

e. Effluent water temperature gauge [_____] to [_____] degrees C [_____] to [_____] degrees F.

f. Pressure drop instrument [_____] to [_____] mm [_____] to [_____] inch water.

g. Direct reading pressure gauges in the air inlet and outlet throats.

2.3.8 Chemical Feed Systems

****

NOTE: Determine if there is an environmentally preferred alternative and evaluate the options for cleaning compounds. The potential for reuse of cleaning chemicals will depend on the fouling material composition and if the suspended biomass or chemicals can be easily removed by settling and/or filtration. Consider conventional acids (HCl, H2SO4) with environmentally safer products such as acetic and citric acids for chemical fouling. NaOCl may be needed for biological fouling.

Perform a cost/benefit study to select between alternative cleaning solutions, reusing the cleaning solution and disposal options. This specification does not include the disposal of sludge generated during the cleaning.

Acid-feed or sequestrant-feed systems are often used immediately upstream of air strippers to control scaling. Acid-feed systems, when used, are integrated with a pH monitoring and control system. For example, a target pH range is set, and the acid feed rate automatically adjusts to maintain the pH within the set range before the water enters the air stripper.

****

Meet chemical feed requirements as specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS and/or Section 46 31 11 CHLORINE GAS FEED

EQUIPMENT (AUTOMATIC, SEMIAUTOMATIC AND MANUAL).

2.3.9 Cleaning Provisions

****

NOTE: The type of cleaning chemicals used to remove mineral deposits and/or biological growth which may foul the air stripper interior and adversely affect the unit's performance will be unique to each site and depends on whether the fouling is from biological growth or chemical deposition and on the materials of construction. Tests may be needed before or after the system is started to determine the best cleaning solution.

For some types of relatively small, low-profile air strippers, the trays can easily be removed and cleaned by submerging and soaking in an acidic solution. Relatively large, low-profile air strippers, may require the use of an overhead hoist system to remove individual trays; which would tend to make in-place cleaning be more practical than a procedure that involves removing the trays. For packed tower air strippers, unless the packed tower air stripper is relatively small, and the packing can be easily removed, cleaning is usually performed via an in-place procedure (e.g., circulation of a cleaning solution). Periodic, replacement of the packing may need to be considered for situations where the cleaning procedure has limited effectiveness.

****

[Furnish the air stripper with a cleaning package capable of being operated periodically. The system includes tanks, pipes and valves to allow flushing with chemical cleaners, biocides or disinfectants. The package includes a corrosion resistant pump, chemical addition port, [cleaning solution storage tank] and plumbing accessories to allow the re-circulation of cleaning solutions through the stripper.] [Design the air stripper for a cleaning procedure during which the air stripper is isolated and filled or flooded with a [[10][_____] percent maximum [sulfuric] [hydrochloric] [_____] acid solution] [_____] cleaning solution.]

2.3.10 Assembly

Factory pre-assemble the system into reasonably sized modules for easy field assembly and mounted on a skid. Supply the skid with a welded steel frame with [2.4][6.4] mm [3/32][1/4] inch thick steel plate or fiberglass reinforced plastic (FPU) grating with ultraviolet (UV) inhibitors decking.

2.3.11 Lifting Lugs

Provide [trays][columns][stacks] and other major components with lifting lugs, as necessary for easy handling with a crane or similar device during installation, maintenance and replacement of column internals.

2.3.12 Guy Wires

****

NOTE: Size of the columns should be taken into account. In temporary installations, or in areas of high seismic activity, guy wires may be acceptable.

****

Supply air strippers and air stripper that are free standing and supported entirely by anchoring in a concrete base and are compatible with the dimensional constraints indicated. Each column air stripper [and stack] are to be self-supporting. A superstructure or frame not extending beyond the foundation is permitted. Guy wires are not be permitted unless directed by the Contracting Officer.

2.3.13 Freeze Protection

****

NOTE: When cold dry air is used for stripping, the evaporative cooling may chill the water more than the conduction of heat through the shell of the stripping column. If evaporative calculations show that this will significantly lower the rate at which the volatiles are removed from the water, the problem can be eliminated by stripping with re-circulated air.

In cold climates, ice may accumulate where the air exits the exhaust stack. The configuration of the exhaust stack should be designed to safely allow for the ice to periodically be removed.

****

[Provide insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Insulate and jacket the system to prevent freezing under the most severe conditions stated in the performance requirements with a water temperature drop of less than 3 degrees C 5 degrees F.] [Recirculating air from the stripper that had the volatilized contaminants removed by the subsequent air pollution control device into the bottom of the column is allowable].

2.3.14 Sump

Provide each air stripper with a sump to receive and store the treated effluent. Size sump to provide a minimum residence time of [2][5][10] minutes when the stripper is operating at the specified capacity. Provide [an inspection port][and][a 13 mm 1/2 inch diameter (minimum) drain/sample port with manually operated valve] at the bottom of the sump to completely drain the air stripper.

2.3.15 Electrical Equipment

****

NOTE: Show NFPA 70 hazardous area classification on the drawings. If the potential for an explosive atmosphere exists, the wiring, blower, motor and other electrical equipment must meet the applicable explosive prevention standards.

****

The electrical equipment is required conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide equipment and wiring in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification. Provide equipment located outdoors, not provided with climate controlled enclosure that is capable of operating in the ambient temperature range indicated in paragraph Design Requirements unless otherwise specified. Provide electrical motor-driven equipment specified herein complete with motor control centers, panels, motor starters, etc.

2.3.16 STRIPPER

****
NOTE: See DG 1110-1-3 Air Stripping for recommendations.
****

The stripper system consist of [1][2][_____] [packed column] [perforated plate (sieve tray)] or [enclosed low profile mass transfer mechanism] air stripper to transfer volatile organic compounds from the water phase to the air base. Use manufacturer's standard size units whenever possible.

2.3.16.1 Materials

****
NOTE: Limit the materials of construction to those that will not be corroded or dissolved by the contaminants in the water or cleaning solutions (acids).
****

2.3.16.1.1 Shell

****
NOTE: Use coated steel for short term applications only, since cracking of the coating could allow the column to corrode.
****

Construct the air stripper of [polyethylene (HDPE) seamless one piece molded modular sections,] [polyvinylchloride (PVC) with ultraviolet (UV) inhibitors,] [fiberglass reinforced plastic (FRP) with ultraviolet (UV) inhibitors,] [structural grade aluminum,] [304 stainless steel,] [316 stainless steel,] or [steel with internal and external coating as specified,] of suitable thickness to prevent deformation. Provide steel tank materials that conform to the applicable provisions of Section 2 of AWWA D100 or Section 2 of AWWA D103 or AWWA D120. Ensure design, fabrication, and erection comply the applicable requirements of AWWA D100 or AWWA D103 except as modified herein and in the design requirements of this specification. Ensure shop fabrication conforms [to Section 9 of AWWA D100 or Section 7 of AWWA D103 or AWWA D120][the manufacturer's recommended fabrication procedures].

2.3.16.1.2 Internals

Construct the air stripper internals of [polyethylene (HDPE)][polyvinylchloride (PVC)][fiberglass reinforced plastic (FRP)][aluminum] [304 stainless steel][316 stainless steel] or copper.

2.3.16.2 Low Profile (Sieve Tray) Stripper

****

NOTE: Low-profile air strippers may also be referred to as sieve-tray, tray-aeration, or perforated-plate air strippers.

Determining the number of trays needed in a perforated plate air stripper is more difficult than determining the height of packing in a packed column air stripper. The efficiency of each tray must be known or estimated to determine the number of trays required. The designer may have to rely on the manufacturer's test data or other estimation methods. These methods may be empirical, scale up from smaller units or more theoretical mass transfer calculation methods.

Volatile organic chemicals in the water phase transfer to the bubbles in the air phase. The air phase containing the volatile chemicals then leaves the top of the column.

****

2.3.16.2.1 Features

Provide the stripper with the following features: Vertically stacked trays with horizontal perforated plate (sieve trays) bottoms that are enclosed in a shell and are separated vertically. Contaminated water is introduced at the top, flows across a perforated plate, over a weir and down to the next lower plate. The process is repeated for each tray until the water reaches the bottom of the unit and enters the sump. Air is introduced at the bottom of the unit and is forced up through the perforations in the trays to form bubbles.

2.3.16.2.2 Calculations

Submit manufacturer calculations to clearly show the basis for the selected number of trays (each tray contains one perforated plate), size and number of the perforations on each plate, tray spacing, size of trays and tray efficiency. Submit actual performance data from the manufacturer or submit calculation methods. Submit design calculations indicating removals of each of the listed volatile compounds; air and water pressure drops through each component of the system, including line sizing, hydraulic loading (L/sq. m gal/sq. ft), air volume (cubic m/second CFM, air to water ratio (dimensionless and with appropriate units).

2.3.16.2.3 Perforated Plates (Sieve Trays)

****

NOTE: Stainless steel is recommended on large units. Plastic materials are acceptable for small low profile air strippers; plastic materials on large air strippers may warp and then leak between the trays.

If frequent fouling is anticipated, stainless steel should be used as it is easier to clean. Plastic

can be damaged by scraping and steam or high pressure water cleaning.
****

Provide all materials for perforated plates, downcomers, downcomer seals, baffles and other components constructed of materials allowed by paragraph Internals, of suitable thickness to prevent deformation. Design tray to prevent short-circuiting of air or water. Provide the number and size of perforations to maximize mass transfer.

2.3.16.2.4 Gaskets

Provide the trays with gaskets that prevent air and water leakage in and out of the shell and between trays. Supply gaskets made of a material compatible with the influent and with the cleaning methods.

2.3.16.2.5 Disassembly

****
NOTE: Once disassembled, high pressure water, steam or physical scraping can be used to clean the trays.
****

Ensure the strippers are easily disassembled for cleaning or have hatches for access to the individual trays or other internal components for inspection and cleaning.

2.3.16.3 Diffused-Aeration Air Stripper

****
NOTE: Diffused-aeration air strippers employ a variety of methods to facilitate the mass transfer of volatile chemicals from the water phase to the air phase. Calculation methods for these air strippers are unique to each design and may not be readily available. Designers may have to rely heavily on manufacturer supplied performance data, or use mass transfer calculation methods developed for other processes, such as distillation or waste water aeration, to verify the performance. If manufacturer supplied performance data are relied on, the designer should determine whether the computer models use theoretical equations calibrated to actual test data, or whether they are based only on theoretical equations or empirical data.
****

Furnish a diffusion-aeration air stripper that is enclosed, uses mass transfer mechanisms which include, but are not limited to perforated bubble tubes or the venturi design to transfer (volatilize) contaminants from the water phase to the air phase.

2.3.16.4 Packed Column

****
NOTE: Calculations must be provided to clearly show the basis for the diameter and packing height. Base the diameter of the column on a maximum liquid loading rate of 60 to 80 per cent of the flooding

loading rate. Data for the mass transfer coefficient (Kla) and pressure drop/flooding calculations must be obtained from a pilot plant run with this packing on the same or similar pollutants or vendor supplied data run with this packing on the same or similar pollutants.

These data and the requirement that the Contractor must meet the removal efficiencies or effluent criteria specified in the system performance requirements should assure that the column is sized properly.

****

Furnish a packed column air stripper with the following features: A column filled with packing material that has a large surface area to volume ratio. The contaminated water is pumped to the top of the column above the packing and is distributed uniformly over the packing. Air is forced up through the bed of packing at the same time the water is "trickling" down through the packing (i.e. countercurrent flow).

2.3.16.4.1 Packing

Furnish the column filled with high efficiency open packing, either structured "arranged" or random "dumped" polypropylene, PVC, stainless steel, ceramic or other media that is durable under the service conditions. Packing diameter does not exceed 20 percent of the column diameter and is as near 9 percent of the column diameter as is feasible with the type of media supplied. Provide the packed section of the column between [_____] and [_____] mm [_____] and [_____] feet in diameter and the height of the packing between [_____] and [_____] mm [_____] and [_____] feet.

2.3.16.4.2 Water Distribution and Re-distribution System

****

NOTE: Columns that are wider relative to their depth need more distributor and re-distributors than are considered in the manufacturer literature

****

Furnish water distribution system made of [PVC] [[304][316] stainless steel] [aluminum] full solid cone spray nozzle or distributor tray that distributes the water over the fill area of the packing. Ensure water distribution system produces a minimum of [125][50][_____] streams/sq. m [12][4.8] [_____] streams/sq. ft at the normal pumping rate. Design the distribution system for easy removal and replacement. If a full solid cone spray nozzle is used, place it at the correct distance from the top of the packing to distribute the spray uniformly over the top of the packing. Provide water re-distribution systems as recommended by the manufacturer. Space the distance between re-distributors to not exceed [_____] mm ft and to be less if recommended by the packing manufacturer.

2.3.16.4.3 Packing Support

Furnish packing support make of [PVC][HDPE][fiberglass reinforced plastic] [aluminum] [[304][316] stainless steel]. If the bed depth exceeds the packing manufacturer's recommended maximum vertical depth of packing, install an intermediate support. Provide a support of suitable thickness

to prevent deformation when the packing becomes plugged and the entire shell above the packing support fills with water.

2.3.16.4.4 Access

****
NOTE: View ports should be considered if the column is tall and the water can become poorly distributed or if biological, iron, manganese, or calcium fouling is likely to occur.
****

Bolt the top of each column to provide access to tower internals from above. Install view ports at the [top] [and bottom] of the column to check the water distribution and to check for fouling. Design the stripper for easy removal of the packing.

2.3.16.4.5 Manholes and Pipe Connections

****
NOTE: Additional ports should be provided if packing fouling is expected to be a problem.
****

Provide the number, type, location, and size of manholes and pipe connections as shown on the drawings and as specified herein. Section 7 of AWWA D100 and Section 5 of AWWA D103 contain the minimum requirements for manholes and pipe connections. Provide flanged access ports, [460][525] [600] mm [18][21][24] inch in diameter, that are water and vapor tight, and able to withstand all loads and internal pressures during construction, operation, and cleaning. Provide one or two access ports at the top of the column for access to the mist eliminator and liquid distributor, and locate one near the bottom of the column to provide removal of the packing and packing support; and provide one with access to the sump.

2.3.16.4.6 View Ports

****
NOTE: View ports may not be necessary if the concentration of minerals in the water is low and iron, calcium or biological fouling is not expected to be a problem.
****

Provide view ports at the top and bottom of the packing to allow checks of the distribution and check for fouling.

2.3.16.4.7 Ladders, Platforms and Cages

****
NOTE: Ladder should start 2.5 m 8 feet above the ground, if the area is not secured. Ladders, platforms and cages may not be appropriate for small units.
****

Provide the air stripper with a platform at the top of the column, and an access ladder to provide access to each access port. Provide catwalks,

ladders, cages, and guardrails where indicated or required for safe operation and maintenance of equipment and in accordance with Sections 7.4 and 7.5 of AWWA D100 or Sections 5.4 and 5.5 of AWWA D103. Make provision for the attachment of a scaffold cable support at the top of the roof on welded tanks. Provide ladders with side rails and non-slip rungs that are a minimum of 19 mm 3/4 inches in diameter and 406 mm 16 inches long. Start the access ladder at [ground level] [2.5 m 8 feet] above the ground. Ensure the distance between rungs does not exceed 305 mm 12 inches. Bolt the ladder and platform onto brackets that are welded to the columns, or welded directly to the column. Design platforms to support a uniform live load of 3.6 kPa 75 psf plus the dead load of the structure. Provide a platform that is a minimum of 915 mm 3 feet wide and fabricated from steel, aluminum, or fiberglass reinforced plastic. Grating openings are required to have no dimension greater than 25 mm 1 inch.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

Requirements for excavating, filling, and grading in Section 31 00 00 EARTHWORK.

3.3 INSTALLATION

Install equipment as shown and in accordance with the written instructions of the manufacturer, under the direct supervision of the manufacturer's representative, and in accordance with the applicable provisions of Section 10 of AWWA D100 or Section 8 of AWWA D103 or Section 7 of AWWA D120. Submit installation drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation in the provided drawings.

3.4 FIELD QUALITY CONTROL

3.4.1 Manufacturer's Field Service

Prior to startup, inspect the equipment for alignment and connections by a factory representative. The manufacturer's representative inspection of the final installation is required to include supervising the adjustment and testing of the equipment. The manufacturer's representative is required to demonstrate that the system meets the performance requirements.

3.4.2 Framed Instructions

Post framed instructions, under glass or in laminated plastic, for installation instruction procedures, sequences, and precautions, including tolerances for level, horizontal, and vertical alignment. Include grouting requirements, grout spaces and materials, process flow diagrams and wiring and control diagrams showing the complete layout of the entire system, where directed. Submit process flow diagrams showing all major

pieces of process equipment with flow rates and material balances. Prepare in typed form, the condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system. Framed as specified above for the wiring and control diagrams and post beside the diagrams. Submit posted diagrams, instructions, and other sheets prior to posting. Submit [one][_____] framed process and instrumentation diagram (P&ID) showing all instrumentation and control locations, functions and settings; major process equipment, pumps, pipes, valves, instruments direction of flow, flow rates pressures and temperatures.

3.4.3 Tests

****

NOTE: Avoid further mention of sampling or analytical methods in this section. Always refer to the chemistry section to avoid conflicts.

****

3.4.3.1 Hydrostatic Tests

Hydrostatically test each unit by completely filling the shell with water and inspecting for leaks. Repair leaks and retest the column. Check equipment for leaks after it has been filled for at least one hour. Conduct shell inspections and testing in accordance with Section 11 of AWWA D100 or Section 9 of AWWA D103. [Perform mill and shop inspections using an approved commercial inspection agency.] [Perform radiographic inspections of the welded shell.] Perform the hydrostatic test and the vacuum box leak test of the tank bottom. Perform final leak test and hydrostatic test before painting.

3.4.3.2 Performance Testing

Operate each unit at the maximum flow specified in the performance requirements for at least one hour prior to sampling. Submit performance reports in booklet form, upon completion of testing of the installed system. Include in the test reports all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate within each test report the final position of all controls. Reflect all performance test data in the operating instructions.

3.4.3.3 Influent and Effluent Sampling

Collect samples in the presence of the Contracting Officer and transport the samples to the laboratory for analysis.

3.4.3.4 Influent and Effluent Analyses

Inspect and test all equipment under operating conditions after installation. Demonstrate the unit to run without operator intervention for 72 contiguous hours. If inspection or test shows defects, correct such defects, and the inspection and test will then be repeated. Performance test samples will be tested in accordance with [_____].

3.4.3.5 Discharge

****

NOTE: A holding/mixing tank requirement can be deleted if an NPDES or sewer discharge permit has been secured.
****

During the performance testing, contain the effluent from the air stripper system within the holding/mixing tank with no flow discharged to the [system] [stream] [sewer].

3.4.3.6 Noncompliance

Removals will meet or exceed the specified system performance requirements. If at any time the result of the organic analyses of the influent and effluent water indicate that the air stripping system is not in compliance with Contract Documents, stop flow through the air stripper and declare the system inoperable. If at any time the operation of the air stripping system does not meet the hydraulic, instrumentation, or control requirements set forth in this contract, stop flow through the air stripping system and declare the system inoperable. Upon notification of the air stripping system non-compliance, immediately proceed to repair or modify the system to meet compliance. Make repairs or modifications at no cost to the government. Notify the Contracting Officer one day before the restarting/retesting the air stripping system.

3.5 SYSTEM STARTUP

****
NOTE: Modify this paragraph for Contractor operation.
****

After completion of all testing, the plant operators are required to be assisted by the manufacturer's representative during plant startup.

3.6 ADJUSTING AND CLEANING

3.6.1 Adjustments

Make adjustments, within the control range, to obtain optimum performance under actual field conditions.

3.6.2 Cleaning

For potable water systems, cleaning [is] [and disinfection in accordance with AWWA C653 are] required prior to placing the unit in service.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Field Training

Conduct a training course of operating staff as designated by the Contracting Officer. Start the training period, for a total of [24][36][_____] hours of normal working time, immediately after the system is functionally complete but prior to final acceptance tests. Cover the topics included in the Operating and Maintenance Manuals in the field instructions. Submit training course curriculum and training instructions, [14][_____] days prior to the start of training.

3.8 PROTECTION

****

NOTE: Some state and local health agencies have listings of acceptable paint materials for the interior of potable water tanks; they will also apply to the interior of the air stripper. The designer must contact the appropriate state and local authorities to determine if the proposed paint systems are acceptable. If these systems are not acceptable, the designer must determine the best acceptable system and revise this specification accordingly. Any deviation from this specification and AWWA Standards must be submitted with justification to CEMP-RT for approval.

****

3.8.1 Welded Tanks

3.8.1.1 Exterior Surfaces

Apply the paint system to the outside of the tank air stripper in accordance with Section 09 90 00 PAINTS AND COATINGS. Solvent-clean all factory primed surfaces before painting. Prepare and prime surfaces that have not been factory primed in accordance with the paint manufacturer's recommendations.

3.8.1.2 Interior Surfaces

Coat tank interior surfaces in accordance with Sections 3.2, 3.3, 3.4, 3.5, 3.6 or 3.7 of AWWA D102.

3.8.2 Touch-up Painting

Touch up factory painted items as needed. Clean items of all foreign material and prime and top coat with the manufacturer's standard factory finish.

3.8.3 Field Painting

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.4 Corrosion Resistant Metals

Do not paint corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel unless otherwise specified.

3.9 MAINTENANCE

****

NOTE: Select the option that is compatible with the Bid Schedule.

****

a. Manage, operate, maintain, and monitor the off-gas control system [until contract close out] [for at least [one year][_____] after construction, startup and performance testing are complete]. At a minimum, provide an operator onsite [eight][_____] hours per week to

operate, maintain, and calibrate the equipment and instruments, and to collect samples for analyses. Ensure a qualified person is on call to respond to emergencies and alarm conditions at the off-gas system within two hours of alarm conditions. Prepare and maintain compliance and monitoring records and reports for the Contracting Officer and regulatory agencies. The operator is required to maintain a log of the actions taken.

b. Provide spare parts for each different item of material and equipment specified, including all parts recommended by the manufacturer to be replaced after [1 year][and][3 years]service. Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply. List of all special tools, instruments, accessories, and special lifting and handling devices required for periodic maintenance, repair, adjustment, and calibration.

c. Include the following information in either the manual or manufacturer literature that contains the information and furnish it with the O&M Manuals. Include in each manual an index listing the contents. Bind all manuals in sturdy three-ring, loose-leaf binders. Provide copies of the O&M Manuals and the manufacturer's literature in electronic format.

(1) Submit [six][_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, normal operation, short- and long-term deactivation, and shutdown. Include an introduction and overall equipment description, purpose, functions, and simplified theory of operation in the beginning of the instructions. Include within theinstructions the manufacturer's name, model number, service manual, parts list and brief description of each piece of equipment and its basic theory and operating features. Include within the instructions piping and component layouts and wiring and control diagrams for the systems as installed. Reflect all performance test data in the operating instructions.

(2) Submit [six][_____] complete copies of maintenance instructions listing routine maintenance procedures, calibration procedures, possible breakdowns and repairs and troubleshooting guides. Include procedures for cleaning and removal of scale.

-- End of Section --