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USACE / NAVFAC / AFCEC / NASA **UFGS-43 31 13.14 (October 2007)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2017
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SECTION 43 31 13.14

DOWNFLOW LIQUID ACTIVATED CARBON ADSORPTION UNITS

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 43 31 13.14

DOWNFLOW LIQUID ACTIVATED CARBON ADSORPTION UNITS
10/07

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NOTE: This guide specification covers the requirements for systems to transfer organic contaminants from water to activated carbon adsorption media.

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

1.1 UNIT PRICES

****
NOTE: On many hazardous toxic radioactive waste (HTRW) projects, water treatment is required. Measurement and payment and unit pricing may be necessary to cover treatment costs.
****

Payment for water treated will be as described in the Payment Schedule of the Bid Form. Unit payment for each modular activated carbon unit will include delivery, installation and placement in service. Unit payment for [reactivation] [disposal] and replacement of the activated carbon will include placement of the spare unit in service, disconnection of the exhausted unit, drainage and treatment of the free water, transport of the

activated carbon [to and from reactivation] [to the disposal] facility, [reactivation] [disposal and replacement] of the activated carbon and placement of the fresh carbon filled unit in the spare position.

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 WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA B600	(2016) Powdered Activated Carbon
AWWA B604	(2012) Granular Activated Carbon
AWWA B605	(2013) Reactivation of Granular Activated Carbon
AWWA C504	(2015) Standard for Rubber-Seated Butterfly Valves
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service
AWWA C700	(2015) Standard for Cold Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(2015) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2011) Welded Steel Tanks for Water Storage
AWWA D102	(2014) Coating Steel Water-Storage Tanks

AWWA D120	(2009) Thermosetting Fiberglass-Reinforced Plastic Tanks

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2015) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A312/A312M	(2016a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A530/A530M	(2012) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A666	(2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D1998	(2013) Polyethylene Upright Storage Tanks
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2652	(2011) Activated Carbon
ASTM D2854	(2009; R 2014) Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

ASTM D3860	(1998; R 2014) Determination of Adsorptive Capacity of Activated Carbon by Aqueous Phase Isotherm Technique
ASTM D4607	(2014) Determination of Iodine Number of Activated Carbon
ASTM D5158	(1998; R 2013) Determination of the Particle Size of Powdered Activated Carbon by Air Jet Sieving
ASTM D5421	(2015) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM E1067/E1067M	(2011) Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
ASTM F593	(2013a; E 2016) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

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

MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2011) Industrial Control and Systems: Enclosures
NEMA MG 1	(2016) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2013) Seismic Design for Buildings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Adsorption Battery Components

Backwash System

Carbon Storage and Transfer System

SD-03 Product Data

Activated Carbon Adsorption Units

Activated Carbon; G[, [_____]]

Material Safety Data Sheet

Adsorption Battery Components; G[, [_____]]

Posting Framed Instructions

Delivery, Storage, and Handling

Discharge

SD-05 Design Data

Activated Carbon Adsorption Units; G[, [_____]]

Activated Carbon; G[, [_____]]

SD-06 Test Reports

Activated Carbon

Adsorption Battery components

Backwash System

Carbon Storage and Transfer System

SD-07 Certificates

Activated Carbon

Shells and Tanks

Shell and Tank Foundations

Motors

SD-10 Operation and Maintenance Data

Activated Carbon Adsorption System; G[, [_____]]

Operation and Maintenance Data in accordance with Section 01 78 23 OPERATION MAINTENANCE DATA, Data Package [2] [3].

1.4 QUALIFICATIONS

1.4.1 Regulatory Requirements

Pressure rated adsorption shells shall bear the ASME BPVC SEC VIII D1 code stamp.

1.4.2 Contractor

Contractor shall have had a cumulative minimum of [2] [3] [5] [_____] years of experience in the construction of water treatment plants, wastewater treatment plants, industrial wastewater treatment plants, or industrial wastewater pretreatment plants.

1.4.3 Single Source Supplier

Assign full responsibility for the furnishing of the adsorption system to a single supplier. The designated single supplier, however, need not

manufacture the system but shall coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

1.4.4 Manufacturer's Representative

Provide the services of a manufacturer's field service 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.

1.4.5 Welding

Welding qualifications of welding procedures, welders, and welding operators shall be in accordance with Sections 8.2 and 8.8 of AWWA D100.

1.4.6 Reactivation Facility

Qualifications of reactivation facility procedures and operation shall be in accordance with AWWA B605.

1.5 PRE-INSTALLATION MEETING

****
NOTE: Remove this paragraph when meeting is not required.
****

[Partnering] [Pre-installation] meeting will be required. Ensure that involved subcontractors, suppliers, and manufacturers are [notified] [represented]. Furnish the date and time of the meeting to the Contracting Officer for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

Submit instructions for any required sampling, preparation and shipping of activated carbon to reactivation or disposal facility. [Materials] [Materials and each chemical] delivered to the site shall be accompanied by a copy of the material safety data sheet. Submit the material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for [activated carbon] [activated carbon and each chemical]

1.6.1 Granular Activated Carbon

****
NOTE: Activated carbon used in treatment of water for potable use should conform to AWWA requirements. Wastewater carbon is not manufactured to AWWA standards. Remove or reword this paragraph when carbon is not required to conform to AWWA.
****

Granular activated carbon for potable water treatment shall be packaged, marked, and shipped in accordance with [AWWA B604], [AWWA B604 and AWWA B605].

1.6.2 Powdered Activated Carbon

****
NOTE: Activated carbon used in treatment of water

for potable use should conform to AWWA requirements. Wastewater carbon is not manufactured to AWWA standards. Remove or reword this paragraph when carbon is not required to conform to AWWA.

****

Powdered activated carbon for potable water treatment shall be packaged, marked, and shipped in accordance with AWWA B600.

1.6.3 Equipment and Accessories

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 SEQUENCING AND SCHEDULING

****

NOTE: Head conditions for the influent pumps, backwash pumps and carbon slurry transfer pumps specified in Section 43 21 13 PUMPS: WATER, CENTRIFUGAL or Section 43 21 39 PUMPS: WATER, VERTICAL TURBINE depend on the head losses encountered in the equipment specified in this Section.

****

Sampling and analyses to demonstrate system performance and effluent compliance shall be performed in accordance with requirements developed in compliance with Section 01 35 45.00 10 CHEMICAL DATA QUALITY CONTROL.

1.8 EXTRA MATERIALS

Provide special tools necessary for adjustment, operation, maintenance, and disassembly for each type of equipment furnished; a lever type grease gun or other lubricating device for each type of grease required; and one or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Tools shall be high-grade, smooth, forged, alloy, tool steel. Tools shall be delivered at the same time as the equipment and handed over on completion of the work.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide an activated carbon adsorption units system as a complete process for removal of organic and inorganic contaminants from water as specified herein. Equipment shall include, but shall not be limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology shall be in conformance with ASTM D2652.

2.1.1 System Submittals

Submit the following data:

a. Process flow diagrams and instrumentation diagrams(s) showing all major pieces of process equipment with controls. Show on the drawings complete piping, wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will

properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances; equipment relationship to other parts of the work; clearances for maintenance and operation; and shop and erection details, including cuts, copes, connections, holes, bolts, and welds.

b. List of Federal, State, and local laws, regulations, and permits concerning activated carbon adsorption units that are applicable to operations and the requirements imposed by those laws, regulations, and permits.

c. Instrumentation and controls; capacities and pressure drop; make and model; complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions.

d. A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] and [3] year(s) of service.

e. Structural calculations for the adsorber shells, tanks and mounting and support details. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that the fabrication drawings and pressure calculations for the shells and tanks were designed for the listed conditions in accordance with the appropriate codes and standards.

f. Designs for foundations, footings and supports. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that the erection drawings for the shell and tank foundations and supports were designed for the listed conditions in accordance with the appropriate codes and standards.

g. Submit removal and replacement instructions including handling and reactivation of spent activated carbon in accordance with AWWA B605.

2.1.2 Design Requirements

****

NOTE: Determine wind speed from ASCE 7, Chapter 1. Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase in the first paragraph if seismic details are not provided. Pertinent portions of UFC 3-310-04 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, properly edited, must be included in the contract documents.

****

Seismic details shall be in accordance with UFC 3-310-04 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown on the drawings].

a. Minimum design life, modular unit: [_____] years. Minimum design life, other equipment: [_____] years

b. Adsorption system dimensions:
(1) Maximum vertical projection: [_____] m ft
(2) Maximum ground surface coverage: [_____] by [_____] m ft

c. Soil bearing capacity: [_____] MPa psf

d. Seismic parameters: [_____]

e. Wind speed (maximum): [_____] km/h mph

f. Ground snow load: [_____] kPa psf

g. Ambient air temperature:
(1) Maximum: [_____]degrees C F
(2) Minimum: [_____]degrees C F

2.1.3 Influent Chemical Conditions

****

NOTE: Obtain an analysis of the water to be treated giving appropriate information to be inserted in the blank spaces. Provide all the available information. Average values for inorganic constituents may be adequate if additional information is not available.

Use of activated carbon for filtration is rarely cost effective. Plain or enhanced sedimentation is the preferred method for removal of suspended solids. Length of runs between backwash cycles and the media capacity may be reduced by biological activity or physical plugging which may result from continuous application of iron bearing or bioactive turbid waters to the adsorption unit. Activated carbon is fouled by growth on the media and formation of deposits on the carbon surface. Iron in the ferrous state may pass through the system. Ferric compounds are insoluble over a pH range of about 3 to 8, the pH range of most water supplies. Manganese is insoluble at a pH of 9 or greater. Pretreatment should be evaluated if iron exceeds 0.2 mg/L, manganese exceeds 0.1 mg/L, calcium exceeds 80 mg/L or magnesium exceeds 40 mg/L.

Lowering the pH by addition of mineral acids has been used to decrease the hydrogen bonding of dissolved organics and to increase metal solubility.

Raw water should be coagulated and filtered if the suspended solids exceed 5 mg/L (ppm) or if the turbidity exceeds 2.5 NTU. Prefiltration may aid in reducing deposition of iron or manganese.

Oxidizing agents, commonly chlorine or oxygen, may

result in a loss of volume capacity and more frequent replacement of the media. Sources of oxidizing agents should be removed where feasible.

****

Influent inorganic chemical concentrations of [waste water] [water from surface impoundment] [ground water] are as determined by the AWWA 10084 method for each.

Influent Characteristic	Minimum	Average	Maximum
pH	[_____]	[_____]	[_____]
Conductivity (mho)	[_____]	[_____]	[_____]
Total hardness (mg/L as CaCO3)	[_____]	[_____]	[_____]
Total Iron (mg/L)	[_____]	[_____]	[_____]
Ferric Iron (mg/L)	[_____]	[_____]	[_____]
Ferrous Iron (mg/L)	[_____]	[_____]	[_____]
Total Manganese (mg/L)	[_____]	[_____]	[_____]
Soluble Manganese (mg/L)	[-----]	[_____]	[_____]
Calcium (mg/L)	[_____]	[_____]	[_____]
Magnesium (mg/L)	[_____]	[_____]	[_____]
Sodium (mg/L)	[_____]	[_____]	[_____]
Potassium (mg/L)	[_____]	[_____]	[_____]
Copper (mg/L)	[_____]	[_____]	[_____]
Total alkalinity (mg/L as CaCO3)	[_____]	[_____]	[_____]
Hydroxide alkalinity (mg/L as CaCO3)	[_____]	[_____]	[_____]
Carbonate (mg/L as CaCO3)	[_____]	[_____]	[_____]
Bicarbonate (mg/L as CaCO3)	[_____]	[_____]	[_____]
Sulfate (mg/L)	[_____]	[_____]	[_____]
Nitrate (mg/L)	[_____]	[_____]	[_____]
Chloride (mg/L)	[_____]	[_____]	[_____]
Fluoride (mg/L)	[_____]	[_____]	[_____]

Influent Characteristic	Minimum	Average	Maximum
Free Carbon Dioxide as CaC03 (mg/L)	[_____]	[_____]	[_____]
Dissolved Oxygen (mg/L)	[_____]	[_____]	[_____]
Free Chlorine Residual (mg/L)	[_____]	[_____]	[_____]
Silica (mg/L)	[_____]	[_____]	[_____]
Total Solids (mg/L)	[_____]	[_____]	[_____]
Total Dissolved Solids (mg/L)	[_____]	[_____]	[_____]
Total Suspended Solids (mg/L)	[_____]	[_____]	[_____]
Turbidity/Nephelometric Turbidity units (NTU)	[_____]	[_____]	[_____]
Color by Platinum Standard Comparison	[_____]	[_____]	[_____]

2.1.4 Performance Requirements

a. Flow rate:

Minimum [_____] L/second gpm
Average [_____] L/second gpm
Maximum [_____] L/second gpm

b. Water temperature:

Minimum [_____] degrees C degrees F
Average [_____] degrees C degrees F
Maximum [_____] degrees C degrees F

2.1.5 Bench Scale Data

****
NOTE: Include results, require performance of tests or both.
****

2.1.5.1 Isotherm Data

Results of isotherm tests, as determined by ASTM D3860, are as follows: [_____]. The isotherm test data shall be carried out with activated carbon similar to that to be supplied for use. If applicable, reprocessed/ reactivated carbon typical of the type to be supplied will be used in the isotherm tests, including the same type of manufacture if from processed coal, coconut shell, wood, etc.

2.1.5.2 Operating Performance Data

Results of operating performance tests are as follows: [_____].

2.1.5.3 Carbon Equivalency Test Data

Results of carbon equivalency tests are as follows: [_____].

2.1.6 Organic Contaminant Concentrations

****

NOTE: Water treated for potable use should meet the maximum contaminant level goals (MCLGs) of 40 CFR 141 for each identified organic contaminant. Additional requirements for potable water may be imposed by regulators or the Army Center for Health Promotion and Preventive Medicine. Because concentrated organic solutions are more readily treated than dilute solutions, overstatement of the influent concentrations of organic chemicals usually leads to problems. It is more prudent to increase the contact requirement in Paragraph: ADSORPTION BATTERY COMPONENTS and not apply safety factors here.

****

Organic Contaminant		
Influent Concentration (µg/Lppb	Maximum Effluent Concentration (µg/Lppb)	Percent Removal Requirment
Total Organic Carbon (TOC)		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA

Organic Contaminant		
Influent Concentration (µg/Lppb	Maximum Effluent Concentration (µg/Lppb)	Percent Removal Requirment
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]

Determine removal percentage as follows:

$$\frac{100\% \times (\text{Influent concentration} - \text{Effluent concentration})}{\text{Influent concentration}}$$

2.1.7 Inorganic Contaminant Concentrations

****

NOTE: Activated carbon treatment of inorganics is specialized. Try to find more than one manufacturer of activated carbon that can treat the contaminants.

****

Inorganic Contaminant		
Influent Concentration (µg/Lppb)	Maximum Effluent Concentration (µg/Lppb)	Percent Removal Requirment
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]

Inorganic Contaminant		
Influent Concentration (µg/Lppb)	Maximum Effluent Concentration (µg/Lppb)	Percent Removal Requirment
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]

Removal percentage will be determined as follows:

$$\frac{100\% \times (\text{Influent concentration} - \text{Effluent concentration})}{\text{Influent concentration}}$$

2.2 MATERIALS AND EQUIPMENT

****

NOTE: Completeness of steam regeneration is pressure/temperature dependent.

****

Provide materials and equipment which are new and unused with the exceptions noted for reprocessed activated carbon, reprocessed materials and modular treatment units. An estimate or analysis of the pre-existing "heel" and the nature of any residual will be provided with the supply documentation if reprocessed carbon is to be supplied. The Contracting Officer will have the option to refuse delivery of reprocessed carbon if, in the opinion of the Contracting Officer, the quality might interfere with accomplishment or verification of the treatment.

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 items that have been in satisfactory use for at least 2 years prior to bid opening. Materials and equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Nameplates

Adsorption shells, pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.3 MEDIA

2.3.1 Activated Carbon

****

NOTE: To determine the working capacity of a specific brand of activated carbon: Determine the

contact time (inverse of reaction rate) for the particular brand of carbon at the known total volatile organic content in the influent water and determine the amount of carbon required (isotherms) to obtain the reduction of the known volatile organic carbon content in the influent water.

****

Material shall be free from impurities that affect the serviceability and appearance of the finished product. Activated carbon shall not require dosing or addition of a chemical mixture or solution to the water to be treated or to the water used for backwashing. The following quantity: [[_____] cubic meters cubic feet] [[_____] kg pounds] of processed and graded activated carbon shall be furnished for [potable] [waste] water treatment. Submit design calculations indicating removals of each of the listed compounds in the carbon bed. Material shall conform to the following:

a. Adsorptive capacity, iodine number as determined by ASTM D4607, not less than [500] [650] [900] [950] [1,000] [_____] milligrams per gram. Submit the iodine number; isotherm and column test data.

b. Apparent density, as determined by [ASTM D2854] [ASTM D5158], [0.4 to 0.6] [_____] grams per cc [25 to 37] [_____] lb. per cu. ft, corrected for moisture.

c. Effective size [0.35 to 1.30] [_____] mm [0.14 to 0.5] [_____] inches and uniformity coefficient not greater than [2.1] [_____], as determined by ASTM D2862, with the following gradation:

Sieve	2.36 mm No. 8	[90]	[_____] percent passing.
Sieve	2.00 mm No. 10		[_____] percent passing.
Sieve	1.70 mm No. 12	[85]	[_____] percent passing.
Sieve	1.40 mm No. 14		[_____] percent passing.
Sieve	1.18 mm No. 16		[_____] percent passing.
Sieve	0.85 mm No. 20		[_____] percent passing.
Sieve	0.60 mm No. 30	[4]	[_____] percent passing.
Sieve	0.42 mm No. 40	[4]	[_____] percent passing.
Sieve	0.30 mm No. 50	[4]	[_____] percent passing.

d. Submit manufacturer's certificates, including the name and address of the production facility, attesting that the activated carbon furnished meets the specified requirements. Certification of the activated carbon [supplier] [transporter] [reactivation facility in accordance with AWWA B605]. Copies of the Department of Transportation licenses of carbon reactivation service

2.3.2 Powdered Activated Carbon

Powdered activated carbon for potable water service shall conform to AWWA B600.

2.3.3 Granular Activated Carbon

****

NOTE: Activated carbon should be in accordance with AWWA if the treated water goes into a potable water system. Verify with the appropriate authorities that wastewater carbon is acceptable for water that

is to be discharged or re-injected.
****

Granules shall be clean and hard.

2.3.3.1 Potable Water Service

Granular activated carbon for potable water service shall conform to [AWWA B604] [AWWA B604 and AWWA B605],as appropriate. Submit reports of testing granular activated carbon in accordance with AWWA B604.

2.3.3.2 Waste Water Service

Granular activated carbon for waste water service [may be reprocessed from previous use if it meets the specified requirements] [shall be of a type suitable for reactivation] and supported by services for transportation of [shell] [and spent carbon] and reactivation [of spent carbon]. Documentation and copies of licenses shall be furnished to the Contracting Officer.

2.4 ADSORPTION BATTERY COMPONENTS

****

NOTE: See EM 1110-1-4008 Liquid Process Piping for compatibility of materials with the solution being treated. General rules for configuration of a liquid phase activated carbon system are as follows:

a. Two stage serial operation to provide longer contact and more complete exhaustion of the carbon is preferred, particularly when anticipated carbon consumption is high, required bed depths exceed 4.5 meters 15 feet and/or contact times in excess of 30 minutes are required for contaminant reduction. In serial operation, the unit with the freshest carbon at any given time should be in the lag position. For critical operations, lead, lag and standby units should be provided.

b. Multiple units in parallel operation are frequently used for high flows with low contamination levels when short contact times are adequate. Single units should be used only in installations in which the system can be shut down for change out of the activated carbon adsorption media. Multiple smaller units are always preferable to single large units containing the same amount of carbon and providing equal contact.

c. upflow Upflow pulsed bed operation should be considered in lieu of multiple units in series.

d. An appropriate piping configuration arrangement can adapt the units for serial or parallel operation. Arrangements that allow conversion from parallel to series and the reverse, provide the flexibility to respond to differing conditions.

e. Design surface loadings range between 0.7 and 4

liters per second per square meter 1 and 6 gpm/sq ft. Lower surface loadings result in longer runs between backwashes and higher backwash flow rate requirements.

f. Minimum bed depth is based on the contact time required to achieve the required removal. Additional bed volume allows time between carbon changes. The minimum bed depth specified should not be less than 0.75 m 30 inches to avoid short circuiting. Minimum freeboard above the bed shall be not less than 25 percent of bed depth. At loading rates between 3.4 and 4 liters per second per square meter 5 and 6 gpm/sq ft the minimum bed depth should be increased from 0.75 m 30 inches to 1 m 36 inches in proportion to the surface loading to maintain the volumetric loading below 4.5 liters per second per cubic meter 2 gpm per cubic foot.

g. Coordinate number and location of units with the appropriate drawings.

****

Adsorption battery shall consist of [_____] units. Performance specified shall refer to each unit and not to the battery as a whole. Adsorption unit shall be a downflow liquid adsorption unit, having a capacity to treat [_____] liters gallons of water at a flow rate not exceeding [_____] L/second gpm with a maximum influent total organic carbon concentration of [_____] [milligrams] [micrograms] per liter during the interval between carbon replacements to a maximum effluent total organic carbon concentration of [_____] [milligrams] [micrograms] per liter. Intervals between carbon replacements shall be not less than [_____] days.

2.4.1 Head Loss

****

NOTE: Compare several manufacturers data and select a reasonable number.

****

Head loss in each unit at rated flow shall not exceed [2] [3] [7] [30] [60] [_____] kPa [0.3] [0.44] [1] [4] [8] [_____] psig when filled with fresh media. Submit demonstration of, or design calculations for, the total head loss through the carbon, adsorbers and appurtenant piping.

2.4.2 Adsorption Shell

****

NOTE: Avoid pressurizing shells that do not conform to ASME BPVC SEC VIII.

****

Each adsorber shell shall have a minimum effective cross sectional area of [_____] square meters square feet with a minimum straight shell (tangent line to tangent line) height of [_____] meters feet.

2.4.2.1 Modular units

****

NOTE: Transportable units should be considered for units containing less than 900 kg 2000 pounds of activated carbon and the required hydraulic capacity is less than 600 liters per second 10,000 gpm or the appropriate configuration is a standard product of a nearby supplier. Spare units are used for replacement of exhausted units, which are returned to the carbon manufacturer for reactivation of the activated carbon. Drum style containers may be used for very small amounts of carbon.

****

Modular units need not be new if pressure rating and all other requirements of this section are met. Units shall be factory assembled and secured to a structural frame suitable for shipment or transport with a forklift and set on a level area for operation. Unit shall be prepared for connection to on-site pipelines. Shell shall be mounted on skid supports of cast-iron or steel to support the weight of the units, carbon and water while in service without point bearing on the floor slab. Skid mountings and shells shall be fabricated for the live and dead loads of the shell full of water. Assembly structure shall be adequate to provide support to the units during transport. Connectors shall be provided for connection of modular tank inlets and outlets to the permanent piping system. Modular units shall be acceptable under [AWWA B605] [Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS] for transport of spent carbon.

2.4.2.2 Permanent Units

Adsorption shells not equipped with an open vent or overflow shall be steel,designed, fabricated, and erected in accordance with ASME BPVC SEC VIII D1 for a gage working pressure of [8.8] [_____] MPa [125] [_____] psi and shall be so stamped. Adsorption shells equipped with an open vent or overflow may be fiberglass or polyethylene. Fiberglass shells shall be in accordance with AWWA D120 or with ASTM D3299 with nozzle flanges in accordance with ASTM D5421. Polyethylene shells shall conform to ASTM D1998. Steel shell and both sides of false bottom shall be lined with nontoxic epoxy, vinyl ester or rubber. Shell shall have supports of cast-iron or steel. Supporting structures and shells shall be fabricated for the seismic and wind loads listed in the design requirements, plus live and dead loads of the shell full of water.

2.4.2.3 Connections

A vent and a rupture disc shall be provided on the influent of each adsorber. Each adsorber shall have provisions for carbon fill and removal and with permanent connections for water inlet, outlet, and backwash.

2.4.2.4 Openings

****

NOTE: Access openings 100 by 150 mm 4 x 6 inches or larger will be provided in upper head of shells less than 0.9 meter 36 inches in diameter; access openings 275 by 400 mm 11 x 15 inches or larger will be provided for shells 0.9 meters 36 inches in diameter and larger.

****

Each shell shall be provided with an access opening [100 x 150] [275 x 375]

[_____] mm [4 x 6] [11 x 15] [_____] inches or larger. Openings shall be provided with closure and positive seal adequate for the tank pressure rating.

2.4.2.5 Hardware

Bolts and attaching hardware shall be stainless steel, conforming with ASTM F593.

2.4.3 Collection/Underdrain System

****
NOTE: Select appropriate system and remove subparagraphs describing systems not needed in the project.
****

Underdrain system within the shell for collecting treated water shall be as specified below and shall distribute the backwash water uniformly over the entire bed cross-section at velocities that will prevent channeling of the carbon bed. Under actual operating conditions the activated carbon shall not be washed out of the apparatus regardless of the change of demand rate up to the maximum on the apparatus.

2.4.3.1 Nozzle Type

A collector/backwash nozzle shall be provided for each [93,000] [_____] square mm [1] [_____] square foot of carbon surface area.

2.4.3.2 Deflector-Plate Type

****
NOTE: Shells smaller than 1500 mm 60 inches in diameter will be equipped with nozzles or deflector-plate collector system.
****

Deflector-plate type shall be [cast-iron] [or] [steel], and [rubber] [or] [nontoxic epoxy] lined, fastened to the bottom of the shell, and arranged for discharge through radial slots. Pipe connections for treated water outlet or backwash inlet shall be on the underside between the deflector and the shell bottom.

2.4.3.3 False Bottom Type

****
NOTE: Shells larger than 1500 mm 60 inches in diameter may be equipped with false-bottom or header-lateral-distributor type collector system.
****

False bottom type shall consist of a false bottom with attached strainers. Strainers and fasteners shall be stainless steel.

2.4.3.4 Header-Lateral-Distributor Head Type

****
NOTE: The false bottom or header-lateral-distributor head type will be allowed

for all shells 900 mm 36 inches in diameter or larger.

****

Header-lateral-distributor head type shall consist of a circular, square or branched manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radially so as to discharge horizontally or downward. Headers and laterals shall be [stainless steel, conforming to ASTM A312/A312M and ASTM A530/A530M] [polyvinyl chloride, conforming to ASTM D1785 or ASTM D2241]. Strainer heads and strainers shall be manufactured of materials compatible with the header-lateral system, and shall be polyethylene, polypropylene, polyvinyl chloride or stainless steel. Laterals and strainer heads, after being placed, shall not protrude into the header or laterals. System shall be supported by [a steel plate or steel angles conforming to ASTM A666with [vinyl ester] [nontoxic epoxy] [or rubber] linings] [or by] [concrete fill] [or] [directly on the bottom of the shell].

2.5 MODE OF OPERATION

2.5.1 Serial Operation

Each unit shall have valves on the influent, effluent and backwash connections to allow any unit to operate and function as the lead or lag unit or stand-by as required.

2.5.2 Parallel Operation

Each of the parallel units shall have valves on the influent, effluent and backwash connections adequate to allow the unit to be taken out of service to backwash or change out the activated carbon in the unit without affecting the operation of the other units.

2.5.3 Parallel or Serial Operation

****

NOTE: CAD typical detail drawings G02101I showing isometrics and G02101E showing elevations of activated carbon units for parallel or series modes is available in the library of typical drawings maintained by the Waterways Experiment Station.

****

Units designated for use in either series or parallel operation shall have valves on the connections that allow switching between modes of operation without disconnecting any of the piping.

2.6 TOTAL ORGANIC CARBON ANALYZER

****

NOTE: Optimum operation for serial operation would be for the lead column to be operated until the influent and effluent are of equal concentration and the carbon bed is completely spent. The combination of a predictable influent and a well developed sampling program would eliminate the need for the on-line analyzer.

****

A wall mounted analyzer for automatically testing the total organic carbon content of the water shall be installed in the effluent line leading from each adsorption unit. The analyzer shall be capable of carrying out intermittent tests on the effluent and of giving visual warning that the residual organic carbon present exceeds a predetermined limit. Analyzer shall be equipped with necessary wiring and [controls for automatic alternation of units] [an alarm device to give notice] when the total organic carbon in the water delivered by the lead adsorption unit exceeds [_____] [milligrams] [micrograms] per liter [ppm] [ppb].

2.7 WATER METER

Each adsorption unit shall be provided with a displacement or turbine-type water meter reading in [_____] liters gallons, conforming to AWWA C700 or AWWA C701 as appropriate. Meter shall be installed in the adsorption unit [influent line] [effluent line] and shall be so located as to be readily accessible for reading and setting. Meter contacts shall be infinitely adjustable over the range of the meter to permit setting to suit actual total organic carbon content of the water being treated. Meter shall be equipped with necessary wiring and electric controls for automatic backwashing or an alarm device to give notice when the adsorber has delivered [_____] liters gallons of water.

2.8 DIFFERENTIAL PRESSURE SENSOR

Differential pressure sensor shall be capable of measuring plus or minus 5 percent variation in the pressure drop across the media. Sensor shall be equipped with necessary wiring and controls for automatic backwashing or an alarm device to give notice when the pressure differential exceeds the set point.

2.9 INTERLOCKS AND ALARMS

Interlock system shall be provided to prevent backwashing of more than one unit at a time and to prevent backwashing when the waste backwash tank capacity is inadequate to contain an additional backwash. A manual-reset alarm timer shall be provided on the backwash control panel for timing backwash cycles. Alarm lights shall be located on the local control panel and duplicated on a panel in the main control room. Audible annunciator shall be located above the appropriate vessel with an automatically resetting waterproof manual shut-off located with no obstructions to access [_____] [1.2] m [_____] [4] feet above grade.

2.10 PRESSURE GAUGES AND SAMPLING COCKS

2.10.1 Pressure Gauges

Pressure gauges connected to the influent and effluent to indicate the pressure loss through the adsorber and its pipe, valve, and fitting assembly shall be furnished for each adsorption unit. Gauges shall be precision type with bronze Bourdon tube and phenolic case and an accuracy of plus or minus 1/2 percent conforming to ASME B40.100.

2.10.2 Sampling Cocks and Valves

[Steel,] [PVC] [or] [brass], ground key, lever handle, faucet type sampling cocks or ball valves shall be provided upstream of the adsorbers and on the downstream side of each unit for sampling the influent and the effluent of each of the individual adsorbers.

2.11 VALVES

****
NOTE: The inapplicable types of operation will be deleted.
****

Design of the valve operators and mechanisms shall avoid initial surges and sudden inrushes of influent or backwash by gradually allowing flows to increase as ports are opened. A dial pointer shall indicate each step of the operation.

2.11.1 Butterfly Valves

Butterfly valves 75 through 1,800 mm 3 through 72 inches shall conform to AWWA C504.

2.11.2 Gate Valves

Gate valves less than 75 mm 3 inches in diameter shall be bronze with screwed ends, conforming to MSS SP-70 and valves 75 mm 3 inches or larger shall conform to AWWA C509. Valves shall open counter clockwise, and the operating wheel shall have an arrow, cast in the metal, indicating the direction of opening.

2.11.3 Package-Type Valve Nest

Package-type valve nest shall consist of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or pneumatically operated. Nest of valves shall have connections to raw water inlet, treated water outlet, backwash inlet and outlet, and activated carbon refill inlet and outlet.

2.11.4 Ball Valves

Full port stainless steel ball valves shall be provided on carbon fill and discharge lines.

2.12 ISOLATION JOINTS

2.12.1 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.12.2 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.12.2.1 Sleeve-type Couplings

Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

2.12.2.2 Split-sleeve Type Couplings

Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.13 PIPE AND FITTINGS

Pipe hangers and supports shall be in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING. Pipe, valves and fittings for liquids shall be in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING. Pipe, valves and fittings for compressed air shall be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.14 BOLTS, NUTS, AND FASTENERS

Bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment shall be furnished with the equipment and shall be galvanized unless otherwise indicated. Where indicated, specified, or required, anchor bolts shall be provided with square plates at least 100 by 100 by 9 mm 4 by 4 by 3/8 inch thick or shall have square heads and washers and be set in the concrete forms with suitable sleeves. Expansion bolts shall have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts shall be of refined bar iron. All threads shall conform to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A123/A123M or ASTM A153/A153M. Bolts, anchor bolts, nuts, and washers indicated to be stainless steel shall be Type 316 stainless steel.

2.15 ELECTRICAL WORK

****
NOTE: Carbon dust is conductive and ignitable and can form explosive mixtures with air. Coordinate hazard areas with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and the drawings. AWWA calls for water tight enclosures.
****

Hazard classifications indicated on the drawings shall be implemented in accordance with NFPA 70. Electrical work shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.15.1 Motors

Electrical motor-driven equipment shall be provided complete with starters and alternating current motors conforming to NEMA MG 1. Fractional horsepower electric motors shall be single-phase 115-volt, single-phase, 60 cycle. Integral horsepower electric motors shall be three-phase, 60 cycle. Motor starters shall be provided complete with properly sized thermal

overload protection and other appurtenances necessary for the motor specified. Each motor shall be designed for operation in a 40 degree C 104 degree F ambient temperature.

2.15.2 Controls and Panels

Manual or automatic controls and protective or signal devices required for the operation specified, and any control wiring required for controls and devices shall be provided. Motor controls shall conform to NEMA ICS 1. Enclosures for power and control panels shall conform to NEMA ICS 6.

2.16 STORAGE TANKS

Each tank shall be fabricated from steel conforming to ASTM A666 not less than 5 mm 3/16 inch thick, lined with enamel, or of fiber glass filament-wound reinforced plastic construction, conforming to ASTM D3299.

2.17 BACKWASH SYSTEM

****

NOTE: The backwash system is a major system that should be shown on the drawings. Four or more adsorbers in parallel may have sufficient effluent flow for backwashing because the backwash flow requirement for a single adsorber is approximately equal to three times the effluent flow. Backwash supply tankage and backwash pumps might not be required if the discharge pressure is adequate. Elimination of waste backwash tankage is rarely feasible.

****

Backwash operation shall be [fully automatic initiated by differential pressure sensors or timers] [semiautomatic initiated manually by a push button switch in response to an alarm connected to a water meter] [manual with operation initiated in response to an alarm connected to a water meter].

2.17.1 Backwash Flow Controller

An adjustable flow control valve shall be installed on the backwash supply header to regulate the flow at any set point between [_____] and [_____] L/second gpm to the backwashing adsorber regardless of variations in upstream head conditions.

2.17.2 Backwash Initiation and Return to Service

[Automatic and semiautomatic controls shall permit backwashing to proceed automatically with no manual assistance.] [Manual backwash and return to service shall be controlled manually by the operator by turning the multiport valve or pilot valve.] Controls shall be subject to convenient and accurate manual adjustment and shall be designed for manual operation in the event of failure of the electrical equipment.

2.17.3 Backwash Supply Tankage

****

NOTE: Each filter is backwashed at approximately 10.2 liters per second per square meter 15 gallons

per minute per square foot to provide 25 to 50 percent bed expansion. Backwash supply 10.2 liters per second x 900 seconds x 2 backwashes for each square meter 15 gpm x 15 minutes x 2 backwashes for each square foot of activated carbon bed surface area.

****

Backwash supply system shall have a minimum effective capacity to provide storage of [_____] liters gallons.

2.17.4 Backwash Waste Holding Tankage

****

NOTE: To provide time for backwash wasting or recycling, the minimum waste backwash holding capacity is 1.5 to 2 times the backwash supply holding capacity.

****

Waste backwash system holding shall have a minimum capacity to provide storage of [_____] liters gallons.

2.17.5 Valves, Switches, and Sensors

Each tank shall be equipped with a [float] [or] [solenoid] operated inlet valve. Solenoid-operated valve shall be activated by a [probe,] [a float-operated switch] [or] [a timer together with a float switch] to automatically shut off the incoming flow in the event of failure of the timing mechanism. Water inlet valves and switches shall be mounted externally. Floats and probes may be mounted internally or externally, in such a manner that the rapid evacuation of the tank will not interfere with their operation.

2.17.6 Pumps

Backwash pump shall be in accordance with Section [43 21 39 PUMPS: WATER, VERTICAL TURBINE] [43 21 13 PUMPS: WATER, CENTRIFUGAL]. Waste backwash return pump shall be in accordance with Section 43 21 13 PUMPS: WATER, CENTRIFUGAL.

2.18 CARBON STORAGE AND TRANSFER SYSTEM

****

NOTE: Most vessels are pneumatically charged directly from the carbon delivery truck. On-site storage and transfer is provided for remote and large systems. The transfer system is a major system that should be shown on the drawings. Activated carbon storage guidelines for medium to large systems: fresh carbon storage should allow for 1 truck + 1 tank of 44,000 kg 20,000 lbs and spent carbon storage should allow for 1 truck + 2 tanks.

****

2.18.1 Fresh Carbon Storage Tanks

A fresh carbon storage system shall be provided. Minimum capacity of the

system shall provide storage of [_____] kg pounds of dry carbon at a bulk density of [_____] kg per cubic meter pounds per cubic foot.

2.18.2 Spent Carbon Storage Tanks

A spent carbon storage supply system shall be provided. Minimum capacity of the system shall provide storage of [_____] kg pounds of wet carbon saturated with organics.

2.18.3 Carbon Slurry Transfer Pump

Carbon slurry transfer pump shall be in accordance with Section 43 21 13 PUMPS: WATER, CENTRIFUGAL.

2.19 FACTORY TESTS

The adsorption system equipment shall be assembled in the shop to the maximum practical extent. A factory pressure test shall be made at [125] [250] [_____] percent of the rated pressure of the equipment. Fiberglass tanks shall be examined in accordance with ASTM E1067/E1067M. Test reports shall be furnished [with the equipment] [to the Contracting Officer prior to shipment of the equipment].

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 EQUIPMENT INSTALLATION

****
NOTE: Pump bases and footings for adsorbers should be located and detailed on the drawings.
****

Each adsorber shell or tank shall be [anchored to a footing isolated from the floor slab] [mounted on a skid base]. Anchor brackets, anchor rods or straps shall be provided to hold the shell to anchors in the footing. Skids shall be fabricated from [cast iron] [or] [steel] channels and shall be designed to support the equipment and to distribute the weight in transit and in service filled with water without point loading on the tank or concrete slab.

3.3 PIPE, VALVES, FITTINGS AND APPURTENANCES

Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING or Section 22 00 00 PLUMBING, GENERAL PURPOSE, as appropriate to the application. Differing metals shall be provided with isolation devices.

3.3.1 Strainers

****
NOTE: This paragraph is needed only for header-lateral-distributor collectors.
****

Strainer heads and strainers shall be protected while concrete fill provided for support of the header-lateral-distributor head is being placed.

3.3.2 Heat Trace and Insulation

Exterior pipe and appurtenances shall be provided with an electrical heat trace and insulated in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.4 ELECTRICAL WORK

Electrical work shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.5 TRANSFER

3.5.1 Onsite

****

NOTE: The flow rate is usually based on a 50 mm 2 inch pipe diameter. Average velocity in the pipe during transfer should be between 0.9 and 2.1 meters 3 and 7 feet per second to maintain the carbon in suspension. Design velocities above 3 meters 10 feet per second result in excessive head losses and unstable operation. The slurry carries between 0.1 and 0.4 kg carbon per liter 0.7 and 3 lbs. carbon per gallon of water.

****

Spent media shall be unloaded from and new media loaded in permanently mounted adsorbers. Carbon slurry shall be transferred between vessels at a rate between [_____] and [_____] L/second gpm.

3.5.2 Offsite Reactivation of Modular Units

Modular units shall be removed from service, disconnected from the permanent piping, drained of free water and returned to the supplier for reactivation.

3.6 PAINTING/CORROSION PREVENTION

All ferrous surfaces shall be coated or painted.

3.6.1 Exterior Surfaces

Factory primed surfaces shall be solvent-cleaned before painting. Surfaces that have not been factory primed shall be prepared and primed in accordance with the paint manufacturer's recommendations. The paint system applied to the outside of the tank shall be in accordance with Section 09 90 00PAINTS AND COATINGS. Color shall be as indicated on the paint schedule or as otherwise approved.

3.6.2 Interior Surfaces

****

NOTE: Some state and local health agencies have listings of acceptable paint materials for the

interior of potable water tanks. Contact the appropriate state and local authorities to determine if the paint systems are acceptable. If these systems are not acceptable, determine the best acceptable system and revise this specification accordingly. Some states require NSF approval for coatings in contact with potable water. The zinc coating system specified in Section 3.8 of AWWA D102 is not acceptable.

****

Tank interior surfaces shall be coated with the coating conforming to Section 3.2, 3.3, 3.4, 3.5, 3.6, or 3.7 of AWWA D102. System of three coats, 0.10 - 0.15 mm 3.9 - 5.9 mils dry film thickness (DFT) per coat, for total of 0.30 - 0.45 mm 11.7 - 17.7 mils minimum DFT.

3.6.3 Touch-Up Painting

Factory painted items shall be touched up as needed. Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material, primed and top-coated with the manufacturer's standard factory finish.

3.6.4 Field Painting

Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.5 Corrosion Resistant Metals

Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required unless otherwise specified.

3.7 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams showing the complete layout of the system shall be posted where directed. 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 shall be prepared in typed form, framed and posted beside the diagrams. Submit wiring and control diagrams, systems layouts and isometrics, instructions, and other sheets, prior to posting. Post the framed instructions before acceptance testing of the systems.

3.8 TESTS

All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of valve openings and seats; all operating mechanisms shall be operated to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

3.8.1 Hydrostatic Tests

****

NOTE: Disinfection of vessels that are supplied

prefilled with carbon is not feasible. The test pressure for vessels supplied with carbon should not exceed the rated pressure. Testing of pipe and fittings should be specified in the same section that the pipe is specified in.

****

After installation, all tanks shall be tested for water tightness. Testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required shall be included. Test pressures shall be [[_____] kPa psi] [as indicated in the schedule]. Piping systems shall be isolated from the tanks for pressure testing at the specified test pressures.

3.8.2 Performance Tests

****

NOTE: The approximate constant flow rate for the operating capacity test will be inserted in the blank spaces provided. For some adsorption units, the tests may be modified as necessary where high capacity activated carbons are used and the total organic carbon is such that complete tests would require abnormally extended periods of time. In such cases this paragraph will be suitably rewritten.

****

After installation of the activated carbon adsorption system, operating tests shall be carried out to assure that the system operates properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests repeated. [Each] [A typical] adsorption unit shall be put through a complete cycle of operation [at a constant flow rate][to exhaustion at a constant flow rate] of approximately [_____] L/second gpm for the capacity test. A complete log of each test run shall be made, giving the following data: date, time of readings and sampling, total backwash, and total water treated. Total organic carbon removed shall be determined by analyses of the influent at such intervals as will give a representative organic carbon content. When the required quantity of water, [_____] liters gallons, has been run through the adsorber, samples shall be taken of the effluent for analysis. Results of the tests shall be used in determining the capacity and performance of the adsorption unit.

3.8.3 Liquid Sampling and Analyses

Influent and effluent samples shall be collected, marked, preserved and analyzed in accordance with the requirements of Section 01 35 45.00 10 CHEMICAL DATA QUALITY CONTROL.

3.8.4 Activated Carbon Sampling and Analyses

Sampling and analyses of the activated carbon media shall be performed in accordance with [requirements for spent carbon transport and requirements of AWWA B605 and of the reactivation facility] [requirements of the RCRA permitted treatment, storage and disposal facility].

3.8.5 Discharge

During the capacity test, treated water shall stored as necessary to maintain the required flow rate. Submit reports for discharge permit

compliance.

3.8.6 Utilities

The obtaining of water, electric power and other utility items as well as the disposal of water drainage are the responsibility of the Contractor.

3.9 MANUFACTURER'S SERVICES

Provide the services of a representative of the manufacturer who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of equipment.

3.10 FIELD TRAINING

Conduct a training course for designated operating, maintenance and support staff members. The training period, for a total of [8] [12] [16] [_____] hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests. Field training shall cover each item contained in the operating and maintenance data.

3.11 MAINTENANCE

Submit a preventive maintenance plan and schedule including routine recommended chemical preventive measures for handling contaminant/biofouling of the carbon adsorption unit under conditions of the application including strong acid/alkali/alternative chemical soaks and instructions for storage and handling of treatment chemicals and waste products.

-- End of Section --